

**WHEN SCIENCE CONTROVERSIES ENCOUNTER POLITICAL
OPPORTUNITIES—COMPARING GMO, HYDROPOWER AND NUCLEAR
POWER CONTENTIONS IN CONTEMPORARY CHINA**

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DISSERTATION ABSTRACT

WHEN SCIENCE CONTROVERSIES ENCOUNTER POLITICAL OPPORTUNITIES—COMPARING GMO, HYDROPOWER AND NUCLEAR POWER CONTENTIONS IN CONTEMPORARY CHINA

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Based on three years' field study and participatory observation, this dissertation traces the development of significant science and technology (S&T) controversies – hydropower resistance, genetically modified organisms (GMOs) dispute, and nuclear power debate – in contemporary China and analyzed communication, sociopolitical and knowledge factors associated with their emergence and evolution. A significant contribution of the current study is to adopt social movement theories to examine the appearance, amplification, evolution and the development of science controversies while fully considering communication and knowledge control patterns.

My study reveals that in China, major public S&T controversies are far more than a product of poor public understanding of science or people's emotional rejection of potentially hazardous technologies. Instead, both the widespread GMO controversy and the relatively more elitist campaigns against hydropower and nuclear power resulted from a combination of factors including the changing media environment, emerging political opportunities, the varying knowledge-control regime, and activists' strategic and

structural treatment of political opportunities and their effort to break existing knowledge-control regimes.

The resistance to hydropower controversy was a concentrated reflection of rising environmentalism and environmental NGOs which have effectively utilized emerging public environmental awareness, bureaucratic fragmentation, media needs for higher public attention, and shackled knowledge-control regimes, though given the remoteness of the protesting sites and limited public awareness, anti-hydropower activism did not show a high level of public participation. Anti-hydropower activism nearly halted every targeted dam in China.

The GMO controversy, on the other hand, was widely spread in Chinese society, although few established civil society groups were involved, and though scientists increased their efforts to maintain the knowledge-control regime. The fragile science-politics alliance, the fragmentation within central leadership and grave public concerns all created a favorable political opportunity structure for anti-GMO activists. As a result, China's commercialization of GM crops has been effectively suspended.

By contrast, resistance to nuclear power faced both a narrow political opportunity structure and a robust knowledge-control regime, thanks to its link to military purposes, its historical glory, and its strong business-politics alliance, as well as lack of public attention. As a result, the debate only helped to postpone construction of new nuclear power plants temporarily.

This dissertation shows entirely consistent patterns in the different controversies, no matter which theoretical approach is used, indicating the appropriateness of synthesizing these approaches. It will not only enable scholars to understand contemporary

science controversies in China more comprehensively but also provide a chance to explore the integration of different theoretical approaches.

BIOGRAPHICAL SKETCH

Hepeng Jia was a leading science journalist in China from 1999 to 2011. A pioneer in Chinese science journalism and science communication, Hepeng Jia was the former editor-in-chief of *Science News Magazine* published by the Chinese Academy of Sciences. He was also a leading science communication practitioner and had represented Asia as a board member of the World Federation of Science Journalists. He received China's National Award for Science Popularization in 2010 and Purdue University's Science Journalism Laureate in 2011. He has published four books, over 30 peer-reviewed academic papers in science communication both in Chinese and in English, and more than 1,0000 journalistic stories. He obtained his Bachelor of Arts at Beijing-based University of International Relations in 1994 and his Master of Arts at Beijing-based Tsinghua University in 1999.

To Haiyan, Jay, and Daniel.

ACKNOWLEDGMENTS

When drafting this acknowledgment, the last part of my dissertation, I am engulfed by a mixed feeling. It is close to the end of my 7-year academic pursuit. Despite my hard struggle in collecting data and improving writing, this dissertation can hardly be called a satisfactory achievement. While bringing new theoretical threads and vivid material to science and technology controversy studies, the current work leaves many information and intellectual gaps; at this point, however, I have to pause for a while. Luckily, my committee, headed by my chair Professor Bruce Lewenstein, kindly endorsed my dissertation defense, allowing me to start a new era in my academic life.

The struggle between two different objectives is not new in the past seven years, partly because I started my doctoral studies at a time when I had achieved a certain level of professional excellence as a science journalist. However, professional excellence soon proved to be a significant burden to my academic pursuit. A thriving science journalism career had made me focus on analyzing specific sociopolitical factors for my news stories while an academic career forced me to pursue cross-culturally generalizability. This tension is particularly true in American communication scholarship, where the Chinese landscape has always been dimmed. For the first two years of my doctoral studies, I struggled between the objectives.

Another pair of seemingly conflicting goals was between defending science and questioning science's knowledge hegemony by revealing its social construction nature. With my extensive journalistic background and critical thinking, I felt I could be a good STS scholar, but the perceived role of STS scholarship as somewhat anti-science made me very uncomfortable.

In the situation, I should say special thanks to Professor Bruce Lewenstein, my advisor and committee chair, who was always generous in sharing his instructions and insights with me. As a result, I gradually marched to a clearly-tasked, yet balanced zone for academic research. My committee members, Prof. Katherine McComas, and Prof. Stephen Hilgartner from Cornell and Prof. Fa-ti Fan from SUNY Binghamton, also offered great support to me. Among them, Prof. Hilgartner is particularly helpful. He guided me to begin my research from social movement theories during an independent study course with him. The independent study finally shaped my dissertation direction. Prof. Fan and Prof. McComas, on the other hand, offered tremendous help by instructing me on how to link my research to China and risk communication.

I want to thank the Cornell East Asia Program, which generously offered a China field study fellowship to me. This funding enabled me to perform a five-month effective and harvested field study. Other professors in the Department of Communication were also great academic, intellectual, and even personal helpers, no matter whether or not I have taken their courses. Among them, I owe so much to Professors Lee Humphreys and Jonathon Schuldt for their generous guidance on research methods. The chairs of the department – Professors Katherine McComas and Poppy McLeod – and graduate director Prof. Susan Fussell and graduate coordinator Joanna Alario were also super supportive of making me successfully finish the program without encountering any major difficulty.

I should also say thanks to my cohort of graduate students – Dr. Carrie Young, Dr. Hang Lu, and Dr. Hwanseok Song and Julie Davydova – who have helped me a lot in the past years. I still remember Hang's assistance to help me use Qualtrics. Our cohort's tradition of hotpot gathering was particularly an encouraging social activity.

Many Chinese collaborators' supports are crucial to my dissertation project and should be acknowledged. Professor Deng Lifeng of Sun Yat-sen University has generously shared his contacts and insights on China's nuclear power controversy. Sun Yat-sen University also gave a small grant to help my field study in China. Dr. Liu Kai of Beijing Jiaotong University has offered decent data supports to my dissertation during his visit to Cornell. I have made repeated consultation with Dr. Miao Weishan of the Chinese Academy of Social Sciences, my long-time friend and collaborator, on the dissertation outline and many detailed data analyses. Dr. Li Yang of Tsinghua University munificently provided her unpublished social network analysis data on China's GMO debates. Many others supported me either by receiving my interview or providing critical information during my field study. Due to ethical consideration, I cannot disclose their names.

Finally, but perhaps most importantly, my wife Haiyan's great sacrifice, understanding, and support are the unreplaceable resource I have always had in finishing my Ph.D. training. Without her tolerance, I really could not have completed this trip.

TABLE OF CONTENTS

<i>DISSERTATION ABSTRACT</i>	3
<i>BIOGRAPHICAL SKETCH</i>	6
<i>ACKNOWLEDGMENTS</i>	8
<i>TABLE OF CONTENTS</i>	11
<i>TABLE OF FIGURES</i>	16
<i>LIST OF TABLES</i>	17
<i>ABBREVIATION</i>	18
<i>Chapter 1. Science controversies encounter political opportunities</i>	21
<i>1.1 INTRODUCTION</i>	21
<i>1.2 LITERATURE REVIEW</i>	23
1.2.1 S&T controversies in the science communication landscape	23
1.2.2 Epistemic roots of S&T controversies	26
1.2.3 S&T disputes from the perspective of social movement theories	32
1.2.4 Understanding S&T controversies in transitional China	35
<i>1.3 GMO, HYDROPOWER AND NUCLEAR CONTROVERSIES IN CHINA</i>	39
1.3.1 Theoretical case selection	39
1.3.2 Divergent patterns of selected cases	42
1.3.3 From pattern difference to the theoretical comparison	43
<i>1.4 RESEARCH QUESTIONS</i>	45
<i>1.5 DISSERTATION OUTLINE</i>	47
<i>Chapter 2. RESEARCH METHOD AND DATA</i>	49
<i>2.1 INTRODUCTION</i>	49

2.2 DATA COLLECTION AND DESCRIPTION	50
2.2.1 Triangulation and qualitative interviews	50
2.2.2 Mass media coverage data	52
2.2.3 Social media data	56
2.2.4 Partisan website data	60
2.2.5 Other documentation data	62
2.3 MULTILEVEL DATA ANALYSIS	63
2.3.1 Analyzing interview data	63
2.3.2 Analyzing mass media data	64
2.3.3 Analyzing social media data	70
2.3.4 Analyzing data from other sources	72
2.4 ETHICAL CONSIDERATION	72
Chapter 3: Hydropower, fragmentation, and knowledge making	75
3.1 INTRODUCTION	75
3.1.1 “Thick” dikes and dams	75
3.1.2 Social movements against hydropower	77
3.1.3 Knowledge control and hydropower controversy	79
3.2 CONTEMPORARY HYDROPOWER CONTROVERSIES IN CHINA	81
3.2.1 Questioning Three Gorges Dam	81
3.2.2 From Dujiangyan to Tiger Leaping Gorge in southwest China	82
3.2.3 Knowledge Mobilization against hydropower	85
3.3 COMMUNICATION PATTERNS OF HYDROPOWER CONTROVERSY	87
3.3.1 Examining the media’s role in hydropower controversies	87
3.3.2 Media morphology, Internet, and public attention in hydropower controversies	94

3.4 SOCIAL MOVEMENT INTERPRETATION OF HYDROPOWER CONTROVERSY_	101
3.4.1 Examining political opportunity structure for TGP debates_____	101
3.4.2 Southwestern dam debates and fragmented authoritarianism _____	104
3.4.3 Institutions and experts fueling hydropower controversies _____	110
3.4.4 Understanding hydropower controversies with social movement theories _____	112
3.5 CONCEPTUALIZING HYDROPOWER DEBATES IN STS LANDSCAPE_____	115
3.5.1 Knowledge contention and civic epistemology in hydropower controversies_____	116
3.5.2 Knowledge-control regimes and the disintegrated knowledge making _____	120
3.6 CHAPTER CONCLUSION_____	128
Chapter 4: GMO controversy: How orthodox science lost control _____	130
4.1 INTRODUCTION _____	130
4.1.1 Social, psychological and political roots of GMO contentions _____	131
4.1.2 The role of the media in the GMO controversy _____	132
4.1.3 Civic epistemology and knowledge control in GMO controversy _____	133
4.2 CONTEMPORARY GMO CONTROVERSIES IN CHINA_____	135
4.3 MEDIA LANDSCAPE OF GMO CONTROVERSY IN CHINA_____	139
4.3.1 Media liberalization and scientists' communication failure_____	139
4.3.2 GMO debate on rising social media_____	146
4.4 EXAMINING GMO CONTROVERSY AS A SOCIAL MOVEMENT _____	155
4.4.1 Emerging political opportunity structure fueling GMO controversy_____	155
4.4.2 Fragmented bureaucrats as a political opportunity structure _____	161
4.4.3 Anti-GMO framing and mobilization_____	166
4.5 KNOWLEDGE CONTROL AND CONTENTION _____	168
4.5.1 Knowledge-control regime in China's GMO controversy_____	168

4.5.2 Civic epistemology and conspiracy theories _____	175
4.6 CHAPTER CONCLUSIONS _____	178
Chapter 5 Nuclear power debate in a narrow political opportunity structure	180
5.1 INTRODUCTION _____	180
5.1.1 Media framing, public attitude, and anti-nuclear social movements _____	181
5.1.2 Nuclear controversy from the STS perspective _____	183
5.1.3 Public attitude toward nuclear power in China _____	184
5.2 CONTEMPORARY NUCLEAR CONTENTIONS IN CHINA _____	186
5.2.1 China’s national memory of nuclear power _____	186
5.2.2 Emerging anti-nuclear power campaigns _____	188
5.3 MEDIA AND NUCLEAR CONTROVERSY IN CHINA _____	193
5.3.1 Examining conventional media reporting of nuclear power _____	193
5.3.2 Nuclear power controversy in the social media era _____	201
5.4 EXAMINING NUCLEAR CONTENTION AS A SOCIAL MOVEMENT _____	209
5.4.1 Restrictive political opportunity structure _____	209
5.4.2 Fragmented authoritarianism and anti-nuclear activism. _____	216
5.5 STS INTERPRETATION OF NUCLEAR CONTROVERSY IN CHINA _____	219
5.5.1 Knowledge-control regime in China’s nuclear power sector _____	219
5.5.2 Alternative knowledge and challenges to knowledge control _____	226
5.6 CHAPTER SUMMARY _____	233
Chapter 6 Comparing hydropower, GMO and nuclear power controversies	235
6.1 CASE SUMMARY _____	235
6.2 MEDIA AND SCIENCE CONTROVERSIES _____	236
6.3 COMMUNICATION PATTERNS _____	239

6.4 TRACING SOCIOPOLITICAL ROOTS OF SCIENCE CONTROVERSIES	241
6.4.1 Political opportunity structure for science controversies in China	241
6.4.2 Framing and mobilization in the public attention market	246
6.5 EXAMINING KNOWLEDGE-CONTROL REGIMES	251
6.6 COMPARING DIFFERENT PATTERNS	254
6.7 PATTERN DIFFERENCE AND THEORETICAL DEVELOPMENT	258
Chapter 7 Conclusion: Science and technology controversies examined in a multidisciplinary lens	260
7.1 INTERACTIONS OF DIFFERENT THEORETICAL FRAMEWORKS	260
7.1.1 Interaction of different theoretical components in China	260
7.1.2 Interaction of different theoretical frameworks	262
7.2 GENERALIZING STUDY FINDINGS	265
7.3 LIMITATIONS AND FUTURE STUDIES	267
7.4 CONCLUDING REMARKS	269
Reference	271
Appendix 1: Interviewee description and code	318

TABLE OF FIGURES

FIGURE 1 THE INTERSECTING ELEMENTS OF SOCIAL MOVEMENTS	33
FIGURE 2 HYDROPOWER REPORTING BY THE FOUR SAMPLED CHINESE MEDIA (1980-2017)	88
FIGURE 3 HIGH-IMPACT BBS POSTS FOCUSED ON HYDROPOWER (2003-2017)	97
FIGURE 4 GOOGLE SEARCH TRENDS (2004-2018)	99
FIGURE 5 COMBINED HYDROPOWER REPORTING BY FOUR SAMPLE CHINESE MEDIA (2004-2017)	99
FIGURE 6 NUMBER OF THE FOUR SAMPLED MEDIA’S COMBINED ARTICLES ON GMO IN CHINA (1995-2016)	139
FIGURE 7 ATTITUDE OF SAMPLED MEDIA ARTICLES TO GMOs IN CHINA 1995-2016	144
FIGURE 8 PERCENTAGE OF SAMPLED MEDIA ARTICLES ADVERSE TO GMOs IN CHINA 1995-2016	145
FIGURE 9 Baidu MEDIA INDEX OF GMOs IN CHINA (2011-2018)	147
FIGURE 10 Baidu SEARCH INDEX FOR GMOs IN CHINA (2011-2018)	147
FIGURE 11 GOOGLE SEARCH INDEX FOR GMOs IN CHINA (2004-2018)	147
FIGURE 12 HIGH-IMPACT BBS POSTS ON TIANYA (2003-2017)	148
FIGURE 13 POLITICAL OPPORTUNITY STRUCTURE, FRAMING, AND MOBILIZATION IN CHINA’S ANTI-GMO ACTIVISM	167
FIGURE 14 A SOCIAL NETWORK ANALYSIS OF BLOG COMMENTS ON GMO ON SCIENCE.NET.CN	171
FIGURE 15 NUMBER OF THE SAMPLED MEDIA ARTICLES ON NUCLEAR POWER IN CHINA (2000-2017) ...	194
FIGURE 16 COMBINED FOUR SAMPLED CHINESE MEDIA NUCLEAR POWER ARTICLES (2010-2017)	201
FIGURE 17 CHINESE MEDIA ARTICLES MENTIONING NUCLEAR POWER SEARCHED THROUGH Baidu INDEX (2011.01-2019.01)	202
FIGURE 18 Baidu USERS' ONLINE SEARCH OF KEYWORD "NUCLEAR POWER" (201101-201901)	202
FIGURE 19 GOOGLE TREND SHOWING THE ONLINE SEARCH OF THE KEYWORD "NUCLEAR POWER" (IN CHINESE AND CHINA) (200401-201901)	203
FIGURE 20 THE FREQUENCY OF HIGH-IMPACT BBS POST ON “NUCLEAR POWER” (IN CHINESE) ON TIANYA.COM (2003-2017)	203
FIGURE 21 NARROW POLITICAL OPPORTUNITY STRUCTURE, UNFRIENDLY FRAMING AND LOW MOBILIZATION FOR CHINA’S ANTI-NUCLEAR ACTIVISM	215

LIST OF TABLES

TABLE 1 CHARACTERISTICS OF HYDROPOWER, NUCLEAR POWER, AND GMO, AND CONTROVERSIES SURROUNDING THEM	43
TABLE 2 DOWNLOADED MEDIA ARTICLES AND THEIR PUBLISHING TIME	55
TABLE 3 MASS MEDIA THEME CODING OF THE THREE STUDIED SUBJECTS.....	67
TABLE 4 SW’S HYDROPOWER ARTICLES BETWEEN 2000 AND 2017 AND THEIR ATTITUDES.....	89
TABLE 5 XEN’S HYDROPOWER ARTICLES BETWEEN 2002 AND 2017 AND THEIR ATTITUDES	90
TABLE 6 PD’S HYDROPOWER ARTICLES BETWEEN 2000 AND 2017 AND THEIR ATTITUDES	91
TABLE 7 THE MAIN THEMES OF SW AND XEN’S HYDROPOWER ARTICLES	93
TABLE 8 SOME OF CPPCC OR NPC’S ACTIONS AGAINST HYDROPOWER SINCE 2003	108
TABLE 9 HYDROPOWER CONTROVERSIES THROUGH THE LENS OF SOCIAL MOVEMENT THEORIES.....	112
TABLE 10 THEMES OF THE PEOPLE’S DAILY HYDROPOWER ARTICLES BETWEEN 1980-99.....	118
TABLE 11 MAIN THEMES OF THE FOUR SAMPLED MEDIA’S HYDROPOWER ARTICLES, ARTICLE ATTITUDE, VISIBILITY OF CONTROVERSIES AND THEIR PERCENTAGE.....	122
TABLE 12 NOTICEABLE PUBLIC INTELLECTUALS AGAINST HYDROPOWER (EXCLUDING ENGO MEMBERS)	124
TABLE 13 MAIN THEMES, ARTICLE ATTITUDE, VISIBILITY, AND PERCENTAGE OF COVERAGE OF THE FOUR SAMPLED MEDIA’S GMO ARTICLES.....	140
TABLE 14 ANALYSIS OF CUI YONGYUAN’S RECENT ANTI-GMO TWEETS (12/20/2018-01/06/2019).....	152
TABLE 15 MAJOR GMO CONTROVERSIAL EVENTS IN CHINA IN RECENT YEARS	156
TABLE 16 XINMIN EVENING NEWS’ NUCLEAR POWER COVERAGE (2002-2017)	194
TABLE 17 PEOPLE’S DAILY’ NUCLEAR POWER COVERAGE (2000-2017)	195
TABLE 18 CHINA SCIENCE DAILY’ NUCLEAR POWER COVERAGE (2007-2017).....	196
TABLE 19 SOUTHERN WEEKEND’ NUCLEAR POWER COVERAGE (2002-2017).....	197
TABLE 20 THE SAMPLED MEDIA ARTICLES ON NUCLEAR POWER IN CHINA (2000-2017)	199
TABLE 21 DIFFERENT PATTERNS OF HYDROPOWER, GMOs AND NUCLEAR POWER CONTROVERSIES ...	255

ABBREVIATION

AEC	Atomic Energy Commission
AMMS	Academy of Military Medical Sciences
Bt	Bacillus thuringiensis
CAAS	Chinese Academy of Agricultural Sciences
CAE	Chinese Academy of Engineering
Caltech	California Institute of Technology
CAMS	Chinese Academy of Medical Sciences
CAS	Chinese Academy of Sciences
CAST	China Association for Science and Technology
CCP	Chinese Communist Party
CGNPC	China General Nuclear Power Corporation
China CDC	Chinese Center of Disease Control
CIAE	China Institute of Atomic Energy
CNEA	China Nuclear Energy Association
CNNC	China National Nuclear Corporation
CNS	China Nuclear Society
CNTA	China National Tourism Administration
CPPCC	Chinese People's Political Consultative Conference
CRAES	Chinese Research Academy of Environmental Sciences
CSD	China Science Daily, published by the Chinese Academy of Sciences
CSHE	China Society for Hydropower Engineering
CTGC	China Three George Corp
CUSBEA	China-US Biochemistry Examination and Application
DRC	Development Research Center of the State Council
EIA	Environmental impact assessment
ENGOS	Environmental non-government organizations
EPR	European Pressurized Reactor

Chapter 1: Introduction

FDA	(US) Food and Drug Administration
GDP	Gross domestic product
HGP	Human Genome Project
HUST	Huazhong University of S&T
HZAU	Huazhong Agricultural University
IAEA	International Atomic Energy Agency
IHEP	Institute of High-energy Physics, Chinese Academy of Sciences
IRRI	International Rice Research Institute
ITER	International Thermonuclear Experimental Reactor
IWHR	China Institute of Water Resources and Hydropower Research
MEE	Ministry of Ecology and Environment of China
MEP	Ministry of Environmental Protection
MOA	Ministry of Agriculture of China (Renamed to Ministry of Agriculture and Rural Affairs in 2018)
MOAR	Renamed to Ministry of Agriculture and Rural Affairs in 2018
MOH	Ministry of Health of China
MOST	Ministry of Science and Technology of China
MWR	Ministry of Water Resources of China
NDRC	National Development and Reform Commission of China
NEA	National Energy Administration of China
NFA	National Forestry Administration of China
NIRP	National Institute for Radiological Protection under the Chinese Center for Disease Control
NNSA	National Nuclear Safety Administration of China
NPC	National People's Congress of China
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission
OECD	Organization for Economic Co-operation and Development
ORNL	Oak Ridge National Laboratory
PD	People's Daily

Chapter 1: Introduction

PIOs	Public information officers
PR	Public relations
PUS	Public understanding of science
PWR	Pressurized water reactor
R&D	Research and development
RUC	Renmin University of China
SACH	State Administration of Cultural Heritage of China
SASTIND	State Administration of Science, Technology, and Industry for National Defense of China
SEPA	State Environmental Protection Administration of China; Renamed in 2008 to Ministry of Environmental Protection (MEP), and then reshuffled to become the Ministry of Ecology and Environment (MEE) in 2018
SNPTC	State Nuclear Power Technology Corporation
SNWTP	South-North Water Transfer Project
SOEs	State-owned enterprises
SW	Southern Weekend, the most liberal Chinese newspaper published per week from Guangzhou
TGP	Three Gorge Dam
TGP	Three Gorge Project
TNC	The Nature Conservancy
UIBE	University of International Business and Trade
USTC	University of Science and Technology of China
VPN	Virtual private network
WCD	World Commission on Dams
WTO	World Trade Organization
WWF	World Wildlife Fund
XEN	Xinmin Evening News (Shanghai-based metropolitan tabloid)

Chapter 1. Science controversies encounter political opportunities

1.1 INTRODUCTION

Science and technology (S&T) controversies are an essential research topic in science communication scholarship (Lewenstein, 2017). However, despite the effort to systemize scientific controversy studies (Martin, 2014), two critical dimensions remain underexplored. First, why have different controversies shown divergent patterns? Second, most controversy studies were performed in Western democracies, which are insufficient for us to understand scientific controversies in broader social and political contexts.

Indeed, S&T controversies have been spreading worldwide, including in authoritarian regimes like China where science traditionally enjoys an ideologically paramount status (Cao, 2014; Ding, 2014). Since February 2016, when I began to prepare the current project, more than a dozen major science-related controversies have flooded the Chinese media and Internet. They ranged from the role of nonprofessional researchers in observing gravitational waves (Y. Tang & Wang, 2016) and the replicability of a dubious cutting-edge genome editing technology (Cyranski, 2017) to the new developments of long-lasting controversies surrounding genetically modified organisms (GMOs) ("China province bans GMO crops for five years," 2016), hydropower projects (J. Li, 2016) and nuclear power (Buckley, 2016a). The most recent one is the well-publicized genomic editing of babies manipulated by Chinese scientist He Jiankui at Shenzhen-based Southern University of S&T (SUSTech).

As in the Western contexts, the S&T controversies in China demonstrate highly divergent evolution patterns, ranging from the long-lasting and massive public rejection of

Chapter 1: Introduction

genetically modified (GM) foods to the collective efforts of environmental non-government organizations (ENGOS) to resist hydropower development and the low-profile internal elite strife surrounding nuclear power. How should we understand the high frequency of S&T controversies and their different patterns? Have social, political and economic factors contributed to their occurrence and development? The current dissertation project tries to answer these questions by combining different theoretical traditions empirically.

In addition to science communication scholarship, science and technology studies (STS) utilize controversies to reveal science's hidden operation rules (Pinch, 2015; Pinch & Leuenberger, 2006). However, while STS intensively explores the central status of knowledge in scientific controversies, it has under-investigated macro-political factors which play a crucial role in influencing the development of such disputes (Jasanoff, 2017), particularly in developing countries (F.-t. Fan, 2007).

Social movement theories, particularly the political process theory proposed by McAdam, Tarrow, and Tilly (2001), seems to have a powerful advantage in exploring the divergent patterns of the widespread S&T controversies in China, where specific political opportunity structures, a central theoretical component of the political process theory, open up in some disputes, leading them to break out and become sustained, but not in others.

However, as STS scholars point out, social movement theories ignore knowledge and epistemic issues (Breyman, Campbell, Eubanks, & Kinchy, 2017; Hess, Breyman, Campbell, & Martin, 2008; Martin & Groth, 1991), resulting in a crucial neglect of the social and political order science co-produces with its epistemic authority (Jasanoff, 2004b, 2017).

Chapter 1: Introduction

Absorbing science communication scholarship, STS, social movement theories, East Asian probes into the science-society-state interaction (W. Anderson, 2012; F.-t. Fan, 2012; Fu, 2007), and studies on China's sociopolitical transitions, my dissertation examines and compares controversies surrounding GMOs, hydropower development and nuclear power. Based on intensive field studies and multilevel data analysis, I will reveal a wide range of communication, sociopolitical and knowledge factors contributing to the occurrence and sustaining of controversies despite science's ideological importance in China.

1.2 LITERATURE REVIEW

1.2.1 S&T controversies in the science communication landscape

According to sociologist Dorothy Nelkin (1987), growing concerns on the social, moral, or religious implications of scientific advances, tensions between environmental value and technological development, worries about health hazards of emerging technologies, and declining public trust in scientists and public institutions contributed to the surging number of this kind of controversies in the public domain. In a sense, the public debates on these technologies are fundamentally controversies over political control (Nelkin, 1995).

Like Nelkin, Brian Martin has systematically studied scientific controversies. In his *Controversy Manual*, Martin (2014) summarized the main dynamics underlying controversies, including actors' (scientists, the media and activists) confirmation bias, their vested interests, the repeated reinforcement of assumptions, and the debated nature of scientific evidence. For example, in the GMO controversy, several studies (Cook, Pieri, & Robbins, 2004; Cuppen, Hisschemöller, & Midden, 2009) found biotechnology scientists

Chapter 1: Introduction

generally thought the public resistance to GMO was because of their ignorance, their naïve requirement of the impossible 'zero risks' and their heavy reliance on emotion to make decisions.

But structural differences between science communities, the media, and the public also contribute to scientific controversies. Flipse and Osseweijer (2013) found scientists and biotechnology industry's often slow response to GMO-related controversial events resulted in their having a far lower presence in the media than challenging activists. When they did respond, the media attention to the events had decreased, and the most public did not have a chance to learn the mainstream scientific conclusions through the media.

Science communication scholars have also intensively investigated the role of the media in controversies. Cook, Robbins, and Pieri (2006) found the UK media have widely cited public representatives and NGOs to counterbalance scientists and the government's effort to frame GMO in S&T terms. The second dimension is to reveal how the media's pursuit of dramatic effects intensifies controversies. For example, studies demonstrated that the media's efforts to balance scientific consensus on climate change with climate skepticism create opportunities for skeptics to speak out (Antilla, 2005; Boykoff & Boykoff, 2004).

A third dimension is to show the effect of media reporting on public attitudes to the controversial technologies. Bauer (2002) found that the media trend of favoring medical biotechnology more than agricultural biotechnology is significantly associated with the European publics' divergent opinions on the two biotechnologies while Frewer, Miles, and Marsh (2002) demonstrated the evidence to support the social amplification of risk framework, which claims that different amplifier stations including media determine the

Chapter 1: Introduction

consequences of a risk event.

Overall, the media selection of information and their preference of conflicts have increased public rejection of controversial S&T (Mazur, 1981; M. C. Nisbet & Huges, 2006). Mazur (2016) further claimed that it is the number of media coverage of S&T controversies rather than their frames or contents to determine the public rejection of the controversial technologies.

Science communication scholars have also traced how S&T controversies stage in the media arena (Hilgartner & Bosk, 1988) and how the media facilitate controversy development (Brossard, 2009; Lewenstein, 1995). They found that the media, instead of being a passive platform to deliver controversy actors' voices, actively promoted the process of the controversies.

A large body of science communication literature investigates public attitudes to controversial technologies and the social, psychological and cognitive factors that shape individual attitudes. There is no substantial evidence to support the assumption that more knowledge leads to stronger support for disputed S&T items (Akin & Scheufele, 2017). Compared with knowledge, trust (or more accurately, trust in scientific institutions) is a much stronger predictor of people's positive attitude to S&T, especially in controversial setting (Chryssochoidis, Strada, & Krystallis, 2009). Other cultural cognitive constructs like political ideology have been found to cause people's biased selection of information and biased attitude to controversial S&T (Kahan, Jenkins-Smith, & Braman, 2011).

Although science communication scholarship has identified and measured a wide variety of social, organizational, communication and individual factors that affect people's attitudes to science controversies, it has not done enough to examine the dynamics of

Chapter 1: Introduction

scientific debates. As a result, we don't know why, in similar situations, people reject science A but keep silent on equally controversial science B? Why have some controversies lasted long while others were short-lived?

To answer all these questions, one needs to take a more in-depth view of the controversies, a critical examination of its actors and a comparative approach across nations, political systems, and cultures.

1.2.2 Epistemic roots of S&T controversies

From social institution to epistemic constructionism. Relying on the epistemological relativism suggested by Bloor's (1991) Strong Program, sociology of scientific knowledge (SSK) scholars have widely examined science controversies. The so-called strong program symmetrically treats all knowledge claims, scientific or unscientific, true or false, and mainstream or marginalized.

Absorbing the essence of SSK but stepping out of its lab settings, other STS scholars have investigated public science controversies with constructionist approaches. In his study on the controversy surrounding HIV-AIDS link, Epstein (1996) showed in his *Impure Science* that Peter Duesberg's unsuccessful challenge of the orthodoxy conclusion on the HIV infection-AIDS link became salient partly because of the campaigns by AIDS activists who were still young and active when being diagnosed with viral infections. The challenge was finally rejected because the "viral hypothesis satisfied the interests of various players, both 'insiders' and 'outsiders'" (p.321). Combining resource mobilization theory (McCarthy & Zald, 1973, 1977) and STS, *Impure Science* initiated the endeavor to investigate science controversies as a social movement, though the effort has not been widely followed among either social movement or STS scholars (Breyman et al., 2017).

Chapter 1: Introduction

In her seminal book *Design on Nature* (2011), Sheila Jasanoff demonstrated how different cultures, risk regulations, and science-government-business links shaped divergent biotechnology governances in the United States, United Kingdom, and Germany. The US style of relying on experts, numbers and its distrust of the public constitutes a risk governance regime sharply different from those of Britain and Germany, which either demonstrate an experience-based consultation (Britain) or focus on rationality, ethics, and experts' professional skills (Germany).

From civic epistemology to knowledge-control regime. In *Design on Nature*, based on the comparative analysis of the policymaking process, Jasanoff proposed the idea of civic epistemology, which “refers to these culturally specific, historically and politically grounded, public knowledge-ways” (2011, p. 249). The concept, advancing Irwin and Wynne’s (1996/2003) effort to justify layman knowledge to confront the monopoly of experts’ views, stresses that “convergence in scientists’ understanding of the facts is not the same thing as public assent to those understandings” (Jasanoff, 2011b, p. 129). The public knowledge-ways is not to understand the mainstream scientific truth as imagined by the public understanding of science (PUS) model, but to “yield to the social reality of sciences that are more problem-driven and politically accountable” (Jasanoff, 2011b, p. 130).

Civic epistemology is a concept highly relevant to public S&T controversies because, in the controversy setting, activists or the general public often raise issues well beyond the mainstream scientific conclusions. The concept of civic epistemology allows an in-depth analysis into the contexts in which these anti-establishment “knowledge-ways” were brewed.

Although Jasanoff raised the idea of civic epistemology in the Western democracy

Chapter 1: Introduction

setting, there is no reason to question the concept's applicability in authoritarian regimes like China where political control, the political importance of S&T and civil understanding of them coexist, just like in the West (J. Y. Zhang, 2015). This similarity is indicated by many studies that have explored how orthodox scientists and unscientific laymen epistemically treat controversial S&T in China in different means (Cao, 2018; L. Deng & Jia, 2019; Hansen, 2017b). Based on these studies, it is also clear that political power and the politics-science alliance have played a more significant role in shaping civic epistemology in China than in the West. This dissertation will clarify the science-politics union.

Meanwhile, in addition to macro politics, it is also essential to understand what other factors have differentiated controversy actors in making their knowledge-ways. One such differentiating factor – often unnoticed – could be cultural characteristics, such as the idea of national sociotechnical imaginaries Jasanoff and Kim (2009, 2015) raised while analyzing the different fates of nuclear power in South Korea and the United States. The concept represents a national memory and imagination on the role of specific technologies in influencing a nation's historical development and steering its future. Jasanoff and Kim demonstrated that nuclear power is imagined as significant S&T progress and national pride in South Korea while mostly an uncontrollable monster needing to be contained in the United States. Despite its broad scholarly impact, the idea has not yet been systematically used to examine different science controversies.

The current dissertation attempts to assess the applicability of the concept by treating the imaginaries as resources for civic epistemology. For science controversies, the other side of the coin is social control revealed in epistemic form. Following Michel

Chapter 1: Introduction

Foucault's concept of biopower which refers to the modern states' regulation of their subjects through numerous and diverse techniques to subjugate bodies and control populations (Foucault, 1978), many scholars have explored how social institutions such as medication and public health realized political control (Conrad, 1992). Epistemically advancing the ideas, Jasanoff (2004b) developed the concept co-production of knowledge and social order which argues that how the world is known and how social relations are disciplined are deeply interconnected, and the change of established social orders has to undergo processes in which knowledge and social relationships mutually adjust each other.

Absorbing Jasanoff's idea of co-production, Hilgartner (2017) advanced the concept of "knowledge-control regimes" in his book *Reordering Life* to analyze the formation and evolution of Human Genome Project (HGP). According to Hilgartner (2017, p. 9), a "*knowledge-control regime* can be defined as a sociotechnical arrangement that constitutes categories of agents, spaces, objects, and relationships among them in a manner that allocates entitlements and burdens pertaining to knowledge." Such regimes allocate epistemic authority, distribute credit, create a property, spread knowledge, ensuring quality, construct professional jurisdictions, and even protect national security.

There are many regimes for such knowledge-controls, which constitute modes of control that apply to specific actors, entities, and jurisdictions, but they vary in the extent to which they are formally codified. Hilgartner (2017, p. 12) also argued that the conceptual structure of a knowledge-control regime is encoded as a "governing frame," which promotes an official viewpoint that endows agents with specific entitlements and burdens pertaining to other agents or to control over spaces, objects, and actions.

Knowledge-control regimes should be considered a regular type of epistemic

Chapter 1: Introduction

management. A journal publication process is a typical example of such a scheme. Authors must abide by a series of norms, such as blinding author information, to submit their papers. These papers, then, are sent to peer reviewers to decide academic originality. It is expected that the author will not release the paper before journal publication. These and other expectations are part of the knowledge-control regime. In the process described here, journal editors implement multiple controls of the knowledge contained in the paper.

In publicly controversial science, dissenting scholars and activists have to try to break such knowledge-control regimes, while mainstream scientists try to maintain them with all means, including laws, rules, authority, norms and institutionalized arrangements. But a knowledge-control regime does not necessarily mean an intentional effort to hide the truth. A central tenant of the concept is that specific knowledge presented in social life is always a result of the interaction between epistemic management and multiple social, political and institutional factors. While the epistemic management in some areas might be stronger than in other regions, the knowledge-control regime is embedded in a networked social context which prevents us from saying the knowledge-control regime in one sector is stronger (or weaker) than in another. What makes the difference is the effect of such control regimes, whose strength varies across different schemes.

In his study on the HGP case, Hilgartner did not specifically analyze “knowledge-control regimes” in the public controversy setting, which is the goal of this current dissertation. Meanwhile, the dynamic interaction between politics and knowledge-making will also be probed.

Exploring state power in S&T controversies. Although multilevel knowledge-control regimes cover the state’s jurisdiction power, like other STS scholars who examined

Chapter 1: Introduction

“movements” in science and medicine (Epstein, 2008; McCormick, 2006, 2007a; K. Moore, 2009; Schurman & Munro, 2010), Hilgartner’s central interest lies in knowledge making. Generally, STS scholars pay much more attention to the role of knowledge, expertise and expert-layman alliances/tensions and “often seek changes in institutions beyond the state” (Breyman et al., 2017, p. 299), but the constructionist approach of science studies has understudied political power or the so-called macropolitics (Jasanoff, 1996, 2017). This negligence is an apparent flaw for studies into science-society relationships in non-Western settings, where government and political leaders often have a more significant say in science issues (Jasanoff & Kim, 2009). The emerging East Asian STS scholarship may offer a chance to fill the gap (W. Anderson, 2012; F.-t. Fan, 2012).

In term of macropolitics, East Asia has manifested a strong interplay between government and knowledge. In Japan, techno-nationalism used to drive its nuclear power program (Kelly, 2015) just like in South Korea (Jasanoff & Kim, 2009). In the latter, the representation of macropolitics is linked to a robust S&T nationalism, as evidenced by Hwang Woo-Suk's stem cell research scandal (Hong, 2008; T.-H. Kim, 2008; Leem & Park, 2008). In China, a strong sense of techno-nationalism and the inadequate research capacity in the 1980s jointly pushed scientists to explore supernatural human functions as a possible pathway for scientific breakthrough (Palmer, 2007).

These unique aspects of East Asian STS scholarship contribute to and expand our understanding of S&T controversies. Besides, East Asian STS scholars are actively involved in socially heated S&T controversies. For example, while highlighting the inherent capitalistic feature of epidemiology whose stress on traceable causal links between illness and environmental factors naturally disfavors victims and working classes (H.-H.

Chapter 1: Introduction

Chen, 2011; Y.-P. Lin, 2011), Taiwanese STS scholars allied with the disadvantaged workers suffering from their former employer's toxic pollutant emission in their juridical fights.

While macropolitics has been brought into East Asian STS, political science theories, such as those about social movements, have not been present. As a result, East Asian STS scholarship so far has failed to trace the dynamic processes of S&T controversies and their sociopolitical roots.

1.2.3 S&T disputes from the perspective of social movement theories

From resource mobilization to political opportunity. Since the 1960s, three major types of rational choice theories of social movements – resource mobilization theory (McCarthy & Zald, 1973, 1977), framing and collective identity theory (Snow, 2013), and the political process approach – have been developed.

Tilly, Tarrow and McAdam developed the political process approach (McAdam, 1982; Tarrow, 1994; Tilly, 1978), which focuses on the idea of political opportunity structures proposed by Tarrow (1994, 1996, 2011). “Structure of political opportunities” means “consistent - but not necessarily formal or permanent - dimensions of the political environment that provide incentives for people to undertake collective action by affecting their expectations for success or failure” (Tarrow, 1994, p.85). As shown in Figure 1, three intersecting elements – political opportunities and threats, cultural artifacts and frames, and mobilization networks and organizations – were proposed as the most important ones for social movements to happen (Tarrow, 2011).

Figure 1 The intersecting elements of social movements

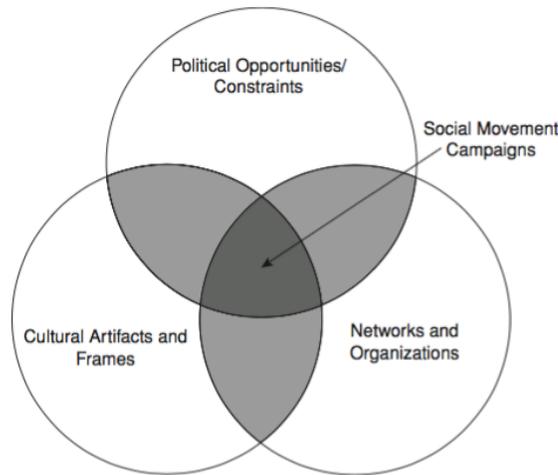


FIGURE 6.1. The Intersecting Elements of Social Movements

(Source: Tarrow, 2011, p.121)

Tarrow and colleagues (2001) also traced interaction mechanisms underlying social movements. To Tilly and Tarrow (2015), mechanisms mean a class of changes that alter relations among specified sets of elements in identical or closely similar ways over a variety of situations (Tilly & Tarrow, 2015, Kindle Locations 685-686). The most common mechanisms in social movements are brokerage, diffusion, and coordinated action. Others include social appropriation, boundary activation, certification/decertification, and identity shift.

Social movement theories' relevance for analyzing S&T controversies. The dynamic process examined by Tarrow and colleagues can be beneficial for investigating the outbreak, development, intensification, and closure of S&T controversies. As discussed above, current science communication and STS approaches to science controversies often fail to answer why some potentially disputable technologies become publicly controversial while others do not, or why some debates lasted longer than others. With the dynamic

Chapter 1: Introduction

analysis, we can say the outbreak of S&T controversies may be associated with certain kinds of [political] opportunity structure. For example, the continued food safety crisis in Europe in the late 1990s offered an opportunity structure for activists to mobilize the public against GMOs (Bonny & Sylvie, 2003). But the United States has not provided such an opportunity structure due to its product-based risk regulatory preference and the stronger industry-government alliance (Jasanoff, 2011b; Schurman & Munro, 2010).

In addition to political opportunity structures, political scientists like Ronald Herring (2008, 2010a, 2010b) have adopted mechanisms like brokerage, framing and diffusion to explain public resistance to GMOs. However, only limited science communication and STS studies (Delborne, 2008; Martin, 1998, 2004, 2010, 2014; Martin & Groth, 1991) have examined mechanisms (and certainly not those mentioned by Tarrow) involved in S&T controversies.

The resource mobilization approach can also help understand the strength of activism. Epstein's study of activists' efforts to change the clinical trial process for HIV drugs, in his *Impure Science* (1996), is an excellent example of combining constructionist epistemic examinations and the resource mobilization approach.

Another useful approach is to adopt social movement framing to analyze S&T controversies. The four framing mechanisms – frame bridging, frame amplification, frame extension, and frame transformation – identified by Snow and colleagues (Snow & Benford, 1988; Snow, Rochford Jr, Worden, & Benford, 1986) can be used to observe and analyze S&T controversies.

But for my purposes, social movement theories do have limits. Scholars in the field do not pay much attention to S&T controversies and the role of knowledge or issues of

Chapter 1: Introduction

expertise (Hess et al., 2008; Martin & Groth, 1991). The latter is often a crucial factor influencing such controversies, shaping critical variables like the political opportunity. As I will show in the dissertation, actors' dominance of knowledge making or their capacity to produce alternative, yet credible knowledge affects the political opportunities available to them. Besides, like mainstream STS scholarship, most social movement theories are based on Western democratic contexts, neglecting southern or Asian experiences (Fadaee, 2016) or adopting a stereotype of these countries' situations, such as losing sight of the dynamic public sphere in an authoritarian state like China (Y.-W. Lei, 2018).

1.2.4 Understanding S&T controversies in transitional China

Surging S&T disputes in China. S&T enjoy an ideologically paramount and unquestionably important status in China (Cao, 2014). Since the 1980s when the country began its opening-up, however, there have been consistent S&T controversies in public discourse – ranging from the gigantic Three Gorges Dam project (Lee, 2013a) and *Qigong* (a type of mysterious exercise to strengthen and control spiritual force (Palmer, 2007)) to GMOs (Cao, 2018) and trash incineration (Lang & Xu, 2013). After the 2000s, the controversies involved more and more actors, including ENGOs, academics, journalists and often contingently organized citizen groups.

Indeed, China's modern history has never been short of S&T debates. Many of these scientific debates often covered the appeal and interest of social forces. For example, studies have identified power struggles behind the so-called scientism's triumph over traditional culture in the early modern history of China in the 1920s (Duan, 2001; Lian, 2012; Y.-s. Lin, 1983).

The authoritarian regimes often more tolerated scientific or technological debates

Chapter 1: Introduction

in China. For example, in the late 1950s, as detailed in chapter 4, even after the anti-rightism movement had clamped down on most dissidents of the socialist regime, Chairman Mao Zedong still tolerated a severe debate on whether to build TGP (P. Zhao, 1992). In the 1980s, S&T controversies, including the harsh discussions on the TGP, interacted with the country's budding liberalism (H. L. Miller, 1996). While in the West, policy disputes are often reflected in scientific controversies (Nelkin, 1995), in the authoritarian regime of China, it is often necessary to camouflage political views with a technical appearance.

On the other hand, as compared with the Western context, among China's S&T controversies, the role of government is always more visible and in nearly all disputes, public's distrust in the government can be identified. The situation calls for an investigation of the macropolitics and public spheres involved in S&T controversies in the country.

From fragmented authoritarianism to consultative authoritarianism. A classic model developed by political scientists to understand the tension between China's authoritarian rule and public protests or resistance to policies is "fragmented authoritarianism," (FA) which argues that differently-tasked government departments and their conflicts result in policy results and delay (Lieberthal & Lampton, 1992). Adopting the model, Mertha (2008) has convincingly examined China's anti-dam protests. Among the three anti-dam cases examined by him, the protest in Dujiangyan that could mobilize more support from the fragmented ruling system while framing itself as a cultural contention succeeded, while the rally without any endorsement from the ruling group was clamped down.

Facing the booming Chinese civil society and more diversified political players,

Chapter 1: Introduction

Mertha (2009) introduced a modified FA (fragmented authoritarianism 2.0) framework, which allows more actors such as journalists and NGOs to play a role in the model. Others, noticing that FA seldom considered scientists and scientific knowledge, tried to introduce these elements into the framework (e.g. Hansen, 2017b). Some observers also maintained that the Chinese Communist Party (CCP) leadership remains tightly controlling and can frequently adapt to the situation despite bureaucratic fragmentation (Mertha & Brødsgaard, 2017; Shambaugh, 2008).

Despite these modifications, there remain some loopholes in the FA framework. Given the existing fragmentation within the Chinese bureaucracy, what types of fragmentation can lead to social protests and their success? What external conditions are needed? Is there a threshold value of fragmentation in the FA framework to break the rule?

Besides, a dimension neglected in current studies that use the FA framework is the central-local government relationship, which is considered a crucial aspect of Chinese politics (Hao, Lin, & Chung, 1994; Zheng, 2007; Zhong, 2015). When and in what conditions will the tension between central and local governments lead to social movements? How does this central-regional tension affect public S&T controversies? Another less discussed aspect in the FA scholarship is the rise of new leftism in China. Should we be able to identify an ideological FA framework? These questions will be empirically addressed through chapters 3 to 5.

The observation that some social protests achieved their goals in China due to policymakers' apparent encouragement of different opinions led Teets (2014) to conclude that the Chinese system would be better consistent with a consultative authoritarianism in which authorities try to seek professional expertise from organizations and individuals

Chapter 1: Introduction

outside the official system, such as ENGOs (F. Wu, 2009; J. Y. Zhang & Barr, 2013).

Rejecting State- and market-centered causal effect explanations, G. Yang (2005) found that the development of ENGOs accompanied four institutional factors including changing political conditions, the media, the Internet and international NGOs expanding in China. In the process, Chinese academics have played a vital role, working as ENGO organizers, policy entrepreneurs or sometimes brokers (J. Y. Zhang & Barr, 2013).

Both diversification (and partial liberalization) of traditional media and the penetration of the Internet are associated with China's civil society takeoff. For traditional media, the professionalization of investigative journalism (H. Wang, 2016), revenue-seeking through attention-grabbing, and harsh media competition (Y.-W. Lei, 2011) all cause the expansion of the public sphere, which, due to political censorship, tend to evolve in the environmental protection areas (G. Yang & Calhoun, 2007).

The Internet has been hailed as providing an online public sphere for the nation's activists, fueling opinionated citizens (Y.-W. Lei, 2011) and overcoming the regime's tight control on traditional media (DeLuca, Brunner, & Sun, 2016). The social media, ranging from blogs to Weibo to WeChat, expanded the contentiousness of the online public sphere (Harwit, 2016; Leibold, 2011; Lu & Qiu, 2013; Rauchfleisch & Schäfer, 2015).

Amidst the selective censorship on social media by the Chinese regime (Cairns, 2017; King, Pan, & Roberts, 2013), many subjects on social media have to be apolitical (Sullivan, 2012) but contentious enough to attract attention (Y.-W. Lei, 2018). The censorship avoidance should make science and environmental controversies welcomed topics by news portals and social media editors.

1.3 GMO, HYDROPOWER AND NUCLEAR CONTROVERSIES IN CHINA

1.3.1 Theoretical case selection

The above sections reviewed various theoretical traditions and approaches to studying S&T controversies. It is necessary to compare these aspects across different S&T disputes. Studies have found that contemporary S&T debates in China demonstrate quite different patterns. For example, anti- trash incineration (Lang & Xu, 2013) has spread across Chinese cities but most of them were spontaneous NIMBY activities without nationwide organization while in other controversies, such as the anti-hydropower movement, ENGOs are the main actor (Han, Swedlow, & Unger, 2014; T.-c. Lin, 2007).

The case selection was based on theoretical necessity and the relevance to studied targets: they should all involve debates on science and technology, they should have relatively broad or perceivable social impacts, they should have lasting duration, and they should have public policy impacts. When doing case studies, researchers want their research subjects highly typical in the studied aspects (Small, 2009). They should examine the theoretical relevance of the case they choose in various perspectives as the situation unfolds (R. K. Yin, 2009). Meanwhile, the constant comparison is critical for conceptual development (Glaser & Strauss, 2009).

Based on my personal experience as a science journalist in China in the past 20 years and online search of topical news stories, I selected a batch of candidate cases, which are all socially impactful and related to S&T issues, including *Qigong* and the supernatural human function debate, food safety scandals (particularly food additive disputes), the GMO controversy, the anti-dam movement, public protests against Paraxylene (PX) (Jia, 2014), collective resistance to trash incineration facility building, the nuclear power debate, and

Chapter 1: Introduction

the air pollution control controversy (particularly the sources of PM_{2.5} (Jia & Wang, 2017)). I screened media coverage and social media mentions. I consulted Chinese peer scholars, journalists, and activists to help avoid my personal bias in the initial selection. They agreed that these selected cases could be considered significant enough and related to contention on S&T issues in the public domain.

Many cases, such as the public protest against Paraxylene (PX) (Jia, 2014), collective resistance to trash incineration facility building, and food additive disputes, were stochastic and lacked constancy. Therefore, I eliminated them from consideration.

After extensive consultation before my doctoral candidacy exam in the summer of 2016, I decided to choose the *Qigong* debate, the GMO controversy, the anti-dam movement, anti-nuclear power conflicts, and controversial studies on air pollution source apportionment as candidate cases. They all had milestone impacts on Chinese society since China began to adopt opening-up in the 1980s. Meanwhile, these controversies displayed knowledge contention and involved political powers. These characteristics enabled them to be readily defined as social movements. I also tried to pursue international comparison so that the theoretical findings of my case studies could have a more extensive theoretical application.

For example, GMOs have suffered massive public rejection in China – with 73% of people opposing GMOs used as foods (Guangxi He, Liao, Shi, Zhang, & Zhao, 2017). The attitude echoed the resistance to the technology in both the developed world (Motta, 2014; G. D. Stone, 2010) and developing countries (Scoones, 2008). The anti-hydropower movement can be traced to the harsh debate on whether to construct the Three Gorges Project (TGP) to build a massive dam in Three Gorges in mid-Yangtze River in the 1980s.

Chapter 1: Introduction

Recently, scholars have widely examined anti-hydropower activities to study emerging Chinese civil societies and ENGOs (Buesgen, 2008; F. Wu, 2009; G. Yang, 2005). For the nuclear power controversy (Jia, 2016), two recent NIMBY activities led to the suspension of nuclear fuel recycling facilities proposed for Guangdong Province's Jiangmen (J. Dai, Zeng, & Huang, 2015) and Jiangsu Province's Lianyungang (Buckley, 2016a). Earlier, another proposed nuclear power plant in Shandong Province's Rushan was also suspended due to local resistance (Zeng, Dai, & Wang, 2015).

The *Qigong* controversy took place in the 1980s and extended to the 1990s. The national fever of *Qigong*, some senior science leaders' (such as Qian Xueshen, founder of China's space program) support for performing special human function studies rejected by mainstream scientists and science communicators' resistance to *Qigong* all marked it as a controversy equal to a remarkable social movement. The PM2.5 source apportionment debates in China's fight against air pollution control were more limited to the scientific community. The interpretative flexibility involved in the knowledge-making, people's severe suffering from the pollution and their widespread protests seemed to make the topic an appropriate candidate case (Jia, Lewenstein, & Yan, 2017).

However, due to limited research time and the lack of international comparability, I eventually decided to drop *the Qigong* case. I also abandoned the PM2.5 source apportionment debate because, despite the knowledge disputes, it was hard to identify social movement elements in the controversy. Eventually, I chose the anti-hydropower movement, the GMO controversy and the nuclear power debate as three S&T controversies for my case studies.

Chapter 1: Introduction

1.3.2 Divergent patterns of selected cases

While the three examples – GMO controversy, anti-hydropower debates, and nuclear power disputes – satisfy the criteria for theoretical orientation, they demonstrate very varying patterns. The hydropower and nuclear industries and biotechnology research also show different characteristics.

For example, despite the harsh citizen outcries against GM foods and Greenpeace's highly successful campaign to reverse the commercialization of GM crops in China, nearly no domestic ENGO is involved (see chapter 4 of this dissertation). For nuclear power, as a whole, public support for the technology remained high even after the Fukushima accident (Y. Wu, 2017) in spite of sporadic NIMBY protests. Unlike in Europe and the United States where anti-nuclear campaigns had been widespread, sparking national coalitions of environmental groups (Kasperson, Berk, Pijawka, Sharaf, & Wood, 1980), there was no nationwide anti-nuclear campaign and no single Chinese organization, including local branches of international NGOs like Greenpeace, committed to anti-nuclear power activism (see chapter 5 of this dissertation).

The hydropower controversy showed a different landscape. Indeed, there is no other science-related dispute in China like the anti-hydropower activism that has lasted so long and promoted such unified voices from ENGOs and their joint protests (see chapter 3 of this dissertation).

The cases of GM crops/food, nuclear power, and hydropower that are contested in contemporary China each have a set of different characteristics. Table 1-1 below lists their geographic locations, history and heritage, different media presentations of the industries/sector, relationship to the public, and the time, scale and actors of the

controversies.

Table 1 Characteristics of hydropower, nuclear power, and GMO, and controversies surrounding them

	Hydropower	Nuclear power	GMO
Locations	TGP: in central China Contended dams in the 2000s: southwestern China	Mostly in eastern and southern coastal areas near major cities	Nationwide
History	Long debated across Chinese history	No history of open contention	Technology is new, but food supply concerns are a long-standing issue in history.
Industrial legacy and strength	Dominantly State-owned sector; lack of publicity tradition	Completely State-owned sector; strong publicity tradition both in military weapon and civil technology development eras	Fragile industry; lack of publicity tradition
Military link	Part of the origin of the industry from engineering troops. No connection now	Originated from atom bomb development; remaining an active link	Completely civil. No military link
Relationship to the public's daily life	Low	Low	High
Media presentation	Moderate	Moderate	High
Time of controversy	The 1980s, then 2003 through mid-2010s	2008 and then from after Fukushima to now	From the early 2000s to now
Scale of controversy	National, but few southwestern locals	Primarily selected media platforms and internal debates	Nationwide, various media, social media, and online portals
Actors of controversy	For: Energy sector, hydropower industry; Against: ENGOs, ecological & environmental experts, environmental agencies; Various media and journalists; CPPCC (China's upper house)	For: Energy sector, nuclear power industry; mainstream scientists; Against: Small circle of dissenting experts and activists; Limited residents against nuclear fuel recycling projects	For: Mainstream scientists; science communicators; foreign companies Against: Various anti-GMO activists; non-science experts; STS scholars; Maoists; and many of the general public

(Source: Author's categorization)

1.3.3 From pattern difference to the theoretical comparison

Selecting GMOs, hydropower and nuclear controversies do not exclude the importance of other S&T disputes, such as the widespread public protest against Paraxylene (PX) (Jia, 2014) and trash incineration (Lang & Xu, 2013; Standaert, 2017).

Chapter 1: Introduction

But compared with the three selected controversies, the other cases are either too China-specific or lacking scientific relevance, so that temporal and international comparisons are hardly possible.

For the three selected controversies, different theoretical traditions reviewed above can each offer exciting explanations. As indicated in chapter 6, these theoretical explanations are entirely consistent across the various disputes. No doubt the individual characteristics of these controversies should contribute to the difference in the theoretical account. For example, the widespread concern about food safety distinguishes GMO controversy from hydropower and nuclear power contentions in terms of the level of public attention. But this does not mean the characteristics *per se* can replace theoretical probing or illegitimate theory-oriented comparisons between cases. Instead, these characteristics need to interact with other factors which will be theoretically analyzed in the following chapters.

For example, people's everyday concern with food safety is one factor leading to the GMO controversy's sustainability and widespread expansion, but the fear has to be combined with other social movement and knowledge factors, such as activists' negative framing and orthodox knowledge's low credibility, to initiate and intensify the controversy.

On the other hand, not every item raising people's daily concern will lead to widespread public controversy. For example, the debut of China's high-speed train was accompanied by a disastrous crash that killed at least 38 people and injured 192 in Wenzhou in July 2011 (Branigan, 2011). The public anger against high-speed train management and the government's cover-up, however, soon gave way to the applause for China's S&T achievements in accomplishing the world's leadership in high-speed train development.

Chapter 1: Introduction

Similarly, despite sporadic protests against (improper use of) food additives, they have never evolved to the extensive public controversy on food additives.

Besides, although the three controversy cases selected in this dissertation have different characteristics, they still share many common features. For example, both hydropower and nuclear power are low-carbon energies dominantly invested by State-owned enterprises (SOEs). Therefore, comparing their different evolution pattern is meaningful in revealing their theoretical difference.

My study is not a mechanical comparison of different controversies. To have a holistic understanding of public S&T controversies, one must more systematically observe and compare them. This synthetic approach is particularly crucial to studying China's S&T controversies, because while the profound political interference in social life necessitates an analysis on variables like political opportunities, the paramount status of S&T in China calls for an integration of science communication and STS scholarship in our understanding of people's perception and utilization of such political opportunities. Thus, S&T controversies cannot be solely examined with structural sociopolitical factors.

1.4 RESEARCH QUESTIONS

Based on the above theoretical review and the proposed synthetic approach to analyze S&T controversies in China, I asked a series of working research questions. The first set of research questions addresses how science communication scholarship can help us understand the selected controversies. They ask:

Research Question 1a (RQ1a): What are the communication elements, such as the media, Internet, and public attitudes to science, involved in the process for GMOs, hydropower, and nuclear power to become controversial?

Research Question 1b (RQ1b): How do the communication elements, such as the media, spur and/or maintain the controversies of GMOs, hydropower, and nuclear power?

Research Question 1c (RQ1c): Have the communication elements, such as the media, caused the controversies of GMOs, hydropower, and nuclear power to develop differently?

The second set of research questions addresses how social movement and other political theories can be integrated into our understanding of the selected controversies. It will look at the science-politics relationship, and the communication elements asked above.

Research Question 2a (RQ2a): Can political opportunity structure explain the different patterns of controversies surrounding GMOs, hydropower, and nuclear power in China and why?

Research Question 2b (RQ2b): Can networks and mobilization explain the different patterns of controversies surrounding GMOs, hydropower, and nuclear power in China?

Research Question 2c (RQ2c): Can cultural artifacts and frames explain the different patterns of controversies surrounding GMOs, hydropower, and nuclear power in China?

Research Question 2d (RQ2d): Can fragmented authoritarianism explain the different patterns of controversies surrounding GMOs, hydropower, and nuclear power in China?

The third and last set of research questions explores STS components of the selected controversies that have been analyzed politically. These questions link STS, science

Chapter 1: Introduction

communication and political process theory.

Research Question 3a (RQ3a): Have knowledge-control regimes influenced the patterns of GMO, hydropower, and nuclear power controversies in China?

Research Question 3b (RQ3b): What are the sociotechnical imaginaries related to GMO, hydropower, and nuclear power controversies in China?

Research Question 3c (RQ3c): How has civic epistemology regarding GMOs, hydropower, and nuclear power impacted the evolution of controversies in China?

These questions were not final tasks for this dissertation to address. Instead, they were set as roadmaps for me to organize the dissertation and as reminders for readers to grasp central components amidst the colorful and intricate scenes of the studied controversies lasting 30 years or longer.

1.5 DISSERTATION OUTLINE

My dissertation consists of seven chapters, with this opening chapter focused on the theoretical review and the concluding chapter exploring a dynamic social model for scientific controversies combining different theoretical perspectives. The second chapter presents research methods, data, and analysis process. The three following chapters then address hydropower, GMO and nuclear controversies respectively.

The third chapter is focused on China's anti-hydropower movement. Among the three subjects, it is first dealt with because it is one of the earliest S&T controversies in contemporary China, first breaking out surrounding the construction of the Three Gorges Project. As the project was finished long before this study was launched, the debate surrounding the project was mostly treated as a background, but it has paved an essential way to the later concentrated efforts by ENGOs to oppose southwestern hydropower

Chapter 1: Introduction

projects. The anti-dam cases show different patterns, yet they jointly demonstrate features specific to hydropower controversies, such as the difficulty to control knowledge by hydropower groups and the effective mobilization by ENGOs.

Chapter 4 deals with the GMO controversy. Combining the media content analysis and interview data, I revealed the fragile alliance between science and the state, the struggle among scientists, the issue politicization and the vast mobilization of various anti-technology groups eventually successfully halted the commercialization of GM crops.

The following chapter studies the nuclear power controversy. While the military background and scientific progress frame (or national sociotechnical imaginaries) of the nuclear industry seemed to quench initial public suspicion, the monopoly of research on the health consequence of radiation by limited players results in less open discussions on nuclear power safety. But to some elite anti-nuclear campaigners, the political opportunity could still be explored, though not a straightforward utilization of the fragmented governance system.

In the sixth chapter, based on the above studies, I compare science communication, sociopolitical and knowledge factors across the three controversies. A table summarizing their different theoretical components and predicting variant consequences is presented. The concluding chapter, which is Chapter 7, summarizes the main findings, examines the interactions among different theoretical frameworks, explores this study's generalizations, and discusses its data and theoretical limitations. I also briefly discuss my further study plan both to overcome the current limitations and to realize the academic contribution more fully.

Chapter 2. RESEARCH METHOD AND DATA

2.1 INTRODUCTION

A qualitative case study is the primary research method of the current dissertation. Qualitative research is inherently multi-method (Flick, 2009). My study is a multi-approach, multi-method endeavor. I primarily used case study for this research. According to R. K. Yin (2009), the case study logic implies each case can help us gradually improve our understanding of our research questions.

In each case I studied, I adopted theoretical sampling (Glaser & Strauss, 1967) to assure the validity. Theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects and analyzes his/her data and decides what data to collect next and where to find them, to develop his/her theory as it emerges. For qualitative scholars, the criterion to judge when to stop sampling is whether they have reached theoretical saturation for the researched/observed cases (Adler & Adler, 1994). Theoretical saturation represents the phase of qualitative data analysis where no new information appears, and all concepts in the theory are well developed. In my case studies, I stopped searching for further evidence when I believed all the possible theoretical explanations had been explored with the available evidence. In reality, there were always gaps that I thought I could not solve with my current data access. For example, I cannot reach China's top leadership to interview their policy intentions regarding S&T controversies.

Following Creswell (2007, p. 126) and Lofland, Snow, Anderson, and Lofland (2006)'s suggestions on evidence collection, I sampled and reached actors/events/cases

with maximum variance and/or extreme or deviant cases to improve the project's validity (Maxwell, 1996). With this logic, I identified cases/events/actors/evidence reflecting various theoretical components – such as political opportunity, framing, mobilization (strategies), technoscience institutions, national sociotechnical imaginaries, and fragmented authoritarianism. I also mainly looked at how science & technology (S&T) information was produced, transmitted, learned and used in the process of controversies for certification of actors, the transgression of the disputes, allying with partners/campaigners, and mobilizing participants.

Within the broad category of case studies, I adopted semi-structured interviews with various actors involved in the GMO, nuclear and hydropower controversies, documentation and content analysis of media coverage, social media postings and policy documents of these technologies and participatory observation of ongoing disputes, and triangulation of different data sources and various types of evidence (Maxwell, 1996, pp. 86-98).

2.2 DATA COLLECTION AND DESCRIPTION

2.2.1 Triangulation and qualitative interviews

I interviewed different actors so that interviews from different informants could be used to verify each other, the primary sense of triangulation. Triangulation also happened between interview transcripts and media coverage. There was also triangulation between media coverage and policy documents.

In the past three years' field studies (including US-based telephone and WeChat interviews), I have done intensive interviews. Due to my lengthy journalistic background, I first sought help from former journalist colleagues while interviewing them. With their

assistance, I was able to reach a good number of activists and dissenting experts who usually are more open to journalists and researchers. As studies reveal, many activists in China originally were journalists (H. Wang, 2016).

Using the snowball method, I asked interviewed activists to recommend others they thought relevant and open to talk. My science journalistic background also enabled me to question many scientists and experts involved in the controversy. I also obtained help from peer Chinese scholars who had studied individual subjects falling in my dissertation scope. Through them, I was able to reach many industrial figures, particularly people in China's nuclear industry.

However, despite my links, I was not as successful at reaching Chinese officials, who are generally cautious in talking with journalists and international scholars, even though I was familiar with some of them. As a result, most officials I reached refused to speak with me or only shortly briefed me about some basic situations.

Eventually, I interviewed 107 informants, including 26 journalists and former journalists, 24 activists, 21 scientists, 10 industry representatives, 4 government officials and former officials, 17 STS, communication and policy scholars who have studied some of relevant aspects of the subjects I research for this project, 2 science communication practitioners and 3 public information officers (PIOs). In the above categorization, for those having multiple roles, I only chose their role most relevant to my research subjects.

Most in-depth interviews took about 1.5 to 2 hours, while some other discussions, particularly those with my former journalist peers, took highly flexible forms, such as face to face interview plus WeChat (a Chinese social media platform) and telephone follow-up talks. For the shorter interviews, the primary research purpose is to get or verify the

information. A detailed list of interviewee characteristics (with names and affiliation intentionally deleted) is provided in Appendix A of this dissertation.

The Cornell University IRB approved this research method on 27 September 2016. The protocol number was 1608006557.

2.2.2 Mass media coverage data

Sampled newspaper data. In addition to interviews, I collected several types of media data. The first type is the mass media coverage of GMOs, nuclear power and hydropower by four representative newspapers. Two of them – the *People's Daily* (PD), which is the official party newspaper of CCP, and the *Southern Weekend* (SW), which is the most liberal Chinese newspaper published per week from Guangzhou – are widely adopted as sample newspapers to study contemporary China (e.g. Y.-W. Lei, 2018). A third newspaper is the Shanghai-based *Xinmin Evening News* (XEN), which is known as a relatively high-end metropolitan tabloid. The fourth newspaper is *China Science Daily* (CSD), daily published by the Chinese Academy of Sciences (CAS) from Beijing. CSD, formerly *Science Times*, is widely considered to demonstrate the most professional science journalism in China.¹ Combined, the four sampled newspapers represent a representative portfolio of typical Chinese newspapers.

Contents from PD, SW and XEN were retrieved from Wise Search, the most comprehensive full-text newspaper database in China, while materials from CSD were from the newspaper's website (password-protected), as its contents had not been included in Wise Search and another full-text Chinese newspaper database CNKI before 2008

¹ For full disclosure: I was the founder of *Science News Magazine*, affiliated to the CSD, and served as its editor from 2008 to 2010.

(CNKI is more famous for its Chinese academic paper database). Both Wiser and CNKI began to collect full-text newspaper data from the early 2000s (the starting time for different newspaper varied). As most controversies studied in this dissertation took place after the year 2000, the time range is excellent for my purposes. But because the TGP debate, the main hydropower controversy, mainly took place in the 1980s, it was also necessary to trace media reporting before stories were collected and archived to the full-text databases. Among the four sampled newspapers, only PD has such full-text database. So, I also downloaded PD articles from the 1980s.

All the newspaper articles were searched and downloaded by different groups of China-based partners with keywords decided after our discussions and trials. For the hydropower controversy, sample articles were examined with the Chinese keywords meaning "hydropower" (水电或水能), "hydroelectricity (水电或水能)," "hydraulic (水利)," "big dam (大坝)," "TGP (三峡工程)," "Nu River (怒江)," and "dam controversy (建坝争论、争坝)." In English, "hydropower" is almost identical to "hydroelectricity," but in Chinese, the literal translation of "hydropower" (水能: *shuineng* or water energy) is seldom used, and hydroelectricity (水电: literally *shuidian* or water electricity) is a much more popular term. However, vast disambiguation existed in the Chinese context, as hydroelectricity (水电: *shuidian* or water electricity) can also mean "water and electricity," which is used in a large amount of household utility-related media stories, which are irrelevant. Manual cleaning was therefore essential.

After the articles were found and downloaded, I manually skimmed all of them and excluded the irrelevant stories. After data cleaning, there were 138 relevant articles for hydropower in SW, 343 in XEN, 319 in CSD, and 1,211 in PD. Taken together, there were

2,011 sample newspaper articles on hydropower for analysis.

For GMOs, sample articles were searched with the Chinese keywords "GMO (转基因)," as this is a highly specific word without any significantly noticeable disambiguation. Such items were downloaded from PD after 1995, from SW after 2004, from XEN after 2007, and from CSD after 2000. After the articles were found and downloaded, I manually skimmed all of them and excluded the irrelevant pieces. After data cleaning, there were 36 relevant articles for GMOs in SW, 97 in XEN, 321 in CSD, and 152 in PD. Together, there were 606 sample newspaper articles on GMOs for analysis.

For nuclear power, sample articles were searched with the Chinese keywords "nuclear power (核电)," "atomic power (原子能)," "nuclear energy (核能)," and "nuclear science and technology (核科技)." Due to the Chinese partners' lack of access to CSD's own site, the data set could only obtain CSD contents for nuclear from WISE after 2007. After data cleaning, I got 1916 sample newspaper articles on nuclear power for analysis (619 in PD, 74 in SW, 604 in XEN, and 619 in CSD).

Table 2 below shows the downloaded media articles across three controversies after sample cleaning. Their publishing time range is also provided.

Table 2 Downloaded media articles and their publishing time

	Hydropower	GMO	Nuclear power
PD	1,211 (1980-2017)	152 (1995-2012)	619 (2000-2017)
SW	138 (2000-2017)	36 (2004-2016)	74 (2000-2012)
XEN	343 (2002-2017)	97 (2007-2016)	604 (2002-2017)
CSD	319 (2003-2017)	321(2000-2016)	619(2007-2017)

(Source: Author's calculation)

Other media articles. Besides the full-range media coverage data from the sampled newspapers, relevant media contents were collected, mostly when interviewees or social media discussions mentioned them. What's more, with the decline of traditional print media and the rise of online media, such as WeChat-based smartphone publications, I have collected relevant articles from the smartphone publications. They were primarily used for information purposes and triangulation.

Media coverage and public reaction patterns. Besides collecting and analyzing sampled media stories, I also explored the overall model of media coverage of the studied subjects. In our digital era, a secure method to trace the pattern is to look at the frequency of media reporting of the topics through Internet tools such as Google Trends and its Chinese equivalent Baidu Index. With thousands of mass media and news sites accessed by its news search engine, Baidu Index can show the frequency of media coverage of specific keywords.

Google Trends or Baidu Index also offers a pathway to examine public reactions to hot social events through its function to trace people's online search results. It has been found that the public interest in science as represented by their Google searches are associated with media reporting of relevant subjects (Baram-Tsabari & Segev, 2011; Segev & Baram-Tsabari, 2012). This method is what I did in examining people's interests in the three target controversies – hydropower, GMOs and nuclear power. Using the same keywords to search relevant stories in the four sampled newspapers and Baidu Index (for news coverage frequency), I examined the Baidu keyword search trends. I chose Baidu instead of Google because Google has been blocked in China since 2009. My purpose in this dissertation is not to examine the statistical association between news coverage frequency and people's online searches but to qualitatively shed light on the general media and public reactions to the controversies to supplement the methodological insufficiency of merely relying on elite discourses reflected by interviews and sampled media reporting.

2.2.3 Social media data

Social media contents were also collected. Unlike mass media, social media and information transmission channels enabled observation of the communication patterns of the studied controversies and people's reaction to them (Brossard, 2013). Mass media often only allow elite discourses, no matter whether they are from leading scientists, senior officials or activism leaders. But social media can significantly expand the platform for debates, particularly in controversial issues such as GMOs and climate change (A. A. Anderson & Huntington, 2017; Davies & Hara, 2017; Smith, Zhu, Lerman, & Kozareva, 2013). Different social media platforms play different roles in transmitting the debates on science and technology controversies.

In this dissertation, I categorize BBS (bulletin board systems), blogs and social network sites like Facebook or Twitter as social media platforms due to their common functions to empower users to interact with their audiences (Obar & Wildman, 2015). BBS is better than the other two major social media platforms in China – WeChat and Twitter-like Weibo. WeChat posts are open only to friends. Although Weibo is an open platform, its operator only allows one ID to download 1,700 tweets for any single search, which for research purposes are too few as compared with all postings in the social media platform. Therefore, I collected BBS posts with appropriate debate/discussion contents (conveniently defined as having 100 following posts) regarding GMOs, nuclear power and hydropower in the most popular Chinese BBS website Tianya, and individual Weibo and blog posts by main actors involved in the controversies.

Using a web crawler software, which can automatically search online contents, this dissertation downloaded Tianya posts regarding GMOs, nuclear power and hydropower using the same keywords used in the mass media search with multiple purposes. One purpose was to record the number of the hot BBS posts (technically defined as the original posts followed by more than 100 comments by the time of data collection) each year to triangulate the communication trends and patterns found in mass media content and people's online searching behavior.

Blogs. Blogs are much longer and more abundant in information than BBS or Weibo. For this dissertation, blog data are instrumental, because they can supplement and triangulate interview data and serve the purpose of comparative studies. I mainly searched three blog sites – Sina Blog, BlogChina.com, and ScienceNet.cn. Sina Blog, operated by China's once largest online portal Sina.com.cn which also operates Weibo, is the largest

blog site in China. BlogChina.com was a very active blog site, but due to the overall decline of the blog as a communication vehicle, it is no longer active enough; however, for historical reasons, it was still adopted as a sampled blog site. ScienceNet.cn, operated by the Chinese Academy of Sciences, is a leading website primarily targeting scientists but also publicly accessible. Typical blogs of main actors were downloaded and analyzed. The results are reported in individual chapters.

Weibo data. With its deep and wide penetration into everyday life and its public sphere role (Rauchfleisch & Schäfer, 2015), Weibo could potentially be an excellent platform to observe the public representation of science controversies (J. Fan, Jia, Peng, & Zhang, 2013). I analyzed the attitudes and behaviors of individual actors involved in the dispute as a substitute when interviews were unavailable. Due to Weibo's access and download restrictions, I could only access a limited number of recent tweets. Therefore, Weibo search was not systematic, focusing on more typical tweets, including those suitable for external software analysis.

For GMOs, former TV anchor Cui Yongyuan, a main anti-GMO actor, regularly produced high-impact Weibo posts. His Weibo tweets became my main research target. Besides, I retrieved data presented in my previous studies on Weibo transmission of GMO controversy in China for analysis (J. Fan et al., 2013; Jia, Fan, & Peng, 2014; Jia, Fan, & Yan, 2015).

For nuclear power, three Weibo searches in May and August 2018 and January 2019 resulted in about 1,500 tweets, a small number which indicated an impassive public reaction to the nuclear power issue. Few anti-nuclear actors opened or regularly updated Weibo accounts. Among the first 600 sampled Weibo tweets (the first 200 tweets from each

search), I only identified four tweets meeting the benchmark analysis criterion of 30 forwards set by the external tool Weiboreach.com (conveniently defined as high-impact tweets here). To overcome the gap, I expanded my search to topics (with hashtag #) including the keyword "nuclear power" [核电], which resulted in nearly 2,000 such issues. Among the first 200 topics among my searched results, only 29 topics had more than 10,000 readerships and were worth further analysis. I also searched posts by known anti-nuclear activists to identify qualified tweets for external analysis.

I did not specifically search Weibo tweets for hydropower, as most controversies on dam buildings had ceased or declined when Weibo became popular in China in 2011. Even though there were Weibo tweets related to the last collective protest surrounding Chongqing's Xiaonanhai dam, Weibo's search engine did not support searching for tweets posted several years ago.

WeChat data. Chinese people have become deeply immersed in WeChat (which has more than 1 billion active users, more than the number of smartphones in China (China Internet Network Information Center (CNNIC), 2017)). But unlike Weibo or Twitter, where people can "follow" any individual account, joining a friend's circle (like Facebook's wall), WeChat is mostly private and viewing the posts of that person requires the permission of that person (Harwit, 2016).

WeChat has two more functions for "publicness." Any individual or organization can publish a public account (standard translation is official account), which can be considered as a smartphone-based publication, without a license that is essential for traditional media in China. Any user can subscribe to the smartphone publication.

The second publicness function is WeChat's group chat. Each group allows up to

500 members. Information from a WeChat public account can be transmitted quickly by being posted into a chat group, and then it can be transferred to other chat groups by overlapping group members (X. Wang & Gu, 2016). As I was involved in multiple relevant chat groups, I observed the dialogues in the groups and summarized some patterns in the following chapters, but I did not record and report any personally identifiable information.

Meanwhile, using external online tool QS Data (www.qsdata.com), which ranks WeChat articles and public accounts, one can obtain the ranking (ranked in terms of views) of public account articles and access them. I collected three types of WeChat data. The relevant public account articles I randomly encountered or intentionally traced when alerted; highly ranked public account articles related to the studied subjects – hydropower, GMOs and nuclear – obtained through QS Data, and unidentifiable chat group posts for observation.

I downloaded, coded and analyzed from QS Data the first 50 articles distributed through WeChat public account (a free-of-charge user can access to a maximum of 100 materials posted in the past three months) for each of the three subjects. As indicated above, due to high literary disambiguation necessary for hydropower, I obtained such public account articles by searching the same keywords as in mass media and then cleaned the combined results. For GMO and nuclear power articles, I only used the single keyword to search in QS Data due to their low disambiguation. Because WeChat articles on nuclear power were highly homogenous in their attitude to the power, I also supplemented the search with activists' names as keywords.

2.2.4 Partisan website data

Unlike news sites which boast their neutrality, partisan websites (and their WeChat-

based public accounts) promote politically biased viewpoints. Because of China's officially recognized socialism ideology and its active censorship, sites openly promoting Western democracy are virtually nonexistent within China. On the other hand, in recent years, Maoist leftism² It has grown in Chinese society and the online world rapidly (L. Ma, 2012). With the fast development of online populism in China, the number of leftist websites quickly expanded (Fang & Repnikova, 2017; A. Y. Hu, 2006). Given the situation, it is necessary to examine whether the rising left-wing populism has influenced science controversies.

Examining the political polarization of science controversies is a common research topic, particularly looking at climate change (Kahan et al., 2011; E. C. Nisbet, Cooper, & Garrett, 2015). A standard way is to measure one's political attitude from right to left (conservative to liberal), but tracing partisan websites has also been adopted (Schuldt, Konrath, & Schwarz, 2011). Due to the lack of a full spectrum of political ideology in China's public sphere, tracing partisan websites may be considered a partial proxy to calculate partisan attitude among the public.

Based on my long-time observation, the anti-GMO position often linked to leftism political appeals, but I haven't found evidence for similar trends in the case of hydropower and nuclear power. So I only examined GMO articles across several selected Maoist websites, including Utopia (Wuyou zhixiang: www.wywxwk.com), Chawang (cwzg.cn), and Red Song Club (szhgh.com). The observation time was August 2018. Using the Chinese keyword GMO (转基因), I found 4340, 234, and 45,778 articles. Unfortunately, I

² In the Chinese context, the left or leftism is entirely different from the West. Leftism in the daily context can be understood as Maoism.

did not have enough resources to analyze all these articles, so I only downloaded and analyzed the first 50 articles ranked by relevance identified from each of these sites.

2.2.5 Other documentation data

Another type of information is various government documents, including the annual government work reports delivered to the plenary meeting of the National People's Congress by the Prime Minister, different five-year plans (五年计划, including comprehensive plans, energy development plans and plans for specific fields such as nuclear power) and the national middle- and long-term S&T plan (and such plans in subfields, such as middle- and long-term plan for agricultural S&T). There were also many governments' circulars relevant to my research. I primarily used these documents for informational purpose. Some typical materials were also used to analyze some STS concepts, such as sociotechnical imaginaries.

In addition to government documents, I also analyzed books and journal papers written by the main actors of the studied controversies. A significant purpose for examining these documents was to look at the knowledge contests between main actors, and the possible sources of alternative knowledge. Meanwhile, for the TGP controversy in the 1980s, three books written during the debate -- *Treatises on Macro Policymaking on Three Gorges Project* (F. Tian, Lin, & Ling, 1987), *Second Collection of Treatises on Macro Policymaking on Three Gorges Project* (F. Tian, 1989), and *Yangtze, Yangtze--Debates on Three Gorges Project* (Q. Dai, 1989) -- were the primary data sources for this topic due to the lack of other materials.

The multiple sources' documentation provided a solid basis for triangulation which also existed between interviews, documentation and participatory observation. The

multiple triangulation not only enhanced the study's reliability but also created chances to explore new theoretical findings through the constant comparison suggested by grounded theorists (Glaser & Strauss, 2009).

2.3 MULTILEVEL DATA ANALYSIS

2.3.1 Analyzing interview data

I adopted what R. K. Yin (2009, pp. 136-160) described as the five case study analysis techniques, including pattern matching (comparing an empirically based pattern with a predicted case), explanation building (analyzing case study data by building an explanation), time-series analysis, logic models, and cross-case synthesis (aggregating findings across a series of individual case studies). Another method is the constant comparison, which combines data coding and analysis to generate theory systematically. It is designed to aid analysts in producing a theory that is consistent, plausible, close to the data and at the same time is in a form clear enough to be readily, if only partially, operationalized for testing in quantitative research (Glaser & Strauss, 1967, pp. 1771-1773 (Kindle Locations)).

Concretely, I first developed an evolution outline of the three selected controversies and then analyzed different data for different purposes. For example, interview transcripts were used for: 1) clarifying and verifying the "truth" and details of individual controversies; 2) finding theoretical components involved, and 3) comparing and matching patterns of these controversies.

Due to my limited resources, the vast data volume, and the short research time for this dissertation, I did not use software to code all interview transcripts systematically. Instead, I read all interview transcripts (commonly immediately after my interviews),

compared them with my interview notes which had highlighted some points either theoretically meaningful or essential to story developments to decide the crucial quotes I would use. Because I made all interviews myself and had some strong impressions when there was vital information, the comparison between notes and transcripts was more efficient than formal coding for identifying important messages both for theories and for dissertation details. To address the possible neglect of other essential clues and theoretical components, I also carefully read relevant transcripts (from interviewees being essential figures in controversies) to identify meaningful contents further.

2.3.2 Analyzing mass media data

I coded media reporting collected from the above four sampled newspapers for framing analysis and tracing the media's frequency of attention. I also analyzed media to form a triangulation with my interviews with journalists. Based on literature (M. C. Nisbet & Lewenstein, 2002) and the trial analysis, I developed a coding system consisting of three aspects – themes, attitude and whether controversy can be identified (dispute visibility).

What I define as themes here is similar to frames, significant aspects of social life covered by the media stories. Frames have been widely used in the relevant literature, and when they were used in environmentally relevant studies (Gamson & Modigliani, 1989; M. C. Nisbet & Lewenstein, 2002), they often linked to specific established meanings, such as S&T progress and Pandora, which were sometimes directional. Thus, I preferred to use the term "theme," for which I referred to more objectively and neutrally defined area of human activities related to the studied topic. For example, one story may report the business or economic aspects of nuclear power while another news article deals with the environmental issues of hydropower development. A simple reason for me to prefer the straightforward

aspects of studied topics is it is easier to code. Besides, coding sampled media articles with these straightforward aspects as themes allows me to make cross-over analysis between article themes and other features such as article attitude and controversy visibility.

Although I did not use the term “frame” in this dissertation, I fully absorbed the previous frame analysis work such as those by M. C. Nisbet and Lewenstein (2002), which proposed the following framing typology for biotechnology:

Progress: Celebration of new development, breakthrough; the direction of history; the conflict between progressive/conservative-reactionary

Economic prospect: Economic potential; prospects for investment and profits; R&D arguments

Ethical: Call for ethical principles; thresholds; boundaries; distinctions between acceptable/ unacceptable risks in discussions on known risks; dilemmas. Professional ethics.

Pandora’s box: Call for restraint in the face of the unknown risk; the opening of flood gates warning; unknown risks as anticipated threats; catastrophe warning

Runaway: Fatalism after the innovation; having adopted the new technology/products, a price may well have to be paid in the future; no control any more after the event

Nature/nurture: Environmental versus genetic determination; inheritance issues

Public accountability: call for public control, participation, public involvement; regulatory mechanisms; private versus public interests

Globalization: call for global perspective; national competitiveness within a global economy; opposite: splendid isolation

(Copied from M. C. Nisbet and Lewenstein (2002, p. 372))

I took the aspects of human activities M. C. Nisbet and Lewenstein (2002) described in their framing typology but split values (e.g., progress, Pandora’s box, etc.)

attached to these frames as much as possible to form some trial article themes. Then I read about 100 sample media articles for each of the three studied controversies to test the applicability of these themes in the Chinese context. I expanded, dropped and adapted the trial themes when reading sample media articles to finalize the themes finally used in this dissertation. Some themes were adjusted in the formal coding process. Eventually, I developed either 10 or 11 themes for each of the three studied controversies.

For the media stories on hydropower, I identified ten major themes. They included business & economy; S&T; environment & ecology; floods, dam safety & water management; engineering; history & culture; politics, activism & national interests; regulatory & public accountability; immigrant affairs; and development & social welfare.

Among the themes, engineering was different from S&T because the former was more related to industrial practice rather than research done by scientists. The theme “regulatory affairs & public accountability” was also separated from “politics, activism & national interests,” which covered articles on political decisions, political leaders' involvement (but the items do not have other clear themes), public participation and activism, and national interest frames, which are common in China (Jia & Liu, 2014; Jia & Liu, 2009).

For the media stories on GMOs, 11 primary themes were identified, including seven themes equal to those in hydropower stories – S&T; business & economy; culture & history; development & social welfare; environment & ecology; politics & national interests; and regulatory affairs & public accountability. Besides, the media articles on GMO specifically covered the themes of food safety, ethical issues, conspiracy, and science communication & popularization. I added a “science communication & popularization” theme because due

to the ongoing GMO controversies, a large group of science communicators emerged, and science communication activities were organized to defend biotechnology. As a result, two types of media articles – including non-news popular science articles to defend GMOs and a kind of news stories specifically on science communication activities – emerged and cannot easily be included into other themes.

The media stories on nuclear power also included seven themes used to code GMO and hydropower stories – S&T; business & economy; culture & history; development & social welfare; environment & ecology; politics & national interests; and regulatory affairs & public accountability. Besides, science communication & popularization, conspiracy, nuclear safety, and engineering themes were covered. An additional theme specific to nuclear power is international nuclear non-proliferation negotiation and potential military use of nuclear energy. Although when cleaning data, I have cleared most nuclear articles solely for military purposes, such as North Korea or Iran nuclear crisis, there were still some articles about both nuclear power and international nonproliferation negotiation, such as those on the international negotiation of Iran's civil nuclear power plant.

Ethics & Pandora is a frequently used frame in environmental or biotechnology stories (M. C. Nisbet & Lewenstein, 2002), so initially, I kept the ethics & Pandora theme. But I dropped the theme after the first 400 article coding did not find any such item.

Table 3 indicated the mass media themes of the three studied subjects. The italic ones were the different themes across the three controversies.

Table 3 Mass media theme coding of the three studied subjects

	Hydropower	GMOs	Nuclear power
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Common themes across the three subjects	<p style="text-align: center;">S&T Business & economy Culture & history Development & social welfare Environment & ecology Politics, national interests & activism Regulatory affairs & public accountability</p>		
Specific themes in different subjects	Engineering	Ethics & Pandora	Engineering
	Floods, dam safety & water management	Food safety	Nuclear safety
	Immigrant affairs	Conspiracy	International nuclear non-proliferation negotiation and military use
		Science communication & popularization	

(Source: The author's coding)

For science communication & popularization theme, I sometimes coded secondary themes based on the main contents being communicated or popularized, but there were also articles discussing science communication of the studied subjects *per se*. In this case, I did not make the secondary theme code. For nuclear power articles, the theme "history and culture" was mostly related to the glorified history of China's nuclear weapon or industry. Secondary themes were also coded following the concrete historical contents.

The sampled media stories' attitude to research subjects was coded at a three-level scale, from a negative attitude (-1) to neutral (0) and then to a positive attitude (+1). Positive attitude typically meant straightforward praise could be identified with keywords like progress, honorable, nationally significant, glorious, independent innovation and benefit (to nations, people or environment), while negative attitude represented clear denunciations or warnings against the subject. The benchmark to determine the tone, however, may vary per the media. For example, PD, a Party propaganda mouthpiece, was the most generous in using positive keywords while SW always tried to show journalistic balance. Thus, a

story defined as neutral in PD may be positive in SW.

Then, during my pretest, the idea to mark the visibility of controversy emerged. Although I have not found any previous study to set dispute visibility as a variable for coding, there is a long tradition to trace identifiability of disputes in media articles (Lewenstein, 1995; Mazur, 1981; Nelkin, 1995). The purpose here is to know what types of media themes and what attitudes are related to the media's framing of controversies and uncertainty. Although media's balancing efforts can naturally create a general controversiality and uncertainty (Boykoff & Boykoff, 2004), this indicator is meaningful in China, as propaganda-styled science news in the country is highly positive (Jia & Liu, 2009) tending to erase such controversiality and uncertainty, particularly in official media. The visibility of controversy was conveniently coded as "0" (debate invisible) and "1" (controversy visible).

Due to the enormous amount of media articles (about 5,000), I did not have technical and financial resources to hire independent coders. I asked the help of an independent Chinese peer researcher for a reliability test. The researchers' primary research method is a media content analysis. We separately analyzed about 100 articles in each of the three studied subjects – hydropower, GMOs and nuclear power – after I delivered my intentions and strategies. The intercoder reliability test was quite high, more than 0.8 across the three subjects. We discussed the difference and reached consensus on coding accuracy. Then I coded all of media articles myself for their themes, attitude and dispute visibility.

I did not code media articles (including WeChat public account articles) I collected during interviews and through various occasions such as WeChat chat groups. Instead, eyeing to explore the typicality (Small, 2009), I carefully read these articles, most of which

were relevant to recent dialogues, from the aim to find relevant information. Various findings will be reported in the individual chapters on particular subjects.

In the individual chapters on researched subjects, I present the mass media data in tables to show the analysis results of coding (frames, attitude, controversy visibility). The results of media reporting frequency and keywords search amounts were also graphed in corresponding chapters.

2.3.3 Analyzing social media data

As described above, my social media data include BBS, blogs, Weibo, and WeChat public account articles. I counted the annual number of the original BBS posts (the first post that is followed by others to form a debate) to support, clarify and verify communication trends found in mass media content analyses and the examination of other data. In terms of Weibo and blog data, I mainly observed some typical tweets and blogs of actors to triangulate and supplement my interview data.

For Weibo data, I used an external, fee-charged Weibo analysis tool Weiboreach.com to calculate typical individual tweets' coverage, number of comments and number of forwarding. Then I analyzed and estimated these tweets' communication structure and their effects. Due to the Weibo data restriction, the Weiboreach.com analysis was more for demonstration than for systematic examination. Weiboreach.com's threshold criterion is at least 30 forwards, which is conveniently defined by the tool as high-impact tweets.

For WeChat articles, I modified the mass media coding rubrics by adding criteria like whether the analyzed public account was published by an established media source (including both print media and traditional online news portals such as sina.com.cn),

whether the account belonged to an individual or an organization, the types of account publisher (see below), and the number of people reading. Whether the account belonged to an individual is an essential criterion because theoretically, all print media outlets are state-owned but individual persons can publish WeChat public accounts as a factual mobile media. For public account types, there was a slight difference across the three studied fields. For example, for GMOs, it is necessary to have an independent category of food-related business (including cuisine, food planting, food distribution, and travel food) split from the general type of business and economy entities. The finalized coding rubrics for the themes of public account articles in GMO setting were: News stories (from conventional media), science issue, business and economy articles, food business, societal and public welfare, culture and history, political and national interest, environment, health, opinion, entertainment, military and religion. These codes may overlap with each other. In this case, the articles were multiply coded.

After examining nuclear power articles downloaded from WeChat-based public accounts, I decided it was unnecessary to develop systematic coding. The materials were highly homogenous in their attitude to nuclear power, sources and the types of publishing accounts, so that finding heterogenous articles (e.g., articles with nuclear-negative tone) already reached my academic goal.

In addition to using QS Data for the top read WeChat public account articles, I also collected and read articles randomly distributed in chat groups in each of the subjects – hydropower, GMOs, and nuclear power -- for content analysis. I did not code these public account articles but carefully read them to identify useful information.

2.3.4 Analyzing data from other sources

I also skimmed the articles on the three targeted controversies – hydropower, GMO and nuclear power – on Maoism partisan websites. I only analyzed the first 50 most read articles downloaded from each of the three sampled partisan sites (Utopia (Wuyou zhixiang: www.wywxwk.com), Chawang (cwzg.cn), and Red Song Club (szhgh.com)). I first coded their attitudes to GMO (positive, neutral and negative). Standard intercoder reliability test was not performed, but when I was uncertain about an article's attitude, I asked my Chinese colleagues who studied communication to help. In all cases, we had a quick consensus.

Analyzing government documents was often done with framing analysis techniques, though I did not code them with frames due to lack of systematic collection of government documents. Analyzing these documents can offer a pathway to trace national sociotechnical imaginaries, which match but are different from the media framing (Jasanoff & Kim, 2009). Detailed analyses were reported in these chapters wherever necessary.

I reported and analyzed the results in both tables and graphs. Some general working research questions associated with the media content analysis include how did different types of Chinese media report and frame various science controversies? What types of frames were associated with the story's attitude and the visibility of debate? Have hot events driven Chinese media coverage of controversies?

2.4 ETHICAL CONSIDERATION

Ethical issues are crucial to social and behavioral sciences, particularly to qualitative studies; as Sieber (1997, p. 127) argues, “unethical applied researchers are likely to harm themselves and their research as well as those they study.” My research is ethically relevant because China is an authoritarian nation where free debates are not encouraged,

and open protests against controversial technologies might be potentially punished. Nearly all investigated controversial technologies – GMOs, hydropower and nuclear – are supported by the government or some branches of it. Protesting these technologies is often thought of as challenging government authority.

Second, Chinese scientists and officials are particularly reluctant to speak out partly due to political control and partly because of a less open scientific culture in the country (Shi & Rao, 2010). In this situation, scientists who talk scientific controversies to "outsiders" are not appreciated by peers. This situation can be considered reputational damage to them even though they may never be punished.

Facing the ethical challenges, a common strategy is to prepare for them (Sieber, 2009). Cornell IRB approved my research in 2016, and I also studied various ethical regulations. The central principle of moral consideration is no harm, including the intentional effort to decrease the potential damages as few as possible (Ellis, 2007).

To ensure no harm, I stuck to two principles – confidentiality and voluntary research participation. During my interviews, besides having the regular informed consent process in which I stressed the privacy and voluntary involvement, I discussed with most in-depth interview informants the possible consequences of our talk and my research.

In this dissertation, I nearly unanimously kept anonymity for my interviewees, even though this may cause some narrative inconsistency. Sometimes, for example, the names of activists whom I interviewed were widely known in open protests and widely reported by media. In this situation, I used some real names but always avoided hiding the clue that can be used to reveal which real-name person was interviewed by me. Besides keeping anonymity, when presenting my findings, I deleted personally identifiable information of

informants as much as possible.

Ethical consideration goes beyond anonymity in impacting my study. For example, with various independent interviews and my personal experience as a former Chinese science communication organizer dependent on international funding, I believed most Chinese environmental non-government organizations (ENGOS) relied on international financial supports during my studied period. However, revealing this may threaten these organization's credibility, and hence their existence in the current Chinese situation was using international grants is severely limited. Therefore, while listing foreign funding as a general sociopolitical factor (political opportunity) fueling China's environmental activism, I avoided exploring funding issues for any individual ENGOS, even in the form of anonymity.

Chapter 3: Hydropower, fragmentation, and knowledge making

3.1 INTRODUCTION

Chinese civilization is closely linked to hydraulic engineering projects, whose centralized disposal of labor and resources led Wittfogel (1957) to raise the concept of Oriental Despotism. Disputes regarding water utilization, however, have never ceased, even after the People's Republic founded in 1949 effectively silenced most intellectuals.

Since the 1980s, when China began to adopt the opening-up policy, hydropower controversies ranging from the debate on the gigantic Three Georges Project (TGP) to the protest against dams in the Nu River (Salween River in Southeast Asia) once again topped the public agenda. Hydropower also became one of the few issues that China's emerging ENGOs joined their hands to reject (T.-c. Lin, 2007) despite the country's record speed in building dams. According to the International Commission on Large Dams, by the end of 2013, China has built 38,000 big dams (higher than 15 meters), accounting for 55.9% of the world's total (China Energy News, 2015).

Why has the hydropower controversy evolved to such a central issue in the Chinese environmental movement and how is it different from other disputes – GMOs and nuclear power – investigated in this dissertation? This chapter traces the development of the hydropower controversy in China in the past 40 years, and then examines the dispute in the landscapes of contemporary media transitions, social movement theories, and several STS concepts.

3.1.1 “Thick” dikes and dams

Because of the universal importance of water, it is natural that hydraulic projects

across the world are designed, developed and implemented per their specific historical, cultural, and political tradition. Bijker (2007) used “dikes and dams, thick with politics” to describe the difference between the Netherland’s dike and storm surge barriers and the coastal levees in the United States was a result of their different political traditions in dealing with risks. Meanwhile, these coastal engineering also shaped political and cultural practices of their hosting countries. For this reason, France developed hydropower capacities in its North African colonies in the 19th and early 20th centuries to show technological progress and to realize imperial control (Pritchard, 2012) and tamed the Rhône River to recover its national pride after the Second World War (Pritchard, 2011).

China’s massive hydropower development and its social and political implications have not escaped scholarly attention (Rogers & Crow-Miller, 2017). Using the concept of developmentalism and authoritarian control, scholars have examined the modernistic efforts behind the grand ambitions to build TGP (Lee, 2013a, 2014) and the gigantic South-North Water Transfer Project (SNWTP) to transfer water from southern China to the arid north 1000 miles away (Rogers, Barnett, Webber, Finlayson, & Wang, 2016; Webber, Crow-Miller, & Rogers, 2017). According to Lee (2013a), Deng Xiaoping’s desperate endeavor to build the TGP despite massive opposition was to use the discourse of developmentalism to justify his leadership as well as his orthodox inheritance from Chairman Mao. The dam also asserted the power of the central state by, for example, unifying power grids in China, replacing a system that was focused on individual or small groups of provinces by a national network of electricity production and distribution (Webber, 2012).

Launched while TGP was being constructed, China’s SNWTP was supposed to

solve environmental problems. But by prioritizing an engineering solution, the SNWTP has shown the common policymaking logic: Authoritarians can accommodate growing public concern for the environment without fundamentally altering existing structures of power (S. M. Moore, 2014; Webber et al., 2017). In fact, besides TGP and SNWTP, all major dam constructions and their corresponding relocation of impacted residents reflect China's state-making efforts, which entails an essential faith in the power of human knowledge systems – including science, technology, and policy – to get better and better futures (Tilt, 2014).

The rich body of literature introduced above highlights the crucial importance of water projects, their symbolic meanings, and the hydraulic technologies deeply embedded in specific sociopolitical contexts. Then it is natural to assume that hydropower controversies are not just about protests against these facilities. Instead, they can reflect the resistance to the social meanings embodied by these water projects.

3.1.2 Social movements against hydropower

Given the crucial importance of water utilization to the society, anti-dam movements have been intensively studied globally. The focal location for the research is in the global south where transnational anti-dam movements were booming in the 1990s (Khagram, 2004). The social movements against the dams are considered as civilians' collective actions against capitalists' greed. These movements, however, are underreported and underrepresented by local media (Da Silva & Rothman, 2011). These movements, however, received the aid of international organizations which have formed transnational activism networks, providing funding, international media attention, professional knowledge, and organizational experience to local activists (Khagram, 2004; Lee, 2013b;

McCormick, 2010).

In China, H. L. Miller (1996) found that the Party's call for scientific policymaking as an effort to correct Chairman Mao's capricious policy-making in the 1980s empowered senior scientists to openly express their concerns about TGP through improved institutions for elites' political participation, such as the Chinese People's Political Consultative Conference (CPPCC, China's Upper House). Interestingly, a Chinese STS journal, *Journal of Dialectics of Nature*, became the main platform to convene reformist scientists and their voices questioning TGP, reflecting Chinese STS scholars' tradition of active participation in social activism.

A decade after the TGP debates, China's ENGOs flourishing in the 2000s became the main actors in the subsequent hydropower controversy. Studies have examined the role of ENGOs as policy entrepreneurs, who have expanded China's hydropower policymaking structure, enabled more voices and interests to be heard (Han, 2013) and raised political concern for the social problems of forced migration and the public distrust of the business alliance between power companies and local governments (Vermeer, 2011). This type of coalition is particularly evident in the Nu River controversy erupting in late 2003 and lasting until now. ENGOs and allied scholars successfully blocked the grandiose State plan to build 13 dams in the upper Nu River.

They have mobilized institutional resources. In addition to the abovementioned international activism whose aid became possible after China opened its door for international NGOs to set up local offices (Lee, 2013b), ENGOs' capacity to facilitate the enactment of new environmental laws -- particularly the rules on environmental impact assessment (EIA) and public participation in the process -- and to mobilize open public

debates have been discussed in the scholarly literature (Magee & McDonald, 2006; Teets, 2014). In a more recent study, an essential yet hidden factor for ENGOs to be able to play their policy entrepreneurship role – the utilization of their supervisory agency – has been noticed (Teets, 2018). To increase its control of civil society, the Chinese government requires that an NGO must have both a governing government body (usually the Ministry of Civil Affairs and its local branches) with which it is registered and a sponsoring agency, which must be either a government agency or a public research organization. The design of the dual registration was aimed at better supervising NGOs, but as Teets noticed, some sponsors became the channels for NGOs to deliver their policy suggestions to top policymakers.

As mentioned above, other scholars adopted the fragmented authoritarianism (FA) framework to examine why some of China's anti-hydropower movements were successful while others were clamped down (Mertha, 2008). While Mertha has correctly pointed out the importance of bureaucratic fragmentation and the involvement of various public actors such as intellectuals and the media in leading to the success of anti-Yangliuhu Water Facility near Dujiangyan, a UNESCO (United Nations Education, Science, and Cultural Organization) World Heritage site, the FA framework relies too much on the structural differences of agencies and their leniency to activism, without further exploring other factors, such as the channel towards top policymakers (Teets, 2018) and the role of scientific knowledge and scientists (Hansen, 2017b).

3.1.3 Knowledge control and hydropower controversy

Tracing the debate on the relationship between the Zipingpu Dam in Sichuan Province and the Wenchuan Earthquake in 2008, Danish STS scholar Hansen (2017b)

argued that the FA framework is too rigid to account for scientists' different positions within the bureaucracy. He hence proposed including an epistemic community (seismologists in this case) as the fourth category of policy entrepreneurs, thus adding one to the three types already included by Mertha in his FA framework 2.0, which includes bureaucrats, activists, and journalists (Mertha, 2009).

While Hansen correctly proposed combining FA and STS, the lack of a detailed analysis of social movement elements in his studies has resulted in a limited understanding. Elsewhere, STS scholar McCormick (2007a) used the Habermasian concept of scientization of social order and the corresponding scientization contest movements to describe Brazilian anti-dam campaigns. She considered the latter as an effort to democratize science, which is the process through which lay understandings are taken into account when scientific knowledge production is used to make political decisions.

In another study applying the Habermasian concept of communicative action, McCormick (2006, 2007b) argued that the Brazilian hydropower governance regime is highly capitalistically driven, as evidenced by the fact that hydraulic information is organized to facilitate hydroelectricity development, without considering the indigenous knowledge of the rivers and the social, cultural and much of ecological impacts of hydropower projects.

But McCormick failed to examine knowledge as a social mobilization resource and did not assess the institutional roles of actors. For example, why have the sympathetic experts collaborated with local activists? How can their alternative knowledge be accepted by the public and policymakers so that it can work as a weapon against hydropower developers? We need to address all these questions in a synthetic approach combining

science communication, social movement theories and the knowledge-control regimes concept which I proposed in the introductory chapter.

3.2 CONTEMPORARY HYDROPOWER CONTROVERSIES IN CHINA

3.2.1 Questioning Three Gorges Dam

Modern China's hydropower controversies started with a decades' long debate on the feasibility of TGP. After the communist party expelled the nationalist government from the Chinese mainland to Taiwan in 1949, the debate on the feasibility of TGP occurred in the late 1950s. The debate was astonishing because Mao Zedong's Anti-Rightism movement had prosecuted many outspoken intellectuals, including scientists and engineers, making any open debate hardly possible.

Although anti-TGP experts, including Li Rui, one of Mao's then secretaries for industrial development, outvoiced TGP supporters, Mao still favored building TGP for its big promise and symbolic signal of national progress. Feasibility studies began in late 1958, involving 10,000 scientists and engineers nationwide, though the studies had to be halted in 1960 when China began to suffer the Three-Year Great Famine (H. Chen, Yang, & Xiang, 2006) that starved an estimated 36 million people (J. Yang, 2012).

After the disastrous Cultural Revolution, a controversy surrounding TGP broke out again in 1985, when the Chinese government finished drafting a feasibility plan to build a 150-meter-high dam in Three-Gorges, the so-called low-dam plan, under the instruction of Deng Xiaoping. The disputes about the TGP in the 1980s involved more actors, though still among elites, and lasted several years until the government made a final decision in 1989 to build a 185-meter high dam to enable large cargo ships to access Chongqing.

The debates on TGP were quite institutionalized despite China's authoritarian

regime. CPPCC convened two extensive inspections to the planned dam site and its upper and lower river regions. Most of the team members, including many leading scientists, such as Zhou Peiyuan (1902-1993), former president of Peking University, opposed the immediate start of TGP. Unlike today's dam controversies which are often focused on dams' environmental impacts, the main excuses to resist the immediate start of TGP were economic feasibility, the risk of sediments that might block the dam's overflow orifice, the priority to build smaller upper river dams, and the real numbers of relocated residents and the capacity to resettle them.

By spring 1989, the government agenda had been dominated by TGP supporters, who received the patronage of Premier Li Peng, a Soviet-trained hydropower engineer. In 1992, the National People's Congress (NPC), China's legislature, passed the initiative to build TGP. With the project completed with a total investment of US\$31.7 billion in the late 2000s, organized opposition faded away and most senior hydro-engineers and other scientists against TGP passed away. The installed generation capacity of the project reached 18 million kilowatts, the world's largest.

3.2.2 From Dujiangyan to Tiger Leaping Gorge in southwest China

After the open controversy on the TGP was silenced, hydropower debates disappeared in China's public sphere for about 14 years until 2003, when the protest broke out against power companies' escalated efforts to develop southwestern hydropower projects primarily in Sichuan and Yunnan provinces. Unlike in the TGP/TGP controversy, environmental and ecological issues dominated the agenda, and budding ENGOs (G. Yang, 2005) and their academic/media supporters became main actors. Wang Yongchen, a former environmental journalist at China National Radio, and the ENGO Green Earth volunteers

that she founded became the center of the anti-hydropower campaign.

The first battle was about a proposed dam located close to UNESCO heritage site Dujiangyan, a hydraulic project built more than 2000 years ago, in Sichuan Province. In early 2003, Wang was invited to join a meeting involving local and national cultural heritage experts who claimed that the proposed Yangliuhu Dam would contaminate the Dujiangyan heritage site's authenticity. With Wang's effort to mobilize other journalists, the Yangliuhu controversy rapidly became a national hot media event. More than 180 national media outlets reported the disputes (Yan Yan, 2009). The extensive media coverage exerted massive pressure on both the central and local governments. In August 2003, the Ministry of Construction, which supervised China's compliance with UNESCO heritages, asked Sichuan Province to be highly cautious in decision-making, avoiding any impact on the authenticity of Dujiangyan as a UNESCO heritage site. In the same month, the Sichuan provincial government announced a suspension of the Yangliuhu project. The project has been abandoned since then (through the date of this dissertation, Spring 2019).

Activists and their government allies soon diverted their newly built strength to oppose a draft hydropower development plan to build 13 dams in the middle, and upper Nu River in another southwestern province of Yunnan released in August 2003 by the powerful government agency National Development and Reform Commission (NDRC).

At a joint governmental meeting held between August 12 and 14, the representative of the State Environmental Protection Administration (SEPA, upgraded to the Ministry of Environmental Protection (MEP) in 2008 and reshuffled to become the Ministry of Ecology and Environment (MEE) in 2018) surprisingly knew the Nu River plan. He found he was the only government official at the meeting disagreeing with the program (Q. Deng,

2013). The SEPA official refused to sign to endorse the plan. Meanwhile, on September 1, 2003, the new Environmental Impact Assessment (EIA) Law was to take effect. SEPA insisted that significant dam projects must pass EIA before construction.

Due to its relatively low hierarchic status, SEPA convened on September 3 an expert seminar on the unique cultural and biological diversity in the Nu River, involving many leading environmental journalists. The seminar produced a batch of articles calling for preserving the Nu River, including PD's highly influential story "Preserving an ecological river for offspring."

The media campaign once again caused massive pressure on hydropower companies and particularly Yunnan local governments. Activists managed to submit a petition through a retired general to Premier Wen Jiabao, a geologist by training. Premier Wen commented on the Nu River hydropower development plan in February 2004: "To those major hydropower projects with high public attention and environmental disputes, [we] should cautiously study and scientifically make decisions" (Yan Yan, 2009). Wen's guide virtually halted the Nu River dam plan until 12 years later, when the draft of the 13th Five-Year Energy Development Plan proposed the Nu River dams again in 2015.

In June 2016, seven leading ENGOs, including Green Watershed, Green Earth Volunteer, Friend of Nature, Green Hanjiang, Hengduan Mountain Research Institute, Chengdu Urban Rivers Association and Green Zhejiang, jointly published an open letter urging the government to abandon Nu River development. Surprisingly, the Nu River hydropower development plan was dropped from the 13th Five-Year Energy Development Plan announced in late 2016.

In December 2003, with just four months' truce, environmentalists launched an

offensive against another proposed dam – Longpan Dam -- above the famous tourist site Tiger Leaping Gorge, after NDRC approved the hydropower development plan in mid-Jinsha River, which is the upstream river of the Yangtze, also in Yunnan Province. This time, in addition to arguing against the dam's environmental and ecological impacts and its influences on another UNESCO heritage site Three Parallel Rivers of Yunnan (Jinsha, Lancang or Mekong, and Nu or Salween rivers), its destruction of the tourism site as well as the scale of residents and area of land to be relocated became focus of contentions. Construction of the Longpan Dam on Tiger Leaping Gorges has been suspended until now (Spring 2019) though some of the eight dams below it were completed (J. Liu, 2013). Starting from the controversy on Tiger Leaping Gorge dam, activists' call of public participation in decision making on dams, as required by the EIA law in principle, became a “standard” procedure for contesting decisions.

3.2.3 Knowledge Mobilization against hydropower

One of the major causes for the anti-dam campaigns in southwestern China is hydropower facilities' impact on biodiversity which is mainly embodied as fish and other aquatic species in the Chinese public sphere. The plan to build Xiaonanhai (literally Small South China Sea) hydropower station, located in the jurisdiction of Chongqing, ignited another public debate in the mid-2000s, shortly after controversies surrounding the Nu River and dams near Tiger Leaping Gorges began to fade away. The debate was about whether the Xiaonanhai dam destroys the Yangtze upper river fish conservation zone. The debate lasted about ten years, ending in MEP's final rejection of Xiaonanhai's EIA. By providing scientific opinions and organizing a scientific field study, a group of senior hydrobiological scientists and international organizations such as World Wide Fund for

Nature (WWF) sat with ENGOs to protest or resist Chongqing municipal government's dam-building plan.

Besides aquatic biological conservation, anti-dam activists and experts also challenged hydropower development by linking earthquake triggering to dam building. The contention was escalated in 2008 when the 8.0-magnitude Wenchuan Earthquake in 2008 that killed 80,000 persons induced a debate on whether Zipingpu Dam, just 500 meters from the seismic fault and 5.5 kilometers from the quake's epicenter, triggered the disastrous earthquake (Hansen, 2017b). After *Science Magazine* reported on the claim of the possible link between Zipingpu and Wenchuan earthquake (Klose, 2008) and the corresponding modeling studies (Kerr & Stone, 2009; Richard Stone, 2009), the debate spread across international seismological and geological communities (Y. Chen, 2009; Gahalaut & Gahalaut, 2010; Ge, Liu, Lu, Godt, & Luo, 2009; Jackson, 2012; Klose, 2012, 2013; X. Lei, 2011; X. Lei, Ma, Wen, Su, & Du, 2008), though most of the discussions were censored in the Chinese media. Activists, such as Fan Xiao, former chief engineer at the Sichuan Geology and Mineral Bureau in Chengdu, actively participated in the debate (X. Fan, 2009) (INT20161222).

With southwestern dam building slowing down, minor eastern and northwestern water projects also became centers of contentions, such as the Hydro Junction Project in Poyang Lake in the eastern province of Jiangxi, which, as China's largest freshwater lake in lower Yangtze River, experienced severe impact after TGP reportedly reduced Yangtze River water flow. The hydro junction project which aimed to stop Poyang Lake from losing water to the Yangtze received strong resistance from the new generation of ENGOs (not the ones active in southwestern hydropower controversy) focused until then on animal

protection. A sharp difference from the previous southwestern anti-dam movement is that the Poyang Lake project is not a commercial one but aims at conserving local ecology. Therefore, what activists resisted is an ecological engineering solution (INT20161217, INT20170111).

These various hydropower controversies have witnessed collective involvement of China's emerging ENGOs and consistent media highlights, which, often occurring after an ENGO convened dissenting experts, have formed intense public pressure, suspending most targeted controversial projects. Comparing what looked like an easy mobilization of dissenting experts, hydropower companies adopted a passive strategy. Zhang Boting, vice-secretary general of the Beijing-based China Society for Hydropower Engineering (CSHE), became the only public spokesperson for the industry. In front of Zhang is a large, divergent, yet loose, group of "environmentalists," including ENGOs, with tiny involvement of local communities impacted by dams (Tilt, 2014). The collective action, experts' participation, adoption of counter-knowledge, media involvement and relatively high success rate are the subject of the theoretical discussions in the following sections.

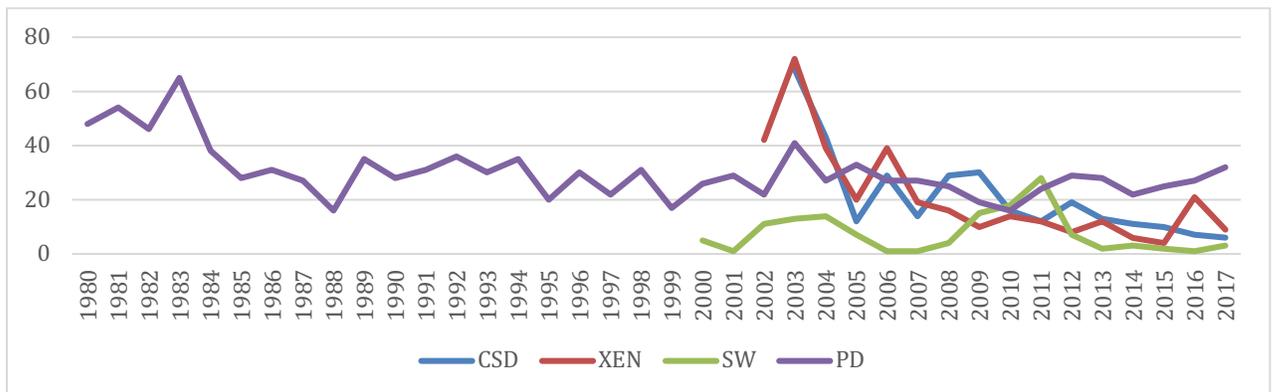
3.3 COMMUNICATION PATTERNS OF HYDROPOWER CONTROVERSY

3.3.1 Examining the media's role in hydropower controversies

Except for the TGP controversy in the 1980s when the Chinese media were not accustomed to critical reporting (but Chinese journalists began to attempt it, as analyzed below), most controversies regarding hydropower development in southwestern, northwestern and eastern China started with the media's critical reporting of planned dams. Media's critical environmental coverage was encouraged by editors and central government leaders as a way for them to supervise environmentally illegal moves by local governments,

according to one senior journalist of an official newspaper (INT20170830). Compared with the official media, market-driven liberal presses devoted more energy to produce investigative stories. "We thought at that time that supervising these hydropower projects is a right way to safeguard public interests," said a senior journalist at one of China's most influential liberal newspapers (INT20161022).

Figure 2 Hydropower reporting by the four sampled Chinese media (1980-2017)



(Source: Author's collection)

Media content analysis supported the claims of journalist interviewees. According to Figure 2 above, across the four sampled media outlets, hydropower coverage was event-driven, with 2003, the birth year of southwestern hydropower controversy, experiencing a record high number of media articles. The Yangtze River interception at TGP in 2003 also resulted in a much higher number of media stories on hydropower than in other years. As PD stories are the only available media content on hydropower before 2000. The 2006 and 2009 environmental regulation storms (when SEPA/MEP intensified EIA implementation) and the 2008 Wenchuan Earthquake all pushed more media coverage of hydropower. After 2012, with both declining new dam building and controversial projects, media coverage of hydropower declined with the exception of PD, which began to report more international

hydropower projects constructed by Chinese companies often with loans from the Chinese government.

Between 2000 and 2017, *Southern Weekend* (SW) published 136 stories and comments primarily about hydropower projects. One hundred articles, or 81% of them, negatively or critically reported hydropower development and its impacts on relocated residents.

Table 4-6 summarizes the main themes of the sampled media’s hydropower stories and their attitude to hydropower developments. While SW is famous for its critical investigative reporting, *Xinmin Evening News* (XEN), an urban tabloid usually reluctant to report negative news, also regularly dedicated negative stories to hydropower, particularly in 2003 when the Yangliuhu and Nu River controversies were hot social issues. As mentioned above, PD, the CCP mouthpiece dominantly serving the Party's propaganda, did not hesitate to negatively frame the first dam building drives, especially between 2003 and 2007, the years witnessing escalated debates on southwestern hydroelectricity projects.

Table 4 SW’s hydropower articles between 2000 and 2017 and their attitudes

Year	Total hydropower articles	Positive tone	Neutral	Negative	Articles with visible controversies
2000	5	1	4	0	4
2001	1	0	0	1	1
2002	11	0	9	2	11
2003	13	0	5	8	12
2004	14	0	7	7	14
2005	7	0	0	7	7
2006	1	0	1	0	1
2007	1	0	0	1	1

Chapter 3: Hydropower controversy

2008	4	0	1	3	3
2009	15	0	4	11	14
2010	18	2	10	6	18
2011	28	2	7	19	27
2012	7	0	0	7	7
2013	2	0	0	2	2
2014	3	0	0	3	3
2015	2	0	0	2	2
2016	1	0	0	1	1
2017	3	0	2	1	2
Sum	136	5	50	81	130

(Source: Author's coding)

Table 5 XEN's hydropower articles between 2002 and 2017 and their attitudes

Year	Total hydropower articles	Positive tone	Neutral	Negative	Articles with visible controversies
2002	41	26	15	0	0
2003	72	44	22	6	4
2004	39	18	18	3	1
2005	20	4	14	2	3
2006	39	20	16	3	3
2007	19	3	12	4	2
2008	16	3	9	4	2
2009	10	2	7	1	2
2010	14	6	5	3	2
2011	12	3	7	2	6
2012	8	2	4	2	1
2013	12	1	5	6	5
2014	6	3	1	2	1

Chapter 3: Hydropower controversy

2015	4	0	1	3	2
2016	21	2	10	9	12
2017	10	3	4	3	3
Sum	343	140	150	53	49

(Source: Author's coding)

Table 6 PD's hydropower articles between 2000 and 2017 and their attitudes

Year	Total hydropower articles	Positive tone	Neutral	Negative	Articles with visible controversies
2000	26	8	18	0	0
2001	28	5	23	0	2
2002	22	10	12	0	0
2003	41	25	14	2	4
2004	26	7	16	3	8
2005	33	11	15	7	18
2006	27	6	14	7	9
2007	27	6	19	2	7
2008	25	6	19	0	8
2009	19	8	8	3	2
2010	16	6	9	1	5
2011	26	7	15	4	7
2012	29	8	21	0	3
2013	28	16	12	0	2
2014	22	10	8	4	8
2015	25	13	10	2	5
2016	27	13	13	1	6
2017	32	17	13	2	6
Sum	479	182	259	38	100

(Source: Author's coding)

Consistent to tables presented above, except SW, most Chinese media outlets as represented by PD and XEN still reported more positive and neutral stories about hydropower than negative ones. But in a society where traditional media outlets were tasked to propagandize positive socialistic values, the frequent appearance of negative stories *per se* indicates hydroelectricity projects have been recognized as controversies. In terms of circulation, the high subscription of SW among intellectuals and urban middle classes represents a more significant social impact, and any adverse reporting in PD, China's politically most prestigious newspaper (its editor-in-chief is equivalent to the level of a minister in the hierarchic political system), causes typically significant political pressure. One veteran anti-hydropower activist recalled with a comforting smile during my interview: "In the period, any media outlet which has not reported hydropower controversy seemed to be environmentally unfriendly" (INT20161225).

In addition to (and often parallel to) adverse reporting, the Chinese media in the 2000s began to make controversies about hydropower visible in their reporting, even in stories with a generally positive tone. Scholars have long recorded balancing different views to create plots and for environmental stories to attract readers (Boykoff & Boykoff, 2004; Corbett & Durfee, 2004), but in China, lack of mentioning disputing views as a result of the media's long-time propaganda tradition may have reduced the attractiveness of science and environmental stories (Jia, 2007; Jia & Liu, 2009). We can also say that media stories highlighting the presence of controversy surrounding hydropower may have created an atmosphere where it was possible to question the validity of building dams. The tables above present the number of articles of WS, XEN, and PD with visible hydropower

controversy.

While the media have played an essential role in facilitating the hydropower controversy in China, interviews (INT20161016, INT20161022, INT20161215, INT20161219) revealed that during the Nu River and Tiger Leaping Gorge controversies, media reporting either was initiated by the environmental agency or received its support in terms of the easy access to comments from environmental officials, among others. Table 7 shows that the leading theme of SW hydropower stories was regulatory issues.

Table 7 The main themes of SW and XEN’s hydropower articles

	SW (2000-2017)	XEN (2002-2017)
Floods, dam safety & water management	5	59
S&T	5	11
Regulatory affairs & public accountability	43	2
Politics & national interests	5	16
Immigrant affairs	7	21
History& culture	6	17
Engineering	5	112
Environment & ecology	31	40
Development & social welfare	7	5
Business & Economy	11	60

(Source: Author’s coding)

Among the 40 SW stories framed as reporting regulatory issues, 31 negatively reported hydropower projects, mostly investigative stories about the dam developers’ irregular actions or the expected negative impacts. Most of these stories quoted either

SEPA/MEP officials or environmental/public policy experts. Comparatively, Shanghai-based XEN, as an urban tabloid based in a metropolitan center, did not report so many regulatory stories. In the sampled period (2002-2017), the completion of TGP and other major dams also resulted in more positive reporting of hydropower construction's engineering achievements. However, XEN reported more environmental stories (as well as stories on floods and their impacts) about hydropower, partly because Shanghai, located in the downstream Yangtze, is more likely to be subject to the possible environmental impacts of the upstream dams, such as salt sea water's incursion due to reduced Yangtze water flow caused by dams. Among XEN's 40 hydropower stories reporting environmental issues, 28 were negative ones.

Table 7 also reveals the alternative frames the media used in challenging hydropower projects that were often portrayed as engineering achievements and beneficial to social development. But in the controversial settings, the media more frequently reported the environmental and regulatory aspects of hydropower development.

3.3.2 Media morphology, Internet, and public attention in hydropower controversies

While producing a large number of critical stories against hydropower developments, Chinese media also demonstrated a unique morphology in such reporting, as evidenced by the diversified authorship structure and unique source layout. My interviews with many journalists indicated that besides a small group of energy journalists who covered the beat of hydropower or power industry in general, many science, environmental, cultural and business reporters reported hydropower issues without constraints (INT20160816, INT20160925, INT20161016, INT20160921a). In the 6th section of this chapter discussing STS perspectives on China's hydropower controversy, I

will explore the implication of the authorship structure for knowledge control on a broader scope. Here I am satisfied with revealing the fact that a large portion of hydropower stories was authored by environmental reporters, who, with environmental reporting increasingly considered by editors as politically safe yet widely welcomed critical stories, enjoyed more and more salient roles within Chinese media outlets. The situation is similar to the association between the deployment of journalists to different topics and the media's overall tendency revealed by M. C. Nisbet and Huges (2006).

Another apparent morphology in Chinese media's reporting of hydropower is the high frequency of dissenting experts primarily in the loosely defined environmental and ecological field. As media theme analysis in the above subsection revealed, most environmental and ecological stories negatively reported hydropower development. My random analysis shows that negative reporting was often supported by citing critical experts' views and unbalanced treatment of anti-hydropower experts as against pro-hydropower experts. A detailed quantitative analysis is beyond the scope of the current dissertation, and the availability of many dissenting experts is also a knowledge control issue to be explored in the STS section of this chapter. What can be said here is that through their continuous field investigation involving both journalists and experts such as *Jianghexing* (Yangtze and Yellow rivers trips), activists, many of whom had earlier been journalists like Wang Yongchen, have helped mobilize a dissenting expert network ready to equip environmental journalism challenging hydropower.

Hydropower developers and supporters, by contrast, have made few effective communication and public relation (PR) efforts, which in reality encouraged journalists and activists not to hesitate to raise new controversial issues against hydropower

(INT20170106). In 2009, when I was a Chinese science journalist, Lu Youmei, former president of China Three Gorges Corporation (CTGC) who led the construction of TGP, told me that during the dam's construction process, an international PR firm came to the company for business but it was rejected because the company's management thought it was unnecessary to make PR for a project the State was determined to accomplish. Lu later felt very regretful of the decision, which he considered a cause leading to later years' continued hydropower controversies in China.

An STS scholar who has long studied hydropower history in China thought two factors might contribute to the industry's poor reactions to hydropower controversies. The industry, dominated by hydropower engineers, has long defined itself as implementing the State's will, and the industry's primary operation location was often in remote mountainous areas so that it saw little necessity to communicate to the public (INT20170715).

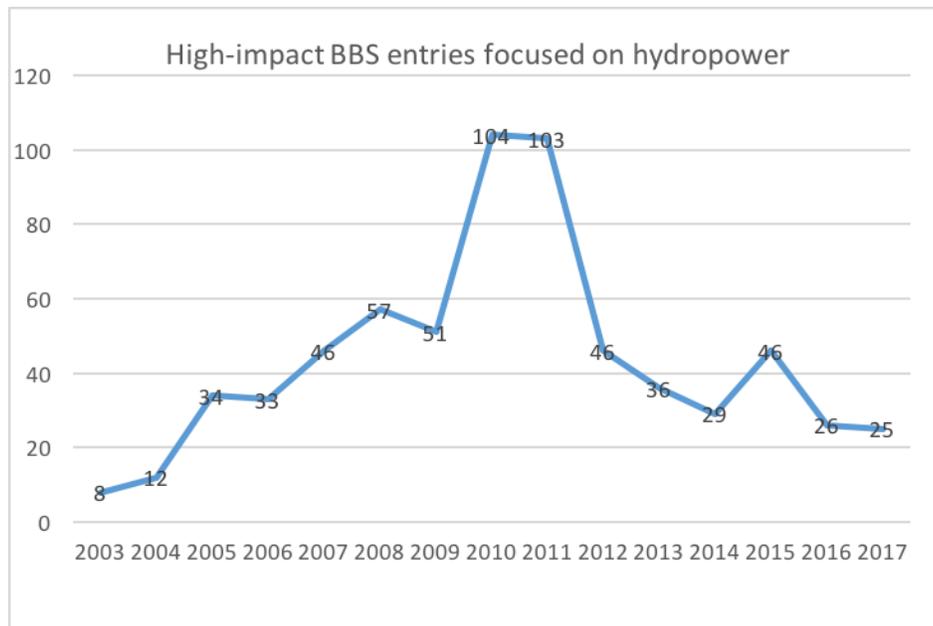
In addition to the print media, the rising Internet in the 2000s also fueled the spread of controversies regarding hydropower. The rise of Internet news portals in the period has dramatically promoted the impact of sensational, often antagonistic news stories in China (Qian & Bandurski, 2011; L. Tang & Sampson, 2012; Xiao, 2011). My study also revealed similar patterns. The leading news portals in China, such as Sina.com.cn, 163.com, sohu.com, and QQ.com, have all produced individual webpages/columns on each of major hydropower controversies from the debated Yangliuhu dam proposal to the controversial Xiaonanhai project. Most leading Chinese Internet news portals do not have the right to report news (L. Tang & Sampson, 2012) independently. But their market dominance has enabled them to obtain free access quickly to impactful stories from conventional media. The lack of the right to independent reporting drove these news portals to concentrate

highly impactful print media stories into a single column, significantly increasing the topic's impacts. "Normally people (meaning Internet users) do not care too much about hydropower issues, but when a controversy [about hydropower] broke out, visits to our special columns [of the hydropower controversy] surged dramatically," one former news portal editor told me (INT20170109).

He was echoed by another former news portal editor who said some journalist-turned environmental activists such as Wang Yongchen often shared with her and her colleagues' important news about environmental issues and involved them in planning investigative news reporting of environmental woes (INT20170114). Hence, activists expertly dominated the media agenda, both online and offline. This situation is consistent with previous scholarly observations on the institutional role of the Internet in fueling China's green politics (G. Yang, 2005, 2009; G. Yang & Calhoun, 2007).

In addition to news portals, various types of social media also played an essential role in fueling hydropower controversy. As discussed in chapter 2, this dissertation adopts a broad definition of social media, including BBS, blogs, Weibo and WeChat. Below is the frequency of high-impact BBS posts about hydropower retrieved from Tianya.com, China's largest BBS site.

Figure 3 High-impact BBS posts focused on hydropower (2003-2017)



(Source: Data were downloaded from Tianya.com by courtesy of Kai Liu on May 8, 2018)

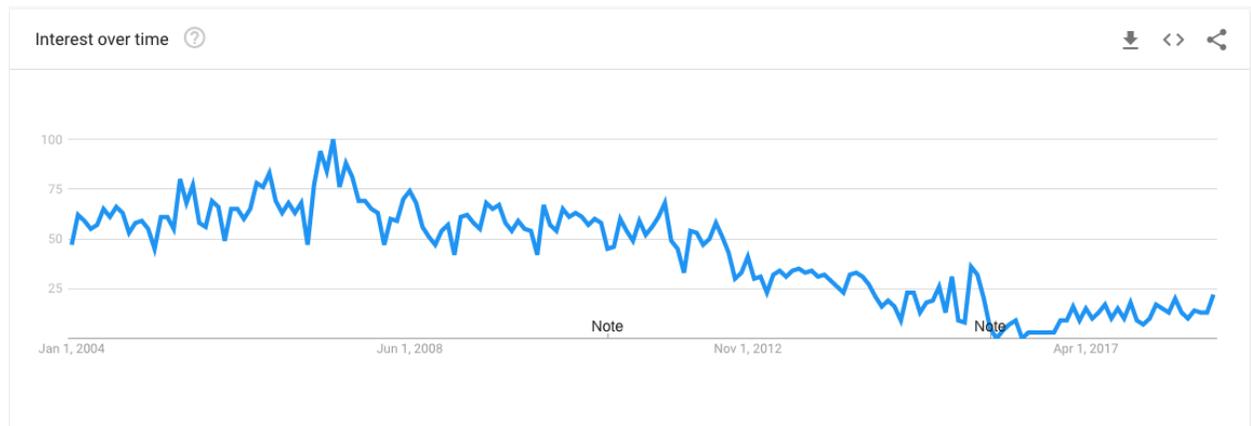
BBS became popular only after 2003, so BBS posts did not share the earlier pattern of mass media's reporting frequency of hydropower, particularly the intensified media coverage of hydropower in 2003. However, in the following years, the rate of high-impact BBS posts gradually became similar to those of our sampled print media, particularly between 2010 and 2011, when the strengthened implementation of EIA by MEP pushed higher media coverage of hydropower issues.

I did not systematically collect Weibo and blog posts on hydropower due to the difficulty of data collection and analysis. As Weibo was introduced only in 2009 when the hydropower controversy had relatively faded, the lack of Weibo data should not constitute a significant challenge to the validity of my media data analysis. Nonetheless, my interview with a researcher on new media who interned at a leading Chinese ENGO for her dissertation on social media and activism revealed that Chinese ENGOs have adopted a flexible strategy to combine the use of different social media platforms (blogs, Weibo and

WeChat) (INT20170109). Often, their opponents – local government departments and State-owned enterprises (SOEs) – failed to adopt such a strategy.

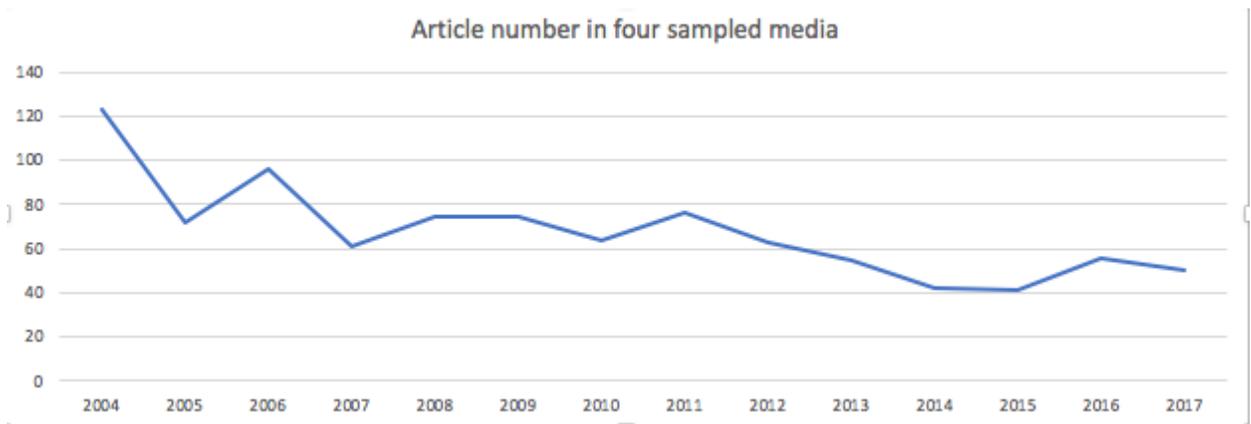
Media reporting of hydropower controversies mobilized by activists have increased mainly public attention to the disputes occurring in the far southwest. The above plotted high-impact BBS posts provided partial evidence. Another form of proof is Google search results obtained from Google Trends (<https://trends.google.com>). Figure 4 reflects the search trend below. Figure 5 was the combined hydropower reporting by the four sampled Chinese media, whose long-term trend was graphed in Figure 2, for the period starting in 2004 for comparison.

Figure 4 Google search trends (2004-2018)



(Source: Data were downloaded from Google Trends on December 25, 2018, by authors)

Figure 5 Combined hydropower reporting by four sample Chinese media (2004-2017)



(Source: Intercepted from Figure 3-1)

Although due to the difference in units (media reporting was calculated in years while Google Trends data can be calculated in dates), the two graphs cannot be directly compared, but we can notice that they roughly share a similar pattern. BBS posts and Google search trends seem to indicate that public reactions to hydropower were primarily driven by, or at least correspond to the media reporting events, though these media stories may be not only about controversies. Another critical point is that Google began to withdraw from China in 2010, but visit to it were not wholly blocked until May 2014 (Wikimedia, 2018). Therefore, Google search data can still be considered as an analysis reference.

The above analysis demonstrated the active and institutional role the media and Internet played in triggering and facilitating China's hydropower controversy. However, only revealing such a role is not enough for us to fully understand the controversies of hydropower and other S&T issues. For example, why did the media not quote orthodox experts to counterbalance activists' arguments against hydropower in their controversial reporting? Why, as we will indicate in the later chapters in this dissertation, did the media treated different controversial topics differently?

It is necessary to further explore these issues both through the social movement theory framework and through STS-oriented theories. In the next section, I will examine the components of social movement theories – particularly of political process theory and FA framework – underlying China’s hydropower controversies. Following that, STS concepts such as knowledge-control regime (Hilgartner, 2017), sociotechnical imaginaries (Jasanoff & Kim, 2013, 2015) and civic epistemology (Jasanoff, 2011b) will be probed.

3.4 SOCIAL MOVEMENT INTERPRETATION OF HYDROPOWER CONTROVERSY

Although the debate on dam building in China hid in professional terminologies and concerns, a political dimension is visible during the controversy. In the early dispute on TGP, dissenters took advantage of the newly opened political opportunity structure (Meyer & Minkoff, 2004) created by China's liberalizing reform in the 1980s while ENGOs' struggles against the southwestern hydropower projects were linked to the rise of the government's environmental protection agencies. When fighting the plan to build dams, the disobedient intellectuals and activists consciously or unconsciously attempted to expand the privileged political freedom in S&T issues and the legitimacy of civil society.

3.4.1 Examining political opportunity structure for TGP debates

Hot debate against the TGP broke out in the mid-1980s among CPPCC members. Three books published during the debate – *Treatises on Macro Policymaking on Three Gorges Project* (F. Tian et al., 1987), *Second Collection of Treatises on Macro Policymaking on Three Gorges Project* (F. Tian, 1989), and *Yangtze, Yangtze–Debates on Three Gorges Project* (Q. Dai, 1989) are the main data sources used in this dissertation. Wordings of the articles reflected the emerging political opportunity structure – an

atmosphere to encourage academic debates as a way to move toward political democracy – and actors' desire to utilize the opportunity.

In his preface to the first book, Zhou Peiyuan (1902-1993), former Peking University president and a leading physicist, argued that the debates on TGP were to implement and expand the Party's encouragement of scientific policy-making. Zhou's "political correctness" was shared by nearly all authors of the three books who appealed for scientification and democratization of policymaking about TGP. Sun Yueqi (1893-1995), a former top official of Kuomintang government in charge of the mining industry who was long marginalized after he surrendered to the communist government in 1949, told a journalist whom I interviewed, "it is time to (publicly) speak something. TGP [debate] is where I should be able to speak safely." (INT20161208a)

It is unfair to say that the authors argued against TGP simply for the sake of free speech. They demonstrated meaningful concerns about the sediment of sandstone (the main concern of Cornell-trained Huang), the insufficiency of TGP in flood prevention (particularly its role in preventing metropolitan Wuhan from flooding), the funding shortage, the big challenge to relocate the 1 million residents whose homes were to be flooded by rising Yangtze water level, and the project's impact on other hydropower projects which had to be suspended for the shortage of funding due to TGP's huge investment. Environmental and ecological impacts, the main argumentation against hydropower projects in later controversies were mentioned (F. Guo, 1987; Hou, 1987) but were not taken as the main issue during the debate.

Although the media did not widely report the 1980s' TGP debates, they indeed played a crucial role to disseminate the opinions of dissenting scholars. The publication

notes of the second *Treatises* claimed that 26 national and international media had reported the controversy. One senior journalist recalled that when she had a chance to attend a CPPCC meeting discussing TGP, she and peer journalists were enthusiastically welcomed with claps (INT20161102).

Journalists' effort to cover the TGP debate itself was a signal of the increasingly liberalizing sociopolitical environment, which is also part of the political opportunity structure. A journalist said she was involved in reporting TGP because, since the mid-1980s, she had opened a column in her news outlet to interview one or two intellectuals with fresh ideas per week. Targeted interviewees were often obtained through a snowballing recommendation. Gradually her interviewees involved more and more people challenging the TGP plan (INT20161208a).

The Chinese government took a very tolerant stance at the early stage of the debate, which can be considered another sign of political opportunity in such an authoritarian regime. The Central Propaganda Department, the supreme master for media censorship, allowed professional discussions on TGP at CPPCC and in professional journals, but disfavored such debates in mass media (B. Zhang, 2011). During the four years' debates, *Science Daily* (which later became *China Science Daily*, our sampled media outlet) and *Guangming Daily* (mainly covering intellectuals), as well as professional journals like *Journal of Dialectics of Nature* published by Chinese Academy of Sciences (CAS) and *Science and Technology Review* published by China Association for Science and Technology (CAST), were actively involved in publishing debating articles.

To summarize, we can find that even though the Chinese media had not marched towards marketization in the 1980s – which many scholars believed linked to a certain

degree of political freedom (Price, Rozumilowicz, & Verhulst, 2003; Shirt, 2011) – they became the agents to facilitate controversies, frame the justifiable features of the anti-TGP campaign, and mobilize support. The involvement of publications like *Journal of Dialectics of Nature* represented another early sign of China's S&T controversies – the presence of socially active STS scholars in debates regarding S&T.

3.4.2 Southwestern dam debates and fragmented authoritarianism

The TGP controversy can be considered a result of the emerging political opportunity structure created by China's liberalization trend in the 1980s. Although the political liberalization trend was halted due to the 1989 Tian'anmen Square bloody clampdown, the fast economic progress continued to fuel social and political diversification, fueling bureaucratic fragmentation, the very basis for the FA framework.

As discussed in the introductory chapter, FA framework can be loosely considered part of the political opportunity structure. Mertha (2008) listed a group of governmental organizations whose interests or goals conflicted with hydropower developers and their official sponsors like NDRC and the Ministry of Water Resources (MWR, which was the Ministry of Water Resources and Electricity during the 1980s' TGP debate). These agencies included SEPA and its updated version MEP, the Ministry of Construction in charge of urban water supplies, and State Administration of Cultural Heritage (SACH, as many cultural and historical relics could be overwhelmed by dams).

In the cases of China's southwestern hydropower controversies, what is in conflict is not only jurisdictions of agencies but also their institutional missions. This conflict can be seen in the Nu River controversy. The breakout point was the abovementioned SEPA meeting on September 3, 2003, which produced the PD article critical of Nu River

hydropower development. It is interesting to note that the PD story did not mention the SEPA seminar, apparently to avoid an impression of bureaucratic conflicts.

“In nearly every hydropower controversy, MEP was behind ENGOs and the media. In Chinese political regime, it is inconvenient for one agency to challenge another and State-owned conglomerates,” one hydropower industry expert said (INT20170106), an opinion shared by another interviewee closely linked to the industry (INT20161229).

While the bureaucratic fragmentation constitutes a political opportunity structure for triggering controversy, societal fragmentation has contributed to the more prominent and more sustainable debates. During the Nu River controversy, few journalists visited the planned dam-building site in Nu River (INT20161215, INT20160816, INT20161016), so they heavily relied on experts critical of hydropower development to produce their stories. After initial media coverage of the Nu controversy, Wang collected signatures from over 50 public figures at a national cultural study conference held in October in a petition to preserve the Nu River, facilitating another wave of media reporting. Journalists’ relying on experts for the authority and legitimacy of their reporting have been well documented (Albæk, 2011) and sympathizing experts were a primary source of anti-establishment science controversies including those in hydropower (McCormick, 2006, 2007a). Many of the experts interviewed by journalists, such as He Daming, an ecology professor at Yunnan University, attended the SEPA September 2003 seminar on Nu River preservation.

Yu Xiaogang, the founder of Yunnan-based ENGO Green Watershed and then a research associate at Yunnan provincial academy of social sciences, submitted a policy report on the poverty and hardship of hydropower-relocated residents based on his

dissertation field study through Yunnan provincial branch of Xinhua Agency³ The official acknowledgment of Yu's report led Yunnan provincial academy of social sciences to pay great importance to Yu's research and allow him to set up a self-funded institute, the precedent of Green Watershed, within the academy (INT20161225).

Some activists admitted that SEPA/MEP officials supported their actions while others denied they were simply a proxy agent of the government agency. "Some SEPA officials would come to support our actions because Pan Yue (then deputy administrator of SEPA who was a former environmental journalist) was friendly to ENGOs in his effort to launch the so-called Environmental Governance Storm. This tone made the rank-and-file officials tend to work with ENGOs." (INT20170515)

Others took advantage of the accommodating institutions too. After the media launched the anti-hydropower campaign regarding the Nu River, they reportedly managed to submit a signed petition to Premier Wen Jiabao through a retired air force general who was an environmental volunteer. Interviews suggested the activists sent similar reports or petitions through environmentally conscious leaders of the government's think tanks (INT20161215), quite similar to Teet's (2018) finding that ENGOs utilized their sponsoring organizations as a policy petition channel.

Most activists I interviewed can find internal channels to submit petitions to senior

³ He submitted the report to the then Premier Zhu Rongji. Chinese official media have long been empowered to reflect the local situation directly to the central leadership without going through the local bureaucratic hierarchy in the form of so-called Internal Reference (*Neibu Caokao*, or simply *Neican*) (Nathan, 1986, pp. 152-171). Throughout this dissertation, this role of official media has been assumed in the protests against controversial technologies and projects.

leaders at the central government.⁴ These channels include official news outlets such as Xinhua Agency and the *People's Daily* and their local branches, state-affiliated think tanks such as the academies of social sciences at various levels, research institutions such as CAS, senior scientists such as CAS/Chinese Academy of Engineering members, science management bodies such as China Association for Science and Technology (CAST), and some privileged academic societies such as old scientists' association (Zhu, 2013)(INT20161221). The diversified channels that activists can utilize to access to the central leadership are evidence that the regime was fragmented in ways that accommodated China's rising environmental activism, or we can consider them as a political opportunity structure favoring a specific type of activism.

Due to China's authoritarian regime, the annual plenary meetings of NPC, the Chinese legislature, and CPPCC are usually occasions when various elites express their political loyalty to the top leadership and their policy agenda, but these events also provided a forum for dissenting professionals to show their complaints and protests against policy, governance and technical issues (Saich, 2011). Table 8 shows critical CPPCC proposals appearing at annual plenary meetings of CPPCC (held in March each year) and other CPPCC events since the 2000s.

⁴ China has an established system to accept calls and petitions from people in the lower administrative jurisdiction. At the central government level, there is a State Bureau of Letters and Calls, and each government department is required to set up such an office or provide a similar function. However, letters and petitions submitted from these regular channels were at most processed by rank-and-file employees, with little chance to reach a senior official, let alone a minister or even a prime minister.

Table 8 Some of CPPCC or NPC's actions against hydropower since 2003

Year	Details
May 2004	In May 2004, Vice-chairman of CPPCC Li Meng led a delegation to inspect environmental and ecological protection in TGP and lower Jinsha River.
Mar. 2005	CPPCC members and a senior scientist at the CAS Institute of Geography and Natural Resources Liang Jiyang submitted a proposal to criticize that hydropower development sickened Chinese rivers.
Mar. 2007	Six CPPCC members submitted a proposal and talked with the media on disordered hydropower development.
Aug. 2007	CPPCC formed a hydropower inspection team to investigate the impact of small hydropower projects.
Sept. 2008	Shao Bingren, deputy director of CPPCC's environmental committee, claimed the overdevelopment of hydropower in upper Yangtze River and organized a team to investigate.
Mar. 2009	CPPCC members discussed the negative aspects of hydropower development and its exclusion from a State economic boosting plan (with a total investment of 4 trillion yuan) to fight the Financial Crisis.
Jun. 2009	SEPA suspended two hydropower projects for their failure to pass EIA. CPPCC organized a delegation to investigate.
Mar. 2010	CPPCC members submitted a proposal to protect wetland against hydropower development.
Mar. 2011	CPPCC members submitted a proposal to protect rural water facilities (appealing the State to invest more money to rural water facilities, which will reduce the investment to hydropower developments)
Mar. 2012	CPPCC members submitted a proposal to strengthen water resource management (from disordered storage of water by hydropower projects).
Mar. 2012	CPPCC members submitted a proposal, appealing to abolish the construction plan of Xiaonanhai hydropower station.
Mar. 2013	CPPCC members submitted a proposal, appealing to strengthen water management of

Chapter 3: Hydropower controversy

	hydropower and hydraulic reservoirs.
May 2013	Shao Bingren, deputy director of CPPCC's environmental committee, stressed at a CPPCC standing committee meeting that hydropower development must be scientifically planned.
Jun. 2013	Xie Qingsheng, a CPPCC standing member, appealed to have special legislation on Yangtze River hydropower development.
Jul. 2013	Xie Qingsheng, a CPPCC standing member, led a delegation to inspect upper Yangtze hydropower developments and appealed that they must be reasonably planned.
Mar. 2014	CPPCC members submitted a proposal, suggesting that the overdevelopment of hydropower and other new energies will increase the abandoning electricity produced from these sustainable sources.
Mar. 2014	CPPCC members mainly from Yunnan Province submitted a proposal, appealing to restart Nu River hydropower development. Other members bitterly criticized the plan.
Mar. 2015	CPPCC members submitted a proposal, appealing to keep the original faces of Nujiang from hydropower development.
Mar. 2015	CPPCC members submitted a proposal, appealing to strengthen legal stipulation of wetland protection (including protecting wetlands from losing water to hydropower facilities).
Mar. 2016	The CPPCC members from China Democratic Progress Party submitted a proposal, appealing to pay attention to the 3.7 million dam immigrants who were still in poverty.
Mar. 2016	CPPCC members discussed the policies to clear (many illegal) small hydropower facilities in Nu River.
Jun. 2016	CPPCC members made an inspection delegation to upper Yangtze River against the overdevelopment of hydropower.
Mar. 2017	CPPCC members submitted a proposal, appealing to strengthen water resource management in the Yangtze River basin.
Mar. 2018	CPPCC members submitted a proposal, appealing to strengthen wetland protection in upper Yangtze River.
Mar. 2018	CPPCC members in different regions jointly appealed to strengthen the management of smaller hydropower facilities, after the National Audit Office concluded in an audit report that small hydropower facilities have cut out water flows of 333 rivers in China.

(Sources: Collected by the author from the media reporting and CPPCC website)

Discussions at CPPCC's annual plenary meetings, or occasionally NPC, attract media attention more easily and legitimate the media's reporting of controversial issues. Hydropower thus became a target for such technical criticism.

3.4.3 Institutions and experts fueling hydropower controversies

In addition to bureaucratic fragmentation, rising ENGOs and the media, other social actors also played facilitating roles underlying hydropower controversies. International organizations, such as UNESCO, International Rivers, World Wildlife Fund (WWF), Oxfam, Conservation International, and The Nature Conservancy (TNC), are such players. International ENGOs' role in transnational anti-dam movements has been well recorded (Khagram, 2004; Lee, 2013b; McCormick, 2010). Most domestic activists I interviewed admitted they had received various types of funding from international charity groups or their foreign counterparts (INT20170310). Together with funding, international ENGOs were significant sources of expertise needed by their Chinese counterparts. International ENGOs were also suppliers of knowledge to Chinese government officials. This situation may explain the fact that even some highly antagonist foreign NGOs like Greenpeace can be allowed to have a legal presence in China (Teets, 2013).

International and domestic experts and scientists, particularly those who study biodiversity, fishing resources, sediments, dams' geological impacts, and relocation of impacted residents, can be considered another element influencing hydropower debates. Brødsgaard (2017) and Hansen (2017a) argued that scientists should be regarded as a central component of FA framework. For example, Cao Wenxuan, a renowned CAS academician famous for his systematic studies on Chinese carps, was the primary opponent

of the proposed Xiaonanhai dam in Chongqing (INT20161227).

With coordination by ENGOs, environmental and ecological research organizations and scientists were widely mobilized against dam building. Since the debut of the southwest anti-hydropower movement in Dujiangyan, the Nu River and Tiger Leaping Gorge, convening dissenting environmental, cultural conservation and animal protection experts to organize seminars widely attended by journalists had become the main tactic to question dam building. Through these seminars, experts' views were unified to an anti-dam tone which was quickly amplified by the media.

Following these earlier events, Wang Yongchen and her Green Earth Volunteers organized numerous Yangtze and Yellow river journalist inspections (*jianghexing*) (annual events for more than 15 years), each of which was headed and joined by environmental, geological and animal protection experts. A mobilization network of activists-experts-journalists-environmental officials formed firm and consistent public opinion pressure on hydropower side. Like earlier experts' seminar that raised anti-dam activism in Dujiangyan, Nujiang and Tiger Leaping Gorge, many of the subsequent journalists' inspections had one or two concentrated targets, resulting in intense pressure on hydropower developers.

Hydropower developers and supporters, as mentioned above, have made few effective counterattacks. Hence, an alliance composing of the fragmented bureaucratic agencies, local and international ENGOs, active academics and the media was formed. Fueled by the institutional accommodation of activism caused by China's social and economic transformation, the alliance outweighed the communication of the apprehensive hydropower industry and its weak local government allies, at least in the battle to win public opinions, leading to everlasting controversies surrounding hydropower development,

and often forcing the latter to suspend the targeted projects.

3.4.4 Understanding hydropower controversies with social movement theories

In this subsection, I made a table to link major hydropower disputes with features suggested by social movement theories. Based on the table, I summarized generic factors contributing to these disputes.

Table 9 Hydropower controversies through the lens of social movement theories

Chapter 3: Hydropower controversy

Controversy	Description; Project defending; Opposing points	Main actors	FA elements	Political opportunity structure	Activism' frame/ media discourse	mobilization
Yangliuhu Dam protest	In 2003, Dujiangyan Administration's plan to build Yangliuhu dam was abandoned amid loud protests and media exposure due to its location close to the UNESCO World Heritage scope.	Supporter: Dujiangyan Administration; Opponents: Budding ENGOs, the media, cultural experts; UNESCO China office, Dujiangyan municipal government	High. Other government agencies and social forces joined hands to oppose the project. The local government did not actively support the project.	Opposing experts had chances to appeal publicly; Media began to exert significant pressure; ENGO became organizers	The campaign was framed as preserving World Heritage and Chinese tradition rather than a civil society protest.	Some 180 media outlets reported the controversy. Journalists-oriented activists were most important mobilizers.
Tiger Leaping Gorge dam contest	In 2004, the plan to construct a dam near Leap tiger Gorge in Jinsha River was suspended. Supporters claimed the dam was crucial to adjust water supplies to downstream dam including TGP. Opponents claimed it will destroy UNESCO's heritage site "Three Parallel Rivers of Yunnan Protected Areas" and flood 100,000 ethnic minority villagers.	Supporter: Hydropower industry particularly Huaneng Group, Yunnan provincial government, MWR; NDRC; Opponents: Budding ENGO, the media, cultural experts; UNESCO China office, SEPA, Ministry of Construction, State Ethnic Affairs Commission	High. Except for hydropower industry and its governing bodies, the project upset nearly all other relevant ministries and their local branches, from environment and culture to water supplies and ethnic minority management.	Dam building plan had to be published to collect opinions; SEPA wanted authority for EIA; Construction ministry was active in maintaining world heritage; Ethnic minority right is politically sensitive in China.	The campaign was framed as preserving World Heritage and preserving ethnic minority. Cultural and tourism values were highlighted to promote public supports. SEPA's role was highlighted.	Media produced extensive critical reporting, with ENGOS jointly organizing the media reporting. This campaign involved SEPA but did not mobilize local communities.
Jinsha River EIA (environmental impact assessment) Storm	In 2004 and 2009, SEPA/MEP halted two dams which had not final EIA approval from the agency. Media widely reported SEPA/MEP's policy actions. The halted dams eventually went ahead after delays and EIA approvals.	Supporter: Hydropower industry particularly Huaneng Group and CTGC, Yunnan provincial government; Opponents: SEPA/MEP, the media	Moderate. SEPA was eager to erect its authority in EIA management. It utilized media forces to increase policy effect.	SEPA as a new government agency was keen to exert its power and maintain its jurisdiction. No other agency was involved.	The campaign was framed as a responsible agency to rightfully implement its public power against greedy and irregular business players.	Only the media was mobilized to report the governance issue. However, media especially picked up hydropower projects to report among the SEPA/MEP list of dozens of projects failing to pass EIA.
Xiaonanhai Dam contest	From 2009 to 2015, the Chongqing government forcefully	Supporter: Chongqing Municipal government. Hydropower	Moderate to high. The project initially focused on the tension	By the time Xiaonanhai controversy broke out, ENGOS had won several	The campaign was mainly framed as an environmental fight rather than regulatory ones.	The controversy was ultimately elite strife without any mass mobilization. The

Chapter 3: Hydropower controversy

	<p>advanced the proposed Xiaonanhai dam, located within the fish protection zone. ENGOs and a limited number of media outlets actively joined and reported the resistance. Supporters argued a State Council plan prescribed the dam site before the fish protection zone. ENGOs unsuccessfully sued government agencies. WWF supported the opposition by working out fish ecology reports. The project was eventually abandoned after Bo Xilai's fall.</p>	<p>industry was not keen on the project due to low profitability;</p> <p>Opponents: Ministry of Agriculture, SEPA/MEP, ENGOs, the media, fish and environmental scientists, lawyers, WWF. Changjiang Water Resources Commission.</p>	<p>between regional development and environmental protection. SEPA and MOA were initially not actively involved. ENGOs were very active, but their policy lobby effect was limited. A lawsuit can be adopted as a resistance weapon but with limited impact. The central element for successful resistance was the fall of Bo Xilai, Chongqing Party Secretary and a powerful rival to Xi Jinxing.</p>	<p>battles against hydropower development and were more confident, organized, and seemingly resourceful in knowledge and law tools. But the bureaucratic fragmentation was not extensive due to Bo's higher power.</p>	<p>Only a limited number with environmental consciousness or critical reporting tradition were involved. The media reporting was very cautious.</p>	<p>court battle, however, attracted some remote supports to ENGOs but not active.</p>
<p>Poyang Lake water facility controversy</p>	<p>Jiangxi provincial government's proposal to build a weir to prevent Poyang Lake from losing water to the Yangtze was actively rejected by ENGOs, arguing the project will destroy lake ecology, endangering bird and fish species. Activists also argued against an engineering solution to the water shortage crisis.</p>	<p>Supporter: Jiangxi provincial government</p> <p>Opponents: New generation of ENGOs featured with wild animal protection. Limited experts, the limited number of the media; WWF</p>	<p>Low. No bureaucratic supporters behind activists. Media's involvement was limited.</p> <p>But Jiangxi provincial government does not have many supporters in the central government. Hydropower industry is passive.</p>	<p>Xi Jinxing appealed Yangtze ecology protection and opposed significant development in the Yangtze. However, Jiangxi government used it to justify its project.</p>	<p>Framed as a grassroots appeal to seek an integrated environmental solution. Only a limited number of media outlets reported the controversy. It did not become a nationally hot media event.</p>	<p>Mobilization through social media and new NGO. No government agency was successfully lobbied.</p>

(Sources: Summarized by the author)

Per Table 9, we can make several observations. First, these controversies can be understood through the FA framework and political process theories. They became controversial not merely because of conflicting scientific claims, but because they involved many political actors, particularly the government agencies, ENGOs and the mass media.

Second, based on the involvement of these actors, the outcomes, development process and consequences of the controversies are different. For example, the hydropower EIA (environmental impact assessment) Storm (in the table above) in Jinsha River only involved SEPA and the hydropower industry with the media only playing a supplemented role, so that the solution came fast and eventually the resistance to the dams in question was cleared.

Third, although both the FA framework and political process theory have a durable explanatory power to analyze China's hydropower controversies, they have a different focus. The FA framework is superb in exploring micro-political structures while the political opportunity structure can cover some macro trends and environment for actors to seek justification.

But despite the FA framework and political process theory' explanatory power, they are insufficient in fully understanding S&T controversies, for both neglect the role of knowledge, how people use the knowledge, and sometimes the perceptual background on which actors rely to exert their influence. The next section of this chapter will examine the interaction between knowledge, power, and institutional/structural issues in China's hydropower controversies. Then, I will briefly analyze the political implications of the controversies.

3.5 CONCEPTUALIZING HYDROPOWER DEBATES IN STS LANDSCAPE

While the previous sections examined communication and social movement components of China's hydropower controversies, it is necessary to push the investigation further to understand how hydropower as an S&T issue may make the controversies different from a typical social movement case such as a peasant uprising or a worker's

strike. As an S&T issue, hydropower has been naturally linked to knowledge to justify relevant actions or mobilize allies.

3.5.1 Knowledge contention and civic epistemology in hydropower controversies

Opponents in the TGP debate in the 1980s included several hydraulic and sediment authorities such as Huang Wanli (1911-2001), Lu Qinkan (1911-2011), and Fang Zongdai (1911-1991), cherished as founders of China's modern hydraulic engineering or sediment science. By contrast, nearly all activists involved in the southwestern hydropower controversies lacked professional training in hydraulic science or hydroengineering. However, they did not fear to debate with hydropower experts because they successfully extended the focus of debate to environment, ecology, and resident resettlement.

Yang Yong, the founder of ENGO Hengduan Mountain Society and one anti-dam environmentalist, said he made a month-long field inspection every year to report the factual water flow and geological situation and then provided the knowledge to other activists to corroborate their counterarguments against official figures cited in the hydropower facilities' feasibility reports (INT20161221). Fan Xiao, the former chief engineer at the Sichuan Geology and Mineral Bureau in Chengdu, actively raised the issue of dams-triggering-earthquakes, several years before the Wenchuan Earthquake (INT20161222). Yu Xiaogang focused on hydropower governance, the impact of hydropower projects on local communities, and residents' participation in hydropower policymaking (INT2016125). Yu also introduced to China the World Commission on Dams (WCD)' report *Dams and Development: A New Framework for Decision-Making* (2000), a classic document widely cited by worldwide activists in their struggle against dam construction.

Other activists, particularly those from more established Chinese ENGOs, avoided debate using S&T terms even though initially they framed their rejection of dams as scientific debates. Instead, "we did not stress science. We debated with hydropower developers on regulatory issues," said a former head of an established Chinese ENGO (INT20170515). The regulatory issues he mentioned mainly referred to the EIA procedure governed by SEPA/MEP (INT20161120).

In addition to the WCD report, various alternative knowledges outside mainstream hydraulic scholarship/engineering, such as hydropower projects' environmental, ecological and geological impacts, fish data monitored by MOA's surveillance network and WWF's field trips, residents' relocation and ethnic minority groups' specific cultural heritage were also distributed among activist groups, dissenting experts, and SEPA/MEP. Most of these bodies of knowledge were outside orthodox hydraulic science and engineering scholarship, but they were used to enrich the argumentation against hydropower development's benefits and even to expand reviewing perspectives adopted in EIAs. For example, after the years-long Xiaonanhai controversy focused on whether dam construction would jeopardize the fish protection zone, MEP finally denied in 2015 the dam's EIA based on updated criteria absorbing the impacts on fish (INT20161227).

This knowledge contention can be understood in terms of civic epistemology, which "refers to these culturally specific, historically and politically grounded, public knowledge-ways" (2011b, p. 249). Although the hydropower sector was dominant in hydraulic engineering knowledge and the economic side of dams, activists did not challenge dam building from these perspectives. Rather, they contested the knowledge of dams' environmental and social impacts, which activists framed as more relevant public

knowledge. Following evidence presented above, one may find that "politically grounded" is also a necessary condition, because without a sponsoring agency and/or CPPCC, the public knowledge-ways to produce and distribute alternative knowledge were hardly possible during the hydropower controversies.

Another component of civic epistemology "historically grounded public knowledge-ways" raises the necessity of examining the concept of national sociotechnical imaginaries, an imagination with a role in shaping a nation's history and future (Jasanoff & Kim, 2009). It seems that the hydropower sector failed to fully enjoy the benefits of positive national sociotechnical imaginaries which it had struggled to create. Since the 1980s, official Chinese media ceaselessly reported the engineering advances of hydropower construction, framing it as the means to promote development. Table 10 summarizes the main themes of the PD's coverage of hydropower in the 1980s and 1990s. For the period, PD is the only newspaper available for analysis.

Table 10 Themes of the People's Daily hydropower articles between 1980-99

	1980-1989	1990-1999
Engineering	153	144
Development	152	37
Economy and business	37	44
Politics & national interests	23	18
Floods, dam safety & water management	10	5
Environment / Ecology	7	15
Science	2	6
History and Culture	1	2
Regulatory	1	0
Immigrant issues	0	3
Total	386	274

(Source: Collected and coded by the author)

However, as environmental awareness continued to grow in the 2000s, activists were primarily dedicated to toppling the nation's dominant developmentalism (Lee, 2014), rejecting the sociotechnical imaginaries of the engineering solution to managing water and the political control and corruption associated with this solution. "Chinese ENGOS' concentration in anti-hydropower in the early 21st century was because dams can provide a black-and-white symbol for social mobilization. The regime's corruption associated with dam building was also a factor leading to broad public participation in the [anti-dam] movement by ENGO members," said a former ENGO leader (INT20170515). SEPA/MEP, the environmental agency, no doubt helped strengthen the imaginaries unfavorable to

hydropower.

Knowledge becomes knowledge not only because it is created by scientists and other "qualified" producers but also because people and policymakers accept it in concrete settings with necessary imaginaries. Now we can say certain knowledge become legitimate by the socially constructed qualified knowledge community, but this does not mean other knowledge considered illegitimate or excluded by this community does not count. Rather, adoption, legitimacy, and imaginaries in the policymaking setting are not solely decided by the "qualified knowledge community" but by relevant agencies whose political authority can empower them with the privilege of knowledge selection. Relevant agencies also empower or authorize activists or dissenting experts to produce and distribute alternative knowledge. In this sense, Chinese hydropower controversy has enriched our understanding of the concept of civic epistemology.

3.5.2 Knowledge-control regimes and the disintegrated knowledge making

While people can have their own "public knowledge-ways," whether such public knowledge-ways can be legitimately and saliently adopted to challenge orthodox knowledge supported by the state (at least by relevant government agencies) and industry relies on the level of social and epistemic control the orthodox side can realize. Hilgartner's (2017) "knowledge-control regime," which refers to "a sociotechnical arrangement that constitutes categories of agents, spaces, objects, and relationships among them in a manner that allocates entitlements and burdens pertaining to knowledge" (2017, p. 9) can be a powerful explanatory tool, though the concept has not been tested in public science controversies since its debut.

According to Hilgartner (2017, p. 12), for specific knowledge, while multiple

knowledge-control regimes are relevant, which can control objects, jurisdiction, and relationships, there is a "governing frame," which promotes an official viewpoint that endows agents with specific entitlements and burdens pertaining to other agents or to control over spaces, objects, and actions. In line with this idea, we can suggest that due to continued and concentrated controversies, the hydropower sector may suffer a weak governing frame **in the public sphere** to control knowledge production, distribution, and acceptance, at least in the specific fields closely connected to debates. The suffering of hydropower sector may both result from political factors that I discussed in the previous section (e.g., FA reduces hydropower supporters' control over jurisdiction) and be produced by the nature of the specific type of knowledge. In this case, it is loosely defined environmental sciences.

During my interview with an industry expert, he repeatedly stressed, by citing new literature, that ecology should be adapted rather than stationary, only highlighting the unalterable nature. Hence, ecologists should consider the benefits dams have brought to the ecology rather than merely insisting on the value of the so-called authenticity of original biodiversity (INT20170106). So, a representative of the dominant mainstream/orthodox hydropower knowledge became an outsider of another type of expertise, appealing to the latter to make appropriate adjustment. Hence, when the "unadjusted" ecology becomes a necessary part of the knowledge to support environmental assessment policies and implementation, partly through the channels created and expanded by anti-dam activists, the strength of orthodox hydropower knowledge as reflected in the industry plan drafting made by NDRC/NEA is weakened in the EIA policy-making and implementation process.

By nature, all types of knowledge should have the same problem, but, in accordance

with the trading zone metaphor (Galison, 1997), there are many types of "harmonized" knowledge in which the potentially differentiating or even conflicting elements/paradigms may have reached consensus through negotiations and/or interest exchange. However, data collected in this dissertation shows that when appearing in the public sphere, environmental, ecological, fishery and gardening experts continuously challenged dams. This knowledge contention can be viewed from Table 3-8, which outlines themes of hydropower in the four sampled Chinese media and the summative statistics of associated article attitudes and whether controversial/debatable contents are visible in these articles.

Table 11 Main themes of the four sampled media's hydropower articles, article attitude, visibility of controversies and their percentage

Issue Frame	Total	Positive	Neutral	Negative	Visible Controversy	The ratio of Visible controversy / Total Number	The ratio of Negative reporting / Total Number
Public accountability & Regulatory	68	3	14	51	63	93%	75%
Environment / Ecology	208	31	71	106	165	79%	51%
Science and technology	91	59	24	8	43	47%	9%
History & Culture	37	11	22	4	17	46%	11%
Politics & national interests	73	45	22	6	23	32%	8%
Immigrant	41	14	20	7	10	24%	17%
Floods, dam safety & water management	107	22	64	21	24	22%	20%
Economics and Business	182	93	80	9	24	13%	5%
Development	110	75	33	2	12	11%	2%
Engineering	344	181	162	1	18	5%	0%

(Source: Collected and coded by author. PD and SW from 2000, XEN from 2002 and CSD from 2003)

Per Table 11, among all themes, regulatory and environmental/ecological themes see the two highest association of negative media articles. The two types of articles also show the highest ratio of negatively reported media stories. The high percentage of negative reporting and visible controversies in environmentally framed stories indicate that the hydropower sector had a low capacity to control knowledge of this type (environment, ecology, fish protection, sedimentation, and so on). Comparatively, stories with an engineering theme had the lowest rate of negative reporting and the second lowest percentage of visible controversies, representing that the hydropower sector had a much stronger control in this type of knowledge. The media analyses show that at least in the public sphere, the orthodox hydropower knowledge community cannot rein in the environmental sector in their effort to promote hydropower development.

This failure may reflect the fact that the hydropower sector's original "technology complex," using the terminology of Pietz (2015), has failed to integrate modern environmental, ecological and biological sciences adequately. In the sense of knowledge-control regimes, besides hydropower sector's insufficient jurisdiction control due to bureaucratic fragmentation, this is also related to the sector's failure to control space or objects due to most dams and reservoirs' normally open geographical conditions that make environmental and ecological impact data easily accessible even for ordinary external researchers.

On the other hand, due to China's environmental woes, ecological and environmental sciences are enjoying an increasingly privileged status in the country, and environmental knowledge production itself is connected with activism, as the environmental movements have shown in the West decades ago (Eyerman & Jamison,

1989). The increasingly salience and privilege of environmental knowledge makes the field a fertile land in producing public figures, ranging from vice environmental minister Pan Yue (currently executive vice president of the Central Academy of Socialism in Beijing) to various anti-dam public intellectuals. Table 12 summarizes some of the prominent public intellectuals (primarily through the media), not including professional activists mentioned above, against hydropower in chronological order.

Table 12 Noticeable public intellectuals against hydropower (excluding ENGO members)

Name	Affiliation	When and where to get involved	Level of involvement
Lu Qinkan	A senior hydraulic scientist	During TGP debates	High
Lv Zhi	Conservation biologist at Peking Univ.	As a head of ENGO of the conservancy, Lv has continuously been involved in debates.	High
Tian Song	STS scholar at Beijing Normal Univ.	In the mid-2000s when the southwestern hydropower controversy became a hot event	Low
Liu Huajie	STS scholar at PKU	In the mid-2000s when the southwestern hydropower controversy became a hot event	Low
Weng Lida	Yangtze River Water Resources Protection Bureau	Consistently opposed to southwestern dams in upper Yangtze River	Deep
Chen Guojie	Chengdu-based Institute of Mountain Hazards and Environment (IMHE), CAS	Involved against TGP and later became a leading opponent to southwestern dams	Deep
Cao Wenxuan	Wuhan-based CAS Institute of Hydrobiology	Involved against southwestern dams for fish protection since the mid-2000s	Moderate
Bai Daming	Yunnan University	Involved against southwestern dams for ecology in the early 2000s	Moderate
Xu Daoyi	Retired scientist at Institute of Geology, China Earthquake Administration,	Involved against southwestern dams for their possibly triggering earthquake in the early 2010s	Low
Sun Wenpeng	Retired scientist at Beijing Research Institute of Uranium Geology	Involved against southwestern dams for their possibly triggering earthquake in the early 2010s	Low
Zhu Ming	Retired scientist at Beijing-based Institute of Geology and Geophysics, CAS	, involved against southwestern dams for their potentially triggering earthquake in the early 2010s	Low

Chapter 3: Hydropower controversy

Li Dongxu	Retired scientist at China University of Geosciences	, involved against southwestern dams for their possibly triggering earthquake in the early 2010s	Low
Jiang Gaoming	Institute of Botany, CAS	A botanic scientist occasionally against hydropower publicly	Low
Yu Kongjian	A famous gardening scholar at Peking University	Sometimes against hydropower publicly	Low
Huang Wanli	A senior hydraulic scientist	During TGP debates. Became an anti-dam intellectual legacy	Low
Liu Shukun	A senior hydraulic scientist	Occasionally against hydropower publicly	
Zhou Jianjun	A hydraulics professor at Tsinghua University	Occasionally against hydropower publicly	Moderate
Liu Dehong	Deputy director for sea affairs at the Ministry of Communications, and a CPPCC member	Stood up to question southwestern hydropower projects in 2005 as a CPPCC members	Low
Yang Zunwei	A CPPCC member and a senior engineer at China Harbor Engineering Corp	Stood up to challenge southwestern hydropower projects in 2005 as a CPPCC members	Low
Lu Renda	A CPPCC member and a deputy chief engineer of China Road & Bridge Corp	Stood up to question southwestern hydropower projects in 2005 as a CPPCC members	Low
Zhang Zhikai	A CPPCC member and wife of Politburo member Yu Zhengsheng	Stood up to challenge southwestern hydropower projects in 2005 as a CPPCC members	Low
Zhu Shou	A CPPCC member and vice-president of China General Association for Light Industries	Stood up to question southwestern hydropower projects in 2005 as a CPPCC members	Low
Li Xiaodong	A CPPCC member and vice-chairman of CPPCC Shaanxi branch	Stood up to challenge southwestern hydropower projects in 2005 as a CPPCC members	Low
Zhao Yimin	Director of MOA Office for Yangtze River Fishery	Involved against southwestern dams for fish protection since the late 2000s	Moderate

(Sources: Collected by the author from the media reporting)

The above table shows that anti-hydropower experts were dispersed across fields such as environment, ecology, fishery, and seismology. Although many of them were not consistent anti-dam activists, their identity and expertise were utilized by ENGOs and other activists to form a strategic front against hydropower developments periodically.

Scientists, scholars, and experts are not the only group of people regularly and habitually questioning the knowledge of hydropower. Government agencies such as SEPA/MEP and MOA are these actors too. But unlike the analysis suggested by political

frameworks such as FA, the knowledge-control regime analysis shows that these agencies compete with hydropower developers and their government sponsors (NDRC, MWS, and NEA) not just for jurisdictional power, but also for knowledge issues.

For example, a hydropower industry expert pointed out that implementing EIA is only part of the story for SEPA/MEP to always “trouble” hydropower industry. “MEP and hydropower industry had a basic divergence. A major indicator to evaluate MEP’s work achievements is to reduce chemical oxygen demand (COD). Building dams will certainly reduce water flow speed and increase COD” (INT20170106).

The claim was not confirmed by people linked to or familiar with SEPA/MEP, but the agency’s effort to collect, learn, organize and distribute knowledge that can resist hydropower is apparent. After SEPA officials learned about the WCD report from Yu Xiaogang in 2003, the agency invited him to Beijing to give its staff a detailed presentation on the report and its possible application in China and commissioned him to translate the WCD report. Yu was also invited to brief SEPA officials at its internal workshops about the report, which, for quite a long period, became a knowledge weapon for various individuals and organizations questioning dams (INT20161225).

According to Hilgartner (2017, p. 9), knowledge-control regimes "play a central role in regulating the production and use of knowledge," and they have a "lawlike structure, which constitutes specific means of controlling knowledge objects, disciplining actors, and bringing order to specific jurisdictions." Based on the empirical data presented above, it seemed that the hydropower sector failed to regulate the production and use of the increasingly salient environmental knowledge. In this field, regarding hydropower projects' environmental impacts and consequences, hydropower companies lacked a lawlike

structure contributing to control knowledge objects, discipline actors, and bring order to specific jurisdictions, at least in the public controversy settings.

Of course, the hydropower sector's insufficient control of environmental knowledge production in the public sphere did not mean it became a weak actor. Despite the debates, the government's energy and economic planning agencies such as NDRC and the National Energy Administration (NEA) continued to approve hydropower development plans. The orthodox hydropower knowledge community, including various evaluation committees to back up these agencies' decisions, continued rejecting the alternative knowledge and their producers. Although nearly all publicly disputed dams were suspended or suffered remarkable delays, most of the undisputed dams were constructed without too strong resistance.

To summarize this section on STS perspectives on hydropower controversies, one can safely conclude that thanks to a civic epistemology that prioritizes environmental, ecological and societal consequences of hydropower development, activists have triumphed over the developmentalism discourse of the hydropower sector. Despite the hydropower sector's firm control over engineering knowledge and the development agenda, its knowledge-control regime failed to contain production and distribution of environmental knowledge – which became more salient public knowledge due to an alliance between the media and activism – due to both epistemic factors and political struggle over jurisdiction. Neither civic epistemology nor knowledge-control regimes were static but dynamically developed in the process of hydropower controversies, in which the choices of main actors, such as juridically powerful agencies like SEPA/MEP, can significantly shape either civic epistemology or relevant knowledge-control regimes.

While civic epistemology and the knowledge-control regime have durable explanatory power in the context of China's hydropower controversy, applying them here also helped enrich the meanings of the two concepts while widening our understanding of knowledge production process.

3.6 CHAPTER CONCLUSION

This chapter investigates China's hydropower controversy, particularly the southwestern hydropower controversies since the 2000s, with the analytical frameworks of communication scholarship, social movement theories, and STS concepts respectively. Each of these frameworks can explain some aspects of the occurrence and development of hydropower controversies, but none of them can solely cover the whole picture. For example, media commercialization and China's political censorship drove journalists to choose politically safer, yet technically sensational environmental issues for their negative reporting and this has boosted and strengthened hydropower controversies. But the reporting needs sponsorship from government agencies and support from experts. The bureaucratic fragmentation as a political opportunity structure resulted in such sponsoring agencies and the rising environmental knowledge that escaped the hydropower sector's knowledge-control regime offered supporting experts for the media. On the other side, both social movement mobilization and negatively framing hydropower projects highly depended on the media. The press was also a vehicle to convey civic epistemology and a catalyst to break knowledge-control regimes of the hydropower sector, at least in environmental knowledge and regulatory aspect of hydropower projects.

On the other hand, factors derived from different theoretical frameworks interacted with each other frequently. Journalists turned to activists in the environmental sector,

linking the media and activism; SEPA/MEP resisted hydropower development from its policy consideration (e.g., controlling COD), but also sought alternative knowledge from activists, partly legitimizing the latter in the public sphere regarding the controversy.

Combining all these factors, we can find the hydropower sector, despite its tens of billions of yuan assets, was positioned in a relatively disadvantaged political and epistemic position. The hydropower sector suffered from media opposition, bureaucratic fragmentation, and the relatively weak knowledge-control regime in environmental knowledge, which became salient knowledge in the public sphere. It did not enjoy glorious national sociotechnical imaginaries to offset the disadvantages. As a result, although most hydropower projects were on schedule, partly due to the sector's firm knowledge-control regime in engineering and development agenda, nearly all publicly controversial dams were halted.

In applying the different theoretical frameworks in explaining China's hydropower controversy, this chapter also developed and enriched these theoretical traditions. For example, it introduced contested knowledge into social movement theories and borrowed fragmented authoritarianism to understand knowledge issues such as civic epistemology. These theoretical developments will be discussed and compared across different cases in the concluding chapter of this dissertation.

Chapter 4: GMO controversy: How orthodox science lost control

4.1 INTRODUCTION

In the past 40 years, disputes over genetically modified (GM) foods and crops have been spreading worldwide (Schurman & Munro, 2010). China is no exception. The public support for GM foods has seen a steady decline in the past 15 years, and resistance to them has grown significantly (Cui & Shoemaker, 2018). As a result, China has not approved any new GM variety since 2006 when the government gave the green light to an anti-virus version of GM papaya.

The GMO controversy has received the broadest scholarly attention in revealing social psychological elements leading to the public perception of the technology (Gupta, Fischer, & Frewer, 2012). Other studies have analyzed social disputes over it (Motta, 2014), activists' strategies to demonize agricultural biotechnology (Herring, 2008, 2010b) and communication factors associated with the controversy (M. C. Nisbet & Huges, 2006; M. C. Nisbet & Lewenstein, 2002).

However, few studies have integrated communication, STS, and social movement scholarship to reveal the broader sociopolitical and epistemic landscape underlying the world's most sustained S&T controversies. In addition, despite intensive local studies in China on public attitudes and an in-depth monograph on the issue's policy implications (Cao, 2018), no research has examined with a theoretical lens how anti-GMO activism, social and political transformation, and epistemic factors have co-evolved in China, the world's largest importer of GM crops (GM soy and corn). Combining different theoretical traditions for a meaningful explanation of China's GMO disputes is the objective of the

current chapter.

4.1.1 Social, psychological and political roots of GMO contentions

From the 1970s, biotechnology has been frequently debated in mass media (Schurman & Munro, 2006). Protests have followed a series of food scares, such as mad cow disease (Irwin, 2001). The British government's initial cover-up and poor reactions shook the public confidence in its S&T regulations (Bonny & Sylvie, 2003).

Indeed, public trust in institutional actors like government often strongly predicted support for GMOs (Einsiedel, 2002; Gupta et al., 2012; Pin & Gutteling, 2009; Pin, Gutteling, & Kuttschreuter, 2009; Priest, 2001; Qiu, Huang, Pray, & Rozelle, 2012; Siegrist, 1999). Scholars believe institutional trust is based on value similarity – meaning whether people think that institutional players like government officials share the same values with them (Siegrist et al., 2000; Siegrist et al., 2012). Brossard and Nisbet (2007) argued that deference to scientific authority, a value long rooted in the American public, was a powerful predictor to explain trust in scientific institutions and the corresponding support for agricultural biotechnology in the United States.

Anti-GMO campaigns have consistently framed GMO as risky, uncertain, and sometimes unethical (Cook et al., 2006; Levidow & Boschert, 2011). These observations are consistent with Herring's (2008, 2010b) more analytical assessment of anti-GMO activists' framing strategies. Although both medical and agricultural biotechnologies rely on genetic modification, activists have effectively branded the latter as “one ominous category: GMOs” (Herring, 2008, p. 459).

On the other hand, biotechnology and other mainstream scientists have been mediocre at engaging the public and mistreated its risk perceptions, thinking the public

resistance to GMO was because of its naïve requirement of the impossible 'zero risks' (Cook et al., 2004; Cuppen et al., 2009). Scientists generally describe risk in a quantitative, measurable way, while the public tends to view it in a qualitative way (McInerney, Bird, & Nucci, 2004).

4.1.2 The role of the media in the GMO controversy

Although Europe's opinion-leading media's earlier coverage was positive to agricultural biotechnology (Gutteling et al., 2002), their attitude has changed since the mid-1990s. For example, Frewer et al. (2002) found European media tended to aggrandize the negative impacts of GMOs and concentrated in reporting GMO safety studies. In their review of the UK media's reporting of its 2003 national debate, "GM Nation?" (Barbagallo & Nelson, 2005), Cook et al. (2006) found the UK media widely cited public representatives and NGOs to counterbalance scientists and the government's effort to frame GMO in science and technology terms. Augoustinos, Crabb, and Shepherd (2010) further demonstrated that the UK media's GMO coverage during the 2003 national debate was full of semiotic signs and metaphors linked to the ongoing Iraqi war. Meanwhile, European media continued to treat medical biotechnology positively but reported agricultural biotechnology negatively (Marks, Kalaitzandonakes, Wilkins, & Zakharova, 2007).

The United States elite media were very favorable to biotechnology (M. C. Nisbet & Lewenstein, 2002). In their analysis of TV evening news of GMO reporting over more than two decades, Nucci and Kubey (2007) found US TV (evening news) coverage of GMO was slight and mostly positive. Compared with the national press, US community newspapers included a more comprehensive range of concerns (Crawley, 2007), indicating that the biotechnology-friendly environment in the United States is most likely a result of

elite support at the national level.

As a whole, when reporting agricultural biotechnology, US media adopted a cost/benefit frame more frequently while British media stories often used the frame of environmental risks (Marks, Kalaitzandonakes, Allison, & Zakharova, 2003). Listerman (2010) found that science and economic frames dominated the US media, German media had an active ethical discourse, whereas British media were inclined to link agricultural biotechnology to a public agenda.

According to M. C. Nisbet and Huges (2006), the GMO controversy was regularly assigned to science journalists rather than political or general assignment journalists in US elite media outlets and appeared mainly in science or environmental pages instead of front and political pages. Flipse and Osseweijer (2013) found that the science community, government, and biotechnology industry's slow response to GMO-related controversial events resulted in their far lower presence in media than anti-GMO activists. When they did respond, media attention to the events had decreased, and most people did not have a chance to read or hear positive perspectives.

4.1.3 Civic epistemology and knowledge control in GMO controversy

Similar to many authors cited above, Sheila Jasanoff also examined the national differences in biotechnology governance across the Atlantic (2005; 2011b). But she explored the more fundamental knowledge-making ways in which biotechnology is understood in the United States, Britain and Germany and their interaction with policymaking. According to Jasanoff (2011b), the United States (as a result of its habitual use of quantifiable risk assessments and its distrust of public roles in regulation) implemented an early and quicker exclusion of non-scientific voices in assessing

biotechnology to form an interest group and market-driven, product-focused, scientific authority-seeking, and litigation-relying risk regulation system, smoothing the advancement of GMOs.

In examining the different policymaking processes, Jasanoff proposed the concept of civic epistemologies, which are the stylized, culturally specific ways in which the public expect the state's expertise, knowledge, and reasoning to be produced, tested and put to use in decision-making (Jasanoff, 2011b). This concept is particularly important in understanding how the GMO controversy featured a sharp tension between mainstream scientists' acceptance and the public's rejection (Rainie, Funk, & Anderson, 2015).

The conflict was captured by Schurman and Munro (2010) by using a concept developed by Schutz and Luckmann (1973) in sociology – lifeworld – which “comprises a stock of culturally transmitted background knowledge that people bring to a situation and that provides them with a common cognitive and normative frame of reference” (Schurman & Munro, 2010 pp. Kindle Locations 252-253). They argued that the conflicts between the scientist-industry lifeworld on the safety and efficacy of GMOs and the activists' lifeworld on its evilness explain the emergence of GMO controversies, its bitter disputes, the tactics each side used, and the social struggle changes across time (Schurman & Munro, 2010, pp. 188-192).

The challenge of civic epistemology to orthodox genetic science and the conflicts of the two lifeworlds raise the question of knowledge control, explored by Hilgartner's (2017) “knowledge-control regimes” concept, which, though proposed through Hilgartner's study on the Human Genome Project (HGP), is still very useful for us to explore the emergence, sustainability and degree of GMO controversies. Using this

framework, we may say that the US science-industry-government alliance (and, to a lesser degree, such partnerships in Canada, Australia, and Brazil) better controls the biotechnology knowledge production and distribution than the activist alliance, and that their control prevents activists and other citizens from comprehensively stigmatizing biotechnology.

In China, scholarly examinations of the GMO controversy are limited to measuring public attitudes (Cui & Shoemaker, 2018; Guangxi He et al., 2017; J. Huang, Qiu, Bai, & Pray, 2006; Qiu et al., 2012) or the nominal appeals (mostly by Chinese STS scholars) to increase public participation in the policymaking process (C. Fan, 2010; X. Jiang, 2014; S. Tian, 2010, 2012). This chapter is an effort to fill the gap in our understanding of GMO controversy in the sociopolitical context in China.

4.2 CONTEMPORARY GMO CONTROVERSIES IN CHINA

Since 1997 when China commercialized Bt (*Bacillus thuringiensis*, an insect-killing bacterium) cotton, the country has experienced rapid growth in both biotechnology research and application. In 2017, China planted 2.8 million hectares of GM cotton and papaya, accounting for 1% of the total global land for biotechnology crops and 0.3% of its 956-million-hectare arable land, ranking 8th in the world in terms of the acreage used for such plants (ISAAA, 2017).

In the early years, GM crop development in China was highly encouraged and free from any controversy, hailed as a significant national S&T progress in the media. But in 2001, the Chinese government enacted a set of State Council (China's cabinet) safety regulations on transgenic agricultural products, apparently to prepare China for the impact from the expected import surge of US agrarian products upon its imminent entry to the

World Trade Organization (WTO) (INT20161118).

The first campaigns against GMOs in China were all launched and organized by Greenpeace. In 1999-2000, Greenpeace launched its first round of attack, spreading a report to claim that China's GM cotton had caused some ecological threats, but there was little media and public attention (INT20161215).

In 2003, Greenpeace dramatically changed the direction of its anti-GMO campaigns to focus on GMO regulation's public accountability and transparency (INT20160926, INT20161122). The timing corresponded to China's coverup during its SARS (severe acute respiratory syndrome) crisis. In 2003, Shanghai consumer Zhu Yanling, backed by Greenpeace, sued Nestle for not labeling GMO ingredients in its baby rice products (N. Xu, 2009). Although Zhu lost the lawsuit and most Chinese consumers at that time accepted GM food (J. Huang et al., 2006), the litigation as a high-profile public event planted seeds among the media and some public members for future anti-GMO activism.

In 2004, Chinese scientists and policy advisors increased their efforts to lobby the government to commercialize GM rice (Jia, Jayaraman, & Louët, 2004). But the commercialization process was suddenly halted by a Greenpeace-supported investigative story published in the popular liberal newspaper *Southern Weekend* (SW) in December 2004. The cover story claimed that scientists commercialized GM rice for their interests despite the uncertainties, and the national GMO safety committee under the Ministry of Agriculture (MOA), which was responsible for offering experts' views on GMO commercialization and safety certificate, was full of biotech experts seeking financial benefits (J. Liu, 2004).

The high-impact SW cover story launched the offensive against GMOs in China.

Chapter 4: GMO resistance

In 2005, Greenpeace found that local farmers illegally planted the GM rice developed by Wuhan-based Huazhong Agricultural University (HZAU) (INT20161122). Greenpeace exposed the scandal, causing another wave of critical media reporting.

In the late 2000s, another organized anti-GMO force was formed in China. The campaigners, consisting of Maoist intellectuals, activists, and some quack scientists, organized around a Maoist website Wuyouzhixiang (literally meaning “Nowhere”: <http://www.wyzx.com>), held up GMOs as a symbol of capitalism and the American imperialists' conspiracy to control China.

To the delight of plant scientists, however, Premier Wen Jiabao publicly showed his support for GMOs in 2008, and the Chinese government launched a gigantic funding program to support GM seed research, among the country's 16 mega research projects (R Stone, 2008). However, the good news to plant scientists soon proved to be their nightmare. The issuance of GM rice biosafety certificates in 2009 raised a nationwide protest against GMOs and the policies to commercialize them. In a move rare in authoritarian China, more than 100 leading Chinese scholars, with CAS botanist Jiang Gaoming as the only scientist among them, submitted a protest petition to the annual plenary meeting of the National People's Congress (NPC), China's legislature, in March 2010.

Greenpeace did not exit. In 2012, Greenpeace exposed a scandal of a Tufts University professor who unethically fed Chinese children with genetically modified golden rice without proper informed consent in a nutritional study on the crop (Qiu et al., 2012). Once again, the public anger and protest against GMOs erupted.

GMO and plant scientists continued lobbying top Chinese leaders including Xi Jinping. But the pro-GMO front received a heavy blow in late 2013 when Cui Yongyuan,

Chapter 4: GMO resistance

a famous TV talk show anchor, joined the movement against GMOs. With his substantial public influence, penetrating language skill, status as a CPPCC (the Chinese People's Political Consultative Conference, equivalent to China's upper house) delegate and strong mobilization capacity through social media, Cui became a new center of China's anti-GMO campaign.

Meanwhile, in 2015, China's propaganda department began to cool down media coverage of GMO issues and dramatically reduced media reporting of GMO controversy. According to sources I interviewed for this study, the purpose is not to support biotechnology but to avoid public unrest (INT20160919, INT20170725). In its newest policy agenda, the 13th Five-Year S&T Development Plan (2016-2020), science authorities (MOST and MOA) revised the roadmap of agricultural biotechnology, prioritizing the plan to commercialize non-staple food GM crops (GM corn and GM soya) while suspending the commercialization of GM rice. However, as late as mid-2019, the fourth year of the five-year plan, no sign of the green light for commercializing GM corn has been heard. Although Chinese media have reported few significant scandals/safety events about GMOs since 2016, several nationwide surveys continued to show public disfavor (Cui & Shoemaker, 2018; Guangxi He et al., 2017; Ren, Gao, & Huang, 2016).

The above summary shows that with lots of media enthusiasm, contention about GMOs was prominent, sustained, and widely engaging science controversy in China. Both Pro-GMO scientists and science communicators and anti-GMO activists tried to attack the other side with extreme claims and often emotional expression. A large number of intellectuals of different backgrounds were involved in anti-GMO campaigns which have been highly diversified. But on the other hand, few civil society organizations, including

nearly all local ENGOs, have actively joined the debates on GMOs.

4.3 MEDIA LANDSCAPE OF GMO CONTROVERSY IN CHINA

4.3.1 Media liberalization and scientists' communication failure

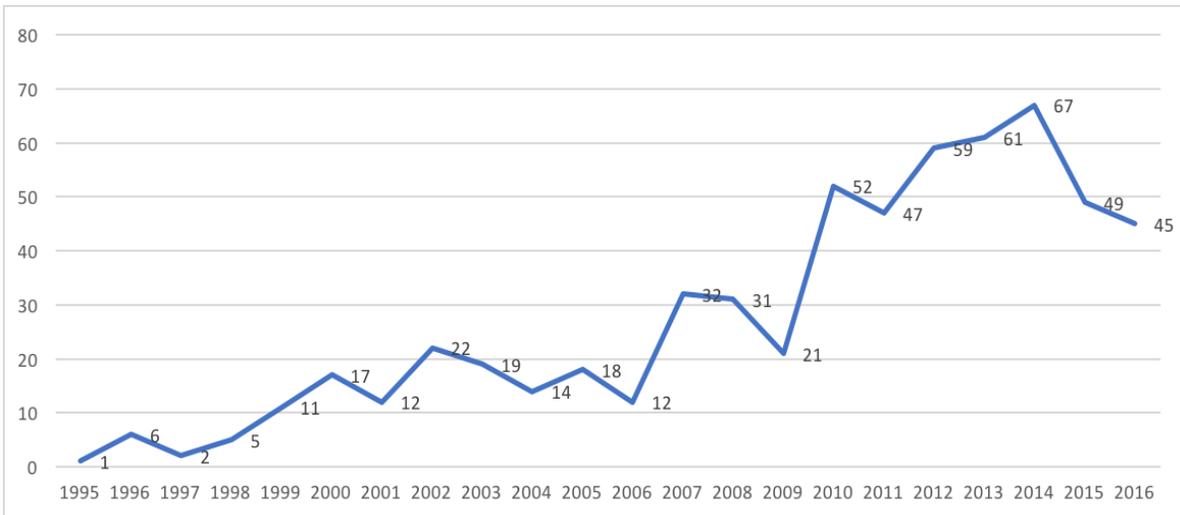
Tracing China's GMO controversy lasting nearly 20 years, one can identify a crucial role the media has played. Since the very beginning of China's GMO controversy, presenting the technology's uncertainties and disputes in the press was a vital task of Greenpeace, which initiated China's anti-GMO campaigns and dominated their agenda until 2013/14 when popular TV anchor Cui Yongyuan became the central actor.

Greenpeace fully utilized China's ongoing media commercialization and partial liberalization (Chan & Qiu, 2002). It hired at the very beginning of its China operation active journalists from liberal media outlets like SW to work as its public relations staff (INT20160926, INT20161122), consistently attracted liberal media's attention to its campaigns ranging from anti-GMO and tracing chemical pollution to fighting climate change, and effectively helped the media frame these events as defending public interests.

Media commercialization and partial liberalization have driven Chinese media to attract public attention through sensational news reporting. GMOs are one of such topics. The mass media's impactful reporting initiated nearly every anti-GMO wave in China. Figure 6 records the increasing number of annual articles on GMOs published in the four sampled Chinese press. The trend was reversed after 2015 when the propaganda department began to interfere with the reporting, according to sources (INT20160919, INT20160925).

Figure 6 Number of the four sampled media's combined articles on GMO in China (1995-2016)

Chapter 4: GMO resistance



(Source: Collected and cleaned by the author; PD: 1995-2016; SW: 2004-2016; XEN: 2007-2016; CSD: 2000-2016)

Liu Jianqiang, the writer of the 2004 SW mentioned above article, told me in a 2008 interview that when Greenpeace proposed to him an investigative story option, he knew nothing about GMOs and had no interest in reporting scientific issues about it. However, the theme that highly respectful scientists may violate public interest for their profits had attracted him (Yi & Jia, 2008).

Table 13 Main themes, article attitude, visibility, and percentage of coverage of the four sampled media’s GMO articles

	Total	Negative	Neutral	Positive	Visible controversy	The ratio of Visible controversy / Total Number
Food safety	65	5	21	39	50	76.9%
Business & economy	34	3	11	20	12	35.3%
Development & welfare	6	0	0	6	1	16.7%
Environment & ecology	14	8	5	1	13	92.9%
Science Comm & Popularization	13	0	1	12	7	53.8%

Ethics & Pandora	1	0	1	0	1	100.0%
Politics & policy	16	3	4	9	13	81.3%
Public Accountability & Regulatory	159	35	95	29	145	91.2%
S&T Progress	256	8	40	208	62	24.2%

(Source: Coded by the author; PD: 1995-2016; SW: 2004-2016; XEN: 2007-2016; CSD: 2000-2016)

Separate interviews with leading journalists of the liberal media confirmed the motivation to maintain public interest from the "infringement" by GMOs (INT20161022, INT20161219). Media content analysis confirmed the interview data. Table 13 summarizes the main themes of GMO-related stories among the four sampled media outlets. As in the case of hydropower, public accountability and regulatory issues became a significant frame in terms of the number of articles. That frame highlighted visible controversies and contained more negative reporting than positive ones. In fact, in the late 1990s, while the domestic newsroom of PD, as a top propaganda outlet, unanimously praised Chinese advances in agricultural biotechnology as a significant scientific achievement, its international pages shared no efforts to introduce the surging international controversies and debates on GMOs.

Compared with the few environmental frames, Chinese media, especially urban tabloids such as WEN, more often framed GMO stories as food safety issues. Accompanying the high dissatisfaction with public accountability were the repeated outbreaks of food scandals such as the 2008 baby milk contamination in which food producers added the industrial chemical Melamine to increase the indicator for protein content of milk falsely, and public confidence in food safety crashed (Lam, Remais, Fung, Xu, & Sun, 2013; Y. Ma & Zhao, 2009; Yunxiang Yan, 2012). One possible reason for the widespread public rejection of GMO is that ordinary people thought of it as food

contamination (P. Ho, Vermeer, & Zhao, 2006; Vermeer & Ho, 2004). Hence, the widespread public concerns on food safety could be easily transferred to public rejection of GM food, just as in Europe (Bonny & Sylvie, 2003; Frewer et al., 2004), particularly after continued media reporting made the GMO dispute a salient science controversy in contemporary China.

As in the environmental reporting, a small group of journalists, such as Jin Wei, currently a leading journalist at financial newspaper *Huaxia Times*, also worked as a prominent anti-GMO activist, though unlike in their environmentalist colleagues who set up formal ENGOs, the anti-biotechnology journalists did not form any formal organization. In the heyday of China's anti-GMO moments in 2010 and 2011, Jin and colleagues had reported the false news that after eating GM corn and GM soya, sows suffered abortion while mice disappeared, causing public panic (Wei, 2013).

Besides the media's effort to promote debates and uncertainties, as in the West, scientists' poor reaction to activists' challenge and public concerns were other factors underlying the biotechnology controversy (Cook et al., 2004; Cuppen et al., 2009; McInerney et al., 2004). Chinese scientists shared their Western counterparts' disdain for the public. "At an academic meeting at the time when GMO first became a controversial topic, we even sneered at the one who tried to persuade the public that GMO is harmless," said a senior biotechnology scientist during an interview (INT20161118). "Without popularizing to the public, [agricultural] scientists only wanted to persuade top leaders. Now the GMO controversy has become a serious barrier [to the commercialization of GM crops]," said one senior agricultural journalist (INT20170723).

Since 2009, when GMOs became a national controversy, Chinese scientists have

been acting to increase their popularization efforts. The \$3.5-billion mega GM seed initiative (R Stone, 2008) also offered a subsidiary grant to support such risk communication activities, in which I was involved to advise HZAU, then a lead implementer of the grant-supported communication projects. What they did were to compose popular science books, launch popular websites or webpages for biotechnology, and set up several exhibition rooms – all classic “deficit” model activities.

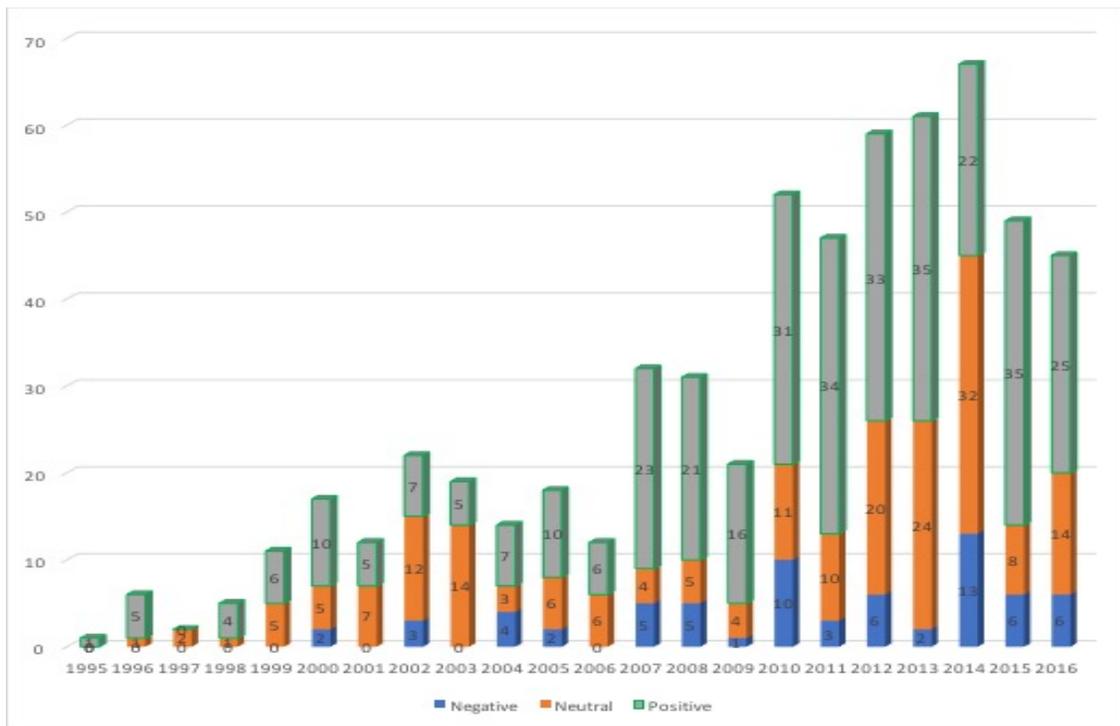
The propaganda-oriented public science information system in China (Jia & Liu, 2009) increased the problem of poor communication. Two PIOs (public information officers) of the Chinese Academy of Science (CAS) institutes and one staff from China Association for Science and Technology (CAST) admitted they would intentionally avoid talking about GMOs and other hot public science controversies to avoid upsetting audience and offending their institutional leaders (INT20160925c, INT20160928, INT20160821).

Scientists plus the biotechnology industry indeed increased their efforts to "educate" the media after the GMO controversy became intensified. Every year, the Chinese Society of Biotechnology, China branches of Monsanto and industry organizations like CropLife, and local biotechnology firms like Beijing Dabeinong Technology organized a couple of media workshops on GMOs, involving hundreds of media journalists. Based on my observations, participating journalists were pro-GMO or technology-savvy, but many stories questioning biotechnology were reported by their colleagues absent from the event or by the media not reached by the training. In the heyday of GMO controversies (roughly 2010-2014), Chinese media showed a very high diversification of authorship (INT20161110) because the high public interest in the topic involved reporters of many different beats. Although I was not able to implement for this study a systematic empirical

comparison, the media structure for supporting greater diversification of authorship looked more diversified than in the hydropower reporting mentioned in the previous chapter and contrary to (and theoretically consistent with) what M. C. Nisbet and Huge (2006) revealed the low participation in biotechnology reporting by US media workers.

The diversification also existed across different media outlets. Figure 7 shows that the four sampled media outlets generally had more positive than negative news stories on GMOs.

Figure 7 Attitude of sampled media articles to GMOs in China 1995-2016



(Source: Collected and coded by author)

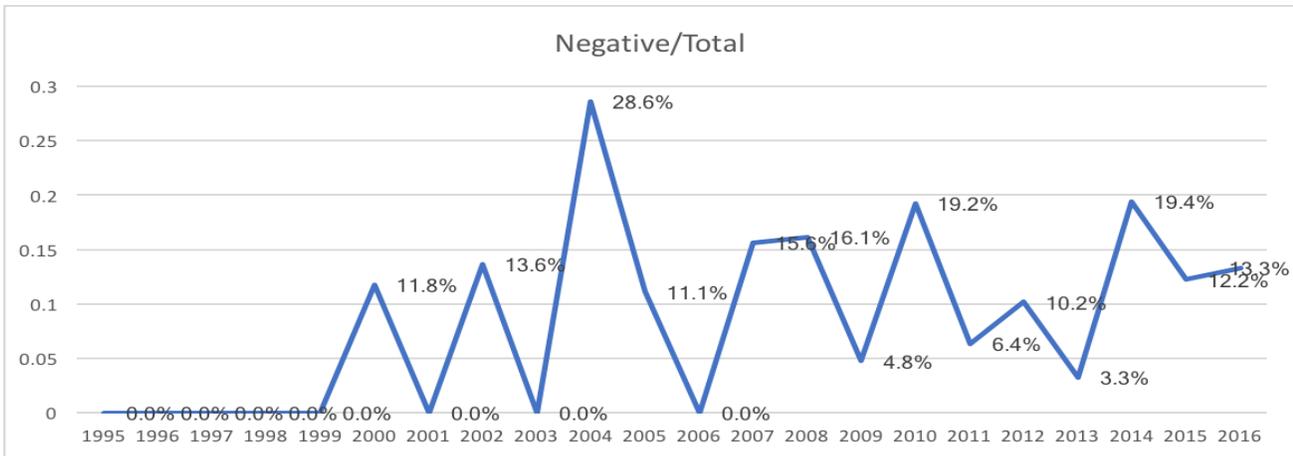
But among them, the more impactful non-official media *Southern Weekend* (SW) published many more negative stories than positive ones (Negative: neutral: positive = 17:9:9). Also, negative stories mostly appeared in front pages or other relevant news pages

while pro-GMO pieces were mostly popular science articles in the cultural section (SW does not have specific science pages) hidden within the paper. "Those [negative GMO] stories were often produced by investigative reporters supported by news editors which I cannot control," said a science editor affiliated with the Cultural Department of SW (INT20161016).

The slow reaction of scientists to cases like the unethical golden rice nutrition experiment (G. Tang et al., 2012) and illegal planting of GM crops also caused an information imbalance on biotechnology in the media, similar to what Flipse and Osseweijer (2013) have observed. More than in the West, Chinese biotechnology scientists were often warned by government officials about talking to the media directly (INT20161226).

Despite the above structural disadvantages, Chinese biotechnology scientists eventually managed to improve media outlets' overall attitude to GMOs, aided to a certain degree by the communist party's publicity departments' media censorship. Figure 8 indicates a decreased number of negative coverage of GMOs by the four sampled media outlets. Although the sample may not be representative enough (GMO friendly science and official media such as CSD and PD published most positive stories), scientists and pro-GMO journalists generally reflected their positive impression (INT20161115, INT20161110a, INT20161118).

Figure 8 Percentage of sampled media articles adverse to GMOs in China 1995-2016



(Source: Collected and coded by author)

However, with the decline of traditional media outlets (including print media and established online news portals) and the rise of social media, the GMO controversy remained popular, especially on social media platforms. The following subsection will explore this aspect.

4.3.2 GMO debate on rising social media

While print media fueled or even triggered China’s GMO controversies, it was the Internet that deeply embedded the dispute among the average Chinese public. Figure 9 is Baidu Index’s media index (unavailable through Google), indicating the frequency of the Chinese media mentioning GMOs in their reporting from 2011 (the earliest available indexing time). Then Figures 10 and 11 present online search trends by Baidu and Google, respectively. Google’s data started in 2004, but after its complete blockage in China in 2011, Google search may not reflect the accurate searching behaviors by Chinese citizens. Luckily, Baidu’s search data starting in 2011 may offset the gap. Similarly, Figure 6 on the number of the sampled media articles on GMO in China may somewhat fill the gap caused by Baidu’s lack of pre-2011 data. Figure 9 to Figure 11 were all screenshots by the author

Chapter 4: GMO resistance

on January 5, 2019.

Figure 9 Baidu media index of GMOs in China (2011-2018)

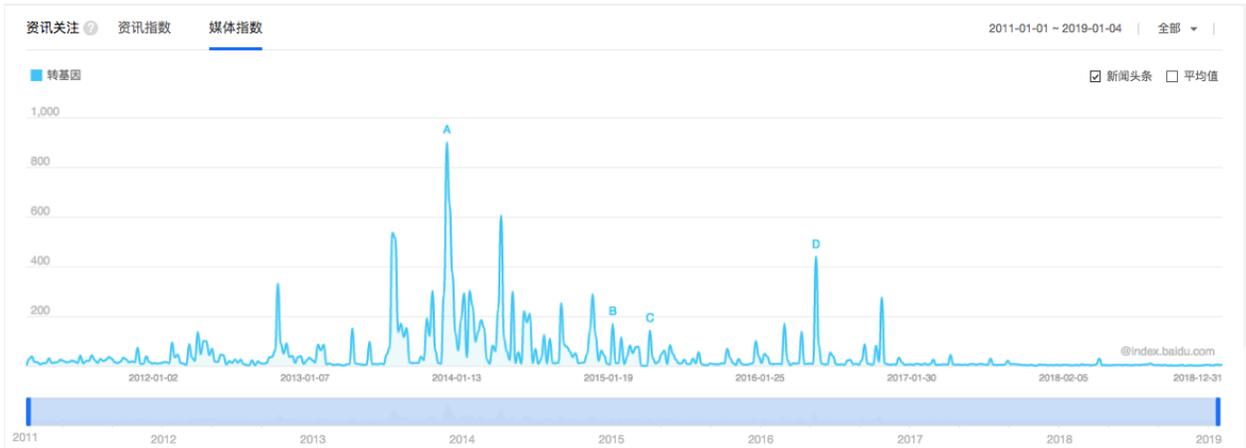


Figure 10 Baidu search index for GMOs in China (2011-2018)

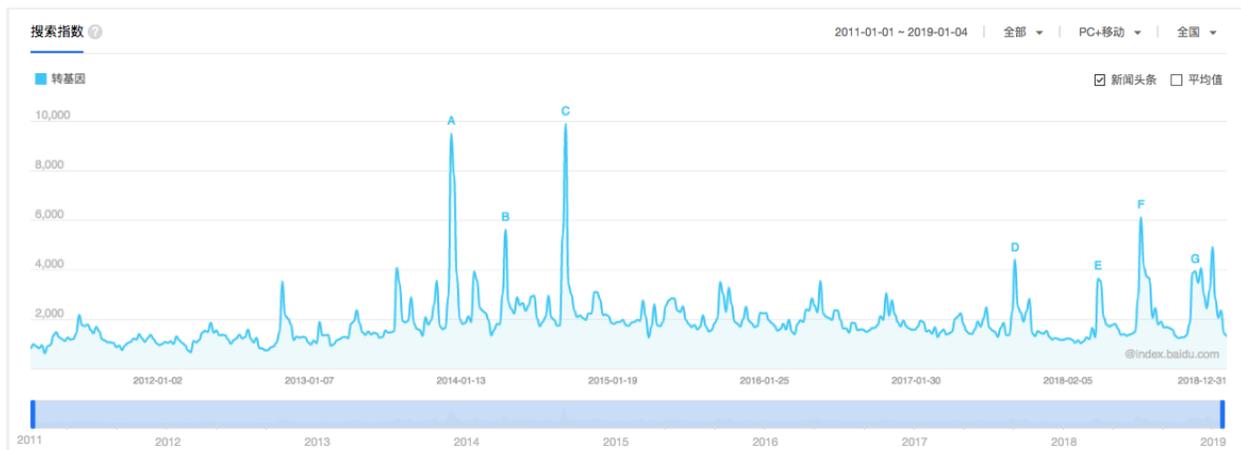


Figure 11 Google search index for GMOs in China (2004-2018)

Chapter 4: GMO resistance

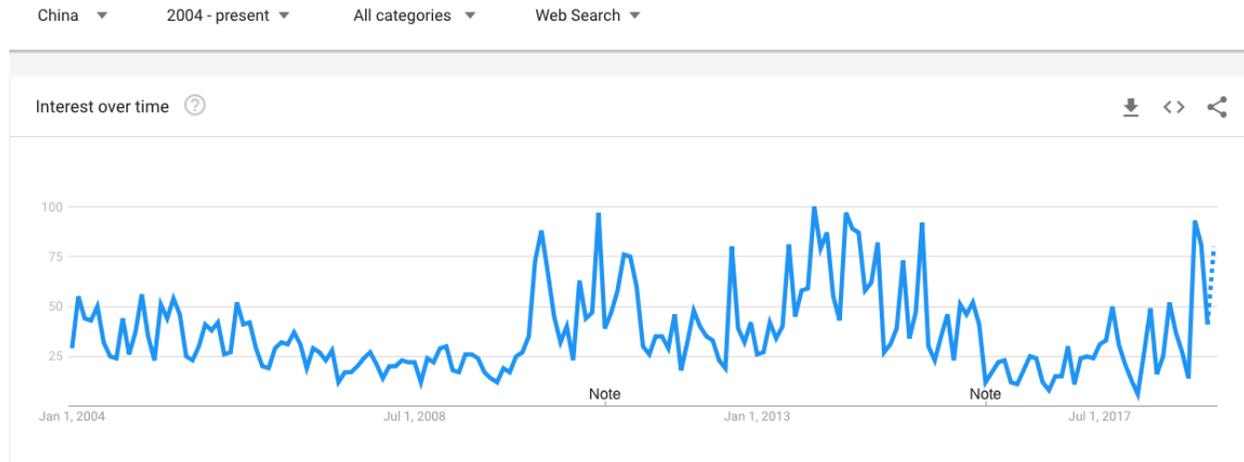
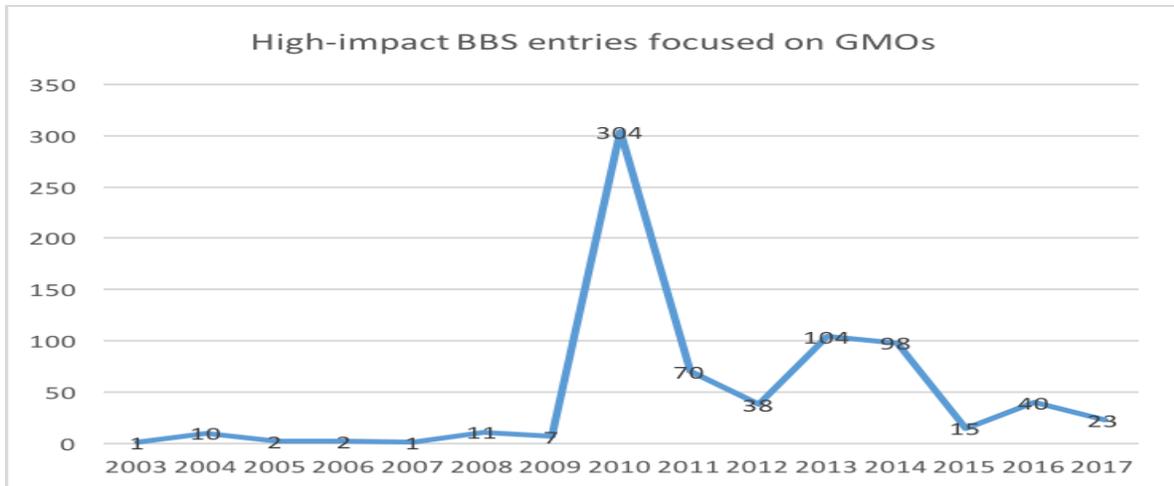


Figure 9 indicates that traditional media reporting of GMOs has shown a declining trend. These figures show that the frequency of media coverage of GMO issues was consistent with people's search behaviors of the keyword GMO. The consistency is uniform with Segev and Baram-Tsabari's (2012) finding that the media attention to news events was driving science-related searches. The pattern indicates that media coverage (and indeed opinion leaders' social media posts) pushed people's attention to and similar concerns about GMOs.

During the period, bulletin board systems (BBS) were also frequently used. Figure 12 represents high-impact BBS posts (with impact defined as posts with more than 100 following comments) on Tianya.cn. The figure indicates that the year 2010 when China issued two biosafety certificates to GM rice, had a significantly higher number of impactful BBS posts.

Figure 12 High-impact BBS posts on Tianya (2003-2017)



(Source: Data collected and graphed by Dr. Kai Liu)

The consistent GMO controversy is also associated with rising Internet-based media platforms, ranging from news portals and blogs to Weibo and WeChat (China's primary social media platforms). Given China's strict control of print media and their electronic versions, online portals and nonofficial websites, blogs, Weibo, and WeChat became the main bases for activists to launch anti-GMO campaigns.

The active role the Internet played in promoting the GMO controversy became clear when SW published in December 2004 its compelling cover story questioning commercialization of GM rice. Within days, Google search indicated that the article was reposted nearly 10,000 times (Yi & Jia, 2008), creating enormous pressure and effectively halting the commercialization process. Several popular news portal editors admitted that they preferred to post hotly disputed GMO news to boost online visits (INT20170108, INT20170109, INT20170725).

Between the SW story in 2004 and the national protest against biosafety certificates in 2010, China experienced a booming development of the Internet, with its users surging from 94 million to 437 million, and blog use percentage growing from 0.5% to 64.4%

(China Internet Network Information Center (CNNIC), 2005, 2011). The technology progress resulted in multiple online information portals for anti-GMO activism. Blogs were the most frequently used ones.

Searching Sina Blog, one cannot find well-archived results containing old blogs on GMOs, partly due to later intensified online censorship, though there was still available in 2018 a long list of contemporary blog articles, mostly taking an anti-GMO stance. Historically, blogs were a major anti-GMO front, and most anti-GMO activists published blog articles. With blogs, personal websites also mushroomed in China. According to the 2011 CNNIC report cited above, in December 2010, China had 1.91 million sites. Many activists, including Chen Yiwen, set up their websites posting anti-GMO news.

A noticeable media advancement regarding anti-GMO activism was the emergence and development of Maoist websites, mainly the extreme leftist site Utopia (Wuyouzhixiang: <http://www.wyzx.com>), which had a particular column specifically attacking GMOs. I searched and analyzed three emerging Maoist websites: Utopia, Chawang (literally meaning “the site for examination,” cwzg.cn), and Red Song Club (szhgh.com). Using GMO as my keyword, I found thousands of relevant articles, including Utopia’s 4,340, Chawang’s 234 and Red Song Club’s 45,778. I read and coded the first 50 most read items from each of these websites, and found all of them, including comments, various rumor-based claims and negative news stories posted from other websites, were all critical of GMOs.

Compared with blogs and websites, the arrival of Weibo and other microblogging platforms played a more significant role in spreading anti-GMO voices of non-establishment elites, amplifying people’s concerns and promoting public protest (Wen, Hao,

& Han, 2016; Q. Xu, Yu, & Song, 2018). Our previous research on the public reaction on Weibo to an unethical study led by Tufts University scientists to feed Chinese children with golden rice without properly informing procedure (G. Tang et al., 2012) revealed that social media quickly amplified the GMO events' impacts, enhanced attitudinal polarization and resulted in fragmentation of public opinions (J. Fan et al., 2013). Social media have significantly increased public participation in the GMO controversy in China (Jia et al., 2014).

Anti-establishment public opinion leaders quickly utilized the widespread public concerns and powerful communication effects of social media. Former TV anchor Cui Yongyuan, currently a center of China's anti-GMO campaigns (INT20161110a, INT20160929, INT20161115), is such an example. After he was involved in the anti-GMO campaign in 2013, Cui masterly handled Weibo and other social media platforms (such as Tencent's microblogging site which is now closed). He highlighted negative aspects of GMOs with the public accountability frame, activated public concerns, mobilized follow-up media reporting and carved his role as a public intellectual to defend the public interests against the infringement of biotechnology (Jia et al., 2015). With 19.5 million followers when I drafted this chapter (January 2019), his tweets dramatically increased the reach of anti-GMO information and public rejection of the technology.

Using an external Weibo analysis tool Weiboreach.com, Table 14 illustrates the massive impact of Cui by analyzing his six most commented GMO-related tweets in the first three pages of his Weibo account that were available for visits (from December 20, 2018, to January 6, 2019). The six tweets alone produced 143 million views (Weiboreach.com defined viewing as information appearing in viewers' Weibo accounts)

and over 9,300 forwards.

Table 14 Analysis of Cui Yongyuan's recent anti-GMO tweets (12/20/2018-01/06/2019)

Time	Contents	Url link	Forwards	Comments	Total views	Effect evaluation
01/05/2019	Cui recommended Lv Yongyuan (a long-term anti-GMO activist)'s tweets of a German study on GMO's adverse effects	https://www.weibo.com/1496852380/HaxfrpMhE?type=comment	2,584	1,657	23.04 million	Massively improved the audience of the German report critical of agricultural biotechnology
12/27/2018	Cui commented a tweet on the illegal plantation of GM corn, condemning ministry of agriculture's nonfeasance.	https://www.weibo.com/1496852380/H9cWte2HE	2,599	2,382	25.58 million	Further demonized the government agency behind agricultural biotechnology.
12/27/2018	Cui commented a tweet claiming a pro-GMO popular science organization committed to illegal pyramid sales.	https://www.weibo.com/1496852380/H97QMpyHm?type=comment	1,159	1,023	31.09 million	Morally demonized pro-GMO science communication and discredited its members.
12/22/2018	Cui commented on a tweeted report on the high cost of organic food, claiming between organic and GM foods, there are third options.	https://www.weibo.com/1496852380/H8jK1j2qs?type=comment	1,196	2,776	21.66 million	Massively improved the audience of the report critical of agricultural biotechnology
12/22/2018	Cui commented on Lv's tweet about a journal article appealing for more GMO debates, saying GMO side was afraid of the public discussion.	https://www.weibo.com/1496852380/H8CGPeK9g?type=comment	946	1,175	20.83 million	Massively increased the open access to the journal article questioning GMO, which had already been amplified by activists.
12/20/2018	Cui claimed a Weibo tweet of the US Embassy in Beijing about the US-wide consumption of GM foods as lying.	https://www.weibo.com/1496852380/H87bqtJrX?type=comment	865	988	20.83 million	Much discredited the US Embassy and the US government's pro-biotechnology policies.
Total	/	/	9,349	10,001	143.03 million	/

(Source: Calculated based on Weibo.com and independent analysis software Weireach.com by author)

Based on Table 14, one can find that many hidden anti-GMO messages reached millions of people, intensifying the widespread anti-GMO mentality. In addition to spreading anti-GMO information, Weibo was also utilized to produce anti-GMO news stories. According to an internal report submitted to the top Chinese leaders drafted by a pro-GMO expert (INT20160922), a series of negative media stories on GMOs were first posted on Weibo by an active anti-GMO activist with a pen name Zhiyanliao (literally "speaking truth"), before the media published them. These stories claimed that planting GM corn in Shanxi and Jilin provinces caused abnormal swine diseases and mouse reduction. Then, the media news was then quickly tweeted by Zhiyanliao and other activists

to form public impacts on social media. Our earlier study also found evidence to show that in exposing the unethical Tufts study, some opinion leaders were "assigned" to amplify Greenpeace's claim on Weibo (J. Fan et al., 2013). A separate interview with a former Weibo editor revealed that finding that GMO topics boosted visits, the social media platform often promoted such tweets in its homepage (INT20170109).

The GMO controversy also quickly spread to WeChat. Using QS Data (www.qsdata.com), I found and downloaded on January 29, 2019, the 50 most read WeChat public account articles for coding and analysis. As expected, all WeChat articles posted by public accounts of traditional media outlets (8 out of the 50 items) were positive, though as a whole, more WeChat articles held a negative tone (25 negatives versus 22 positives).

In terms of the primary theme of the 50 sampled WeChat articles, public accountability and regulatory issues (18), food safety (11) and science communication (10) dominated the agenda. It is noticeable that controversy contents were visible even in those pro-GMO articles, particularly for public accountability-framed stories in which relevant government departments, particularly Ministry of Agriculture and Rural Affairs (MOA), responded to an accusation made by Cui Yongyuan in early December. The ministry denied Cui's claim that the ministry itself avoided GM foods for its internal food consumption. Similarly, many science communication articles defending GMO safety often had to admit controversies and then refute those adverse claims. Besides, among the top 50 viewed items, two completely embraced conspiracy theories behind GMOs and over 50% of the food safety articles quoted false information or discredited anti-GMO activists like F. William Engdahl.

Another pattern one can observe is the high diversification of public accounts that

published GMO stories, ranging from news outlets (e.g., the WeChat accounts of conventional media) and popular science sites to entertainment, culture, religion and cuisine accounts. The high public attention to GMO issues was a driving force for many non-news and non-science sites to post GMO stories so that they could win more visits, a benchmark criterion for a WeChat account to earn advertising money or impact. When discussing the diversified media morphology for the mass media to report GMOs, I described the high diversity of reporters and the media outlets in reporting GMO. The WeChat data further confirmed the pattern. I will explore its epistemic implication in the section on the knowledge-control regime.

So far, in this section, I have analyzed the communication factors underlying China's GMO controversy. Mass media liberalization and commercialization, scientists' structural disadvantage in dealing with disputes, the Internet's ability to boost public attention, social media's capacity to create and fuel alternative public opinion leaders, and people's deep concern about food safety and their lack of institutional trust jointly promoted the widespread rejection of plant biotechnology and GM foods.

However, just as in the hydropower controversy, the communication pattern is not enough for us to fully understand the debates of GMO issues. For example, why did the media not rely on orthodox scientists when reporting on GMOs? Why has the GMO controversy lasted much longer than other scientific controversies? More specifically, why in authoritarian China has politically prioritized biotechnology research and development scheme been frequently disputed and discredited without receiving much censorship?

It is necessary to explore these issues further using both the social movement theory framework and several STS-oriented theories. In the subsequent section (Section 4), I will

examine the components of social movement theories – particularly of political process theory and FA framework – underlying China’s GMO controversies. Following that, STS concepts such as knowledge-control regime (Hilgartner, 2017) and civic epistemology (Jasanoff, 2011b) will be probed in Section 5.

4.4 EXAMINING GMO CONTROVERSY AS A SOCIAL MOVEMENT

4.4.1 Emerging political opportunity structure fueling GMO controversy

Tracing China's GMO controversy in the past 20 years, one can quickly identify the three drivers – a favorable political opportunity structure, robust frames, and effective mobilization – of social movements (Tarrow, 2011). Unlike in Western democracies, China lacks the institutional faces of these drivers. For example, the political opportunity structure embedded in the tension between government's executive branches, legislature, and advocacy groups which explained the fate of anti-nuclear power campaigns in Western European countries (Kitschelt, 1986) is virtually non-existent in China. However, various political opportunities linked to China’s economic reform and opening-up still structurally brew, promote and sustain science and technology controversies, of which the GMO debate is a salient one.

For the political opportunity structure facilitating GMO controversy, China's opening-up to allow the massive penetration of international civil society organizations, including Greenpeace in the Chinese society, should be counted as a primary element. The introduction of foreign NGOs resulted from Chinese agencies' effort to seek professional consultation services, as evidenced by the fact that Greenpeace came to China as a project office linked to the nature conservancy project of the then State Forestry Administration (now State Forestry and Grassland Administration of China) (Teets, 2014). However,

without political tolerance, Greenpeace, and other international NGOs' involvement in the authoritarian nation's environmental activism was unimaginable. Therefore, the political environment allowing Greenpeace to initiate and sustain anti-GMO campaigns in China can be safely considered a political opportunity.

A second political opportunity favoring Greenpeace to launch its anti-GMO campaign in China is the internationalization of academics. The early activities of Greenpeace in China connected to some internationally active Chinese environmental or ecological scientists, who utilized Greenpeace's expertise and perhaps funding but meanwhile offered chances for the organization to legitimate its activities (INT20161215). The move to preserve biodiversity from challenges posed by adopting biotech crops enabled the debate to be defined as an academic dispute, tolerable to the authoritative Chinese regime (INT20170310) and echoed China's international political stance of conserving biodiversity (INT20160926).

But Greenpeace as a highly experienced social movement promoter quickly shifted its focus from low-profile biodiversity conservancy to challenging public accountability of biotechnology developers. The Chinese government's highly criticized cover-up of the SARS epidemics in 2003 legitimized public call for accountability and transparency.

Table 15 lists all major controversial events about GMOs in China in recent years. Nearly every major event was associated with the poor accountability of scientists or government officials and the lack of transparency of relevant policies.

Table 15 Major GMO controversial events in China in recent years

Event	Description	Time	Media coverage	Initiators or main activists	Media frames (themes)
Lawsuit	The consumer claimed	Mid	Various urban tabloids	Greenpeace but	Weak public

Chapter 4: GMO resistance

against Nestle	Nestle failed to label GM ingredients for its baby food.	2003		unconfirmed	accountability frame, focusing on foreign firms
Scientists tried to commercialize GM rice selfishly	During the biosafety committee meeting, Southern Weekend published a highly influential story accusing scientists' efforts as prioritizing personal over public interests.	Dec. 2004 and after	<i>Southern Weekend's</i> exclusive reporting, widely reposted online	Greenpeace	Strong negative public accountability frame, directly targeting Chinese scientists. Avoid targeting government
Illegal planting of GM rice developed by Chinese scientists	Greenpeace tested rice planted in Hubei Province and identified two GM rice varieties grown by Hubei-based HAZU were illegally planted.	Mid 2005	Widely reported by liberal media	Greenpeace	Strong negative public accountability frame, confirming scientists' pursuits of illegal interests
Series of studies claiming unsafety of GMO	Austrian scientist Juergen Zentek claimed his studies found genetic toxicity of GM corn. Seralini claimed his studies found GM corn harmed mouse's health.	2007	Few media eventually reported. Science media later reported orthodoxy rejections of these studies.	Greenpeace widely distributed among Chinese journalists.	Pure science frames, not extending to everyday food
Beijing Olympic claimed to prevent GM ingredients from entering food supplies to athletics	Activists issued the issue, contrasting it with official claim on GM safety. It activated loud public protests not only about GMO but also for the prejudice towards domestic consumers. Later the government claimed it was a misrepresentation of GM food regulation.	2008	Widely reported by urban tabloids and some liberal media. Official media then rejected it as a rumor based on a misunderstanding of official rules.	Non-Greenpeace activists	Strong negative public accountability frame. Food safety frame began to emerge. The frame of international equality adopted.
Biosafety certificate disputes	MOA issued biosafety certificates to HZAU's GM rice in 2009. Its exposure activated massive public protests nationwide	2010-11	The large amount of adverse media reporting, including many Party media outlets. Derivative events such as public petition, lawyers' indictment,	Greenpeace first raised the issue, but its leading role was replaced by: 1) Established anti-GMO activists; 2) Leftists thinkers; 3) STS scholars; 4) Agricultural experts.	Strong negative public accountability frame, extending to MOA as a specific target. Other negative frames, such as the impact on farmers later emerged.
"GM corn" caused rat, pig abnormal	Activists claimed a widely planted hybrid corn (grandparent includes a GM variety, but the modified gene was not kept) to be GM corn. It reportedly caused fewer rats and more pig deaths in Guangxi, Shanxi, and Jilin. MOA refuted rumor after it organized on-site inspections.	2010-11	Various local tabloids reported the rumor, which was later rejected not only by official media but by established liberal media, but it was widely distributed on social media.	Non-Greenpeace individual activists Some anti-GMO journalists Maoist intellectuals	Food safety frame, science, and technology frame (for those rejecting the news)
Golden rice scandal	A Tufts nutrition experiment feeding Chinese children gold rice without proper informed	2012	Widely reported by urban tabloids and liberal media and extensively posted on social media. Massive	Initiated by Greenpeace but joined by all types of anti-	Food safety frame, Strong negative public accountability frame

Chapter 4: GMO resistance

	consent.		protests as it involved children. The Tufts professor was blamed, and its China collaborators sacked.	GMO activists and intellectuals. Scientists kept silent.	
Guangxi college students' sperm quality decreased by uptake of GM food	The rumor was coined by some anti-GMO Maoist activists who linked the so-called GM (in fact no-GM hybrid) corn planting in Guangxi to a 2009 study on sperm quality.	2013	Reported only by Guangxi local media but massively redistributed on social media.	Non-Greenpeace activists	Food safety frame
MOA Kindergarten forbid using food with GM ingredients	MOA Kindergarten reportedly banned its supplier from supplying GM food (mainly GM soya oil). MOA later rejected the claim.	2013	Widely reported by urban tabloids and liberal media and extensively posted on social media	Non-Greenpeace activists	Food safety frame, Durable negative public accountability frame, questioning MOA's discriminative measures
CCTV reported identified illegal GM rice in Wuhan	A pro-GMO journalist Wang Zhi'an claimed during his TV investigative stories that three of five randomly bought bags of rice contained GM ingredient.	2014	Widely reported by urban tabloids, liberal media, and official media. Extensively posted on social media. Questioned by scientists for disqualified testing methods. Wang claimed he supported developing GMOs but opposed to scientists' abuse of the technology.	Initiated by a pro-GMO journalist but quickly joined by various anti-GMO activists and intellectuals	The initial frame focused on public accountability but promptly expanded to food safety frames in subsequent media reporting.
TV anchor Cui Yongyuan's GMO fights	Starting from an online debate between Cui and GMO defender Fang Zhouzi, the dispute quickly spanned to a nationwide protest against GMO. Cui independently shot two documentaries on GMO consumption in America and Japan. Cui also openly debated with a Fudan life scientist during his lecture at the university.	2014-now	Widely and consistently followed by urban tabloids and liberal media.	Independently initiated by Cui but was widely supported by anti-GMO activists. Cui hired an anti-GMO activist as his interpreter and mainly interviewed anti-GMO activists	Cui focused on public accountability issue, particularly on transparency but media following him expanded the dispute to food safety issue.
Northeast farmers' illegal planting GM corn	Greenpeace identified a large amount of GMO ingredients in corns planted in northeastern provinces. China still did not approve plantation of GM corn or GM soya.	2015-now	Possibly due to a censorship ban on Greenpeace, few domestic media reported but widely distributed on social media	Initiated by Greenpeace. No non-Greenpeace activists were directly involved	Initially focused on public accountability issue targeting MOA but transformed into food safety issues in follow-up social media accounts

(Source: author's collections)

Most of the cases listed above would not have been widely noticed without media involvement or intervention. Some milestone incidents, such as the impactful SW's 2004 critical reporting of the commercial-interest-driven effort to commercialize GM rice which effectively halted the crop's commercialization, could even be defined as media events

(INT20161118) (Yi & Jia, 2008). Others, like GM rice's biosafety certificate, could not be publicly disputed without the media exposure. Thus, the media commercialization and partial liberalization examined in the previous section must be considered a central component of the political opportunity structure nurturing GMO controversy in China.

While Greenpeace and the media were the main actors at the early stage of anti-biotechnology campaigns, the issue's politicization in the late 2000s offered fresh blood to activism. In 2010, the biosafety certificate granted to HZAU and the Chinese Academy of Agricultural Sciences (CAAS) in the previous year ignited nationwide fear and anger against biotechnology. A group of princelings of the first generation of Chinese leaders, including the daughters of Mao Zedong, Ren Bishi (1904-1950, a standing member of politburo in 1940s), and Ye Jianying (1897-1986, military marshal) reportedly formed a small but influential group to lobby the top Chinese leader Hu Jintao to halt commercialization process of GMOs. The struggle was framed as legal action by the communist offspring inheriting the socialist legacy against Deng Nan, the daughter of Deng Xiaoping (1904-1997) (Y. Yin, 2017). Deng Nan, who inherited her father's strong support for agricultural biotechnology (to be discussed in next section), was the former vice minister of science and technology and then the head of China Association for Science and Technology.

Despite China's harsh censorship, articles like Y. Yin (2017) that directly defamed Deng Nan or even Deng Xiaoping's policy stance on GMOs were still available for my study, mainly through Maoist sites such as Utopia (Wuyou zhixiang: www.wywxwk.com), Chawang (cwzg.cn), and Red Song Club (szhgh.com), which also posted voices reportedly from the so-called "red princelings." As analyzed in the previous section, these Maoist sites

were unanimously against GMOs. Hence, the rise of Maoism and other leftist activists should be considered another factor of political opportunity structure.

We should not over-estimate Maoists' direct influence in policymaking. After all, most of the "red princelings" retired a long time ago. But their presence justified Maoist intellectuals and activists' anti-GMO stance. As active Chinese leftism theorist Li Beifang (2016) argued, leftists had a complex composition, but embracing Chairman Mao Zedong and opposing GMOs could become two basic symbols to unite Chinese leftists. Leftists actively networked with other leading public figures, such as retired generals Peng Guangqian and Mi Zhenyu, former chemical minister Qin Zhongda, and Marxism-leaning Hong Kong economic professor Larry Hsien Ping Lang to form the anti-GMO front.

Accompanying the rise of Maoists, a group of diehard left-leaning anti-GMO activists emerged. Many of them, including retired economist Gu Xiulin, former CAAS researcher Tong Pingya, copywriter Zhao Hua, a military novel writer Lv Yongyan, and some crank scientists like Chen mentioned above Yiwen, are still active today (2019). They joined the established intellectuals consisting of STS scholars, rural sociologists, Marxist economists and occasionally ecologists to question the safety of GM foods and the capitalistic nature of agricultural biotechnology. Although unlike the established scholars and generals, these activists seldom attracted media attention, their full-time devotion provided "massive gun powder" to anti-GMO capitalism. For example, Chen Yiwen was Cui Yongyuan's English translator for the latter's investigation of GM food consumption in the United States in 2014. Other crank scientists also claimed to have provided knowledge supports to Cui. These left-leaning anti-GMO activists also frequently contributed to the Maoist websites or posted on their blogs anti-GMO articles.

The consistent effort to counter GMOs from the perspective of political ideology (as compared with Greenpeace's environmentalism stance and ordinary public's food safety concerns) seemed to affect. A 2016 national survey found that 40 percent of the Chinese public believed that GMOs were an American conspiracy against China (Guangxi He et al., 2017).

Taken together, China's opening-up and introduction of NGOs, media commercialization, and ideological schism constituted an emerging political opportunity structure favoring activism against GMOs. But for the actors – Greenpeace, journalists, and Maoists – to play their active role as powerfully as effectively halting China's GM crop commercialization for more than a decade, this emerging political opportunity structure is not enough. At the policy-making end, there need to be structural opportunities that can make top policymakers receive, consider and accept (at least partially) the policy options, no matter how institutionalized they are, from activists. Otherwise, we will not be able to explain how the GMO controversy as a social protest could be sustained so long and have such widespread influence. The fragmented authoritarianism, particularly bureaucratic fragmentation and the virtually weak alliance between politics and science, which could be treated as a political opportunity structure as I did in the hydropower chapter, provides a relevant theoretical lens to examine this perspective.

4.4.2 Fragmented bureaucrats as a political opportunity structure

In the previous chapter, the fragmented authoritarianism (FA) framework was used to explain the victory or failure of China's anti-dam activities (Mertha, 2008). In a broader sense, the framework can be considered part of the political opportunity structure. In the bureaucracy politics, the perceived relative weakness of MOA and the perceived opinion

disparity among top Chinese leaders can be an indication of political and bureaucratic fragmentation that constituted an opportunity structure in which activists were encouraged to raise disputes.

During China's GMO controversy, one remarkable phenomenon is that the low-profile Ministry of Agriculture (MOA, renamed to the Ministry of Agriculture and Rural Affairs in March 2018) often displayed a perceivable weakness. For example, an article in *Beijing Youth Daily* in October 2013 reported Vice Agricultural Minister Li Jiayang, a senior genetic scientist and former vice-president of CAS, had been hired by Dupont to work on biotechnology and accused Li of representing the interests of multinational companies by helping them promote GMOs (Yi Li, 2013). The fact that the media openly blamed a senior incumbent government official of the potentially improper foreign link was scarce in China. But it was not unique. Sun Zhengcai, a former crop scientist who was agricultural minister between 2006 and 2009 during which the ministry approved the biosafety certificates of China's two types of GM rice and one type of GM corn, was also a target for open attack long before his fall as a political star in July 2017 (Unknown, 2014). Overseas observers widely thought Sun's fall as a sacrifice to pave the way for Xi Jinping's life-long tenure because he used to be considered a promising future generation of State leaders (Buckley, 2017).

Cui Yongyuan, currently the center of China's anti-GMO activities, repeatedly and openly questioned MOA and its officials in his Weibo account and his CPPCC proposals (Cui ended his CPPCC membership in 2019 after retiring from CCTV), often using very humiliating words. The MOA's apparent weak strength in the authoritarian political hierarchy may be another piece of evidence implying bureaucratic fragmentation

(INT20161226, INT20170823).

Lawyers and anti-biotechnology activists repeatedly sued MOA for hiding important information regarding its approval of biosafety certificates of both China's own GM varieties and imported soybean and corn. China Justice Online (<https://wenshu.court.gov.cn>) operated by the Supreme People's Court of China recorded two lawsuits against MOA. There are certainly more such litigations as Chinese courts often refused to accept an accusation against a government agency (X. Yang, 2016). Although MOA won both lawsuits, the fact that a ministry was sued for lack of transparency by the public in authoritarian China was an indication that the ministry's authority was discounted in the public sphere and this impression encouraged more to join anti-GMO activism.

While the perceived agency weakness encouraged activists, it does not mean the real power of the agency was low. But in the GMO case, although the MOA could dominate the technology's development agenda at early stages, the jurisdiction to make key policies had gone beyond the ministry's authority after it became a hot "issue" (20161110b, INT20161118, 20170823). This power erosion was first reflected in 2001 when China was eager to make its GM food labeling rule to fend off the possible impact of flooding US farm imports after China's expected WTO entry.

In 2010, the biosafety certificate issuance triggered protests from red princelings, over 120 leading Chinese scholars' effort to submit a petition to NPC in March 2010 (X. Tian, 2010), and the concentrated adverse reporting by the media, including official outlets like *Outlook Weekly* published by Xinhua Agency. Since then, the vast sensitivity of the GMO issue has reportedly resulted in attitude disparity among top Chinese leaders.

In March 2011, a national exhibition was held to show off milestone achievements of the 16 mega science and technology initiatives launched in 2008. All Politburo standing members attended the event. Premier Wen went to the booth of agricultural biotechnology, reiterating his supports but Hu Jintao and several other members intentionally avoided stopping here (INT20161226).

Hu's avoidance of the biotechnology booth did not mean he rejected GMOs. In 2008, he inspected the Peking University College of Life Sciences and praised the GM cotton research there. In June 2011, during his inspection in Hubei Province, he specifically visited HZAU's GM rice lab, but the official Xinhua Agency story about the Hubei inspection (Zou & Zhang, 2011) intentionally omitted this visit (Q. Zhang, 2017). Meanwhile, Premier Wen reportedly was pressured within the Politburo for his outspoken support for GM technology (INT20161110a). Hence, there was a deadlock. Top Chinese leaders constrained themselves from talking on GMOs to reduce sensitivity and avoid controversy, but activists interpreted this as a policy concession, which further encouraged activism.

Chinese scientists spared no effort to lobby policymakers (INT20170723). In 2011, scientists submitted a CAS consultative report on GMOs to top leadership, and in 2013, a total of 61 CAS and CAE (the Chinese Academy of Engineering) academicians wrote a petition to central leadership to appeal for quicker commercialization of GM rice. The effect was far from satisfactory. The CAS consultative report and academicians' petition did not result in any policy change (INT20161221). One leading scientist complained: "The situation was too poor. The highest official I can meet [for the GMO issue] was MOA vice minister [who was not a key decision-maker]" (INT20161009).

Despite the paramount ideological role science enjoys in China (Jia & Liu, 2014), the science-politics alliance here appeared to be *weak*. "Chinese leaders pay attention to science, but it is preconditioned that they think science is free of problem. When facing strong public protest, the leaders themselves would hesitate whether the science in question is reliable," one senior science policy advisor told me. "Top Chinese leaders today are highly responsive to public opinions. They are particularly worrying that offending the public would cause social unrests" (INT20170619).

Chinese leaders' high-profiled supports for science is very utilitarian (Cao, 2004). While research on GM technology is an issue of science policy, the decision to commercialize GM crops is far more complicated, involving policy considerations of international trade, intellectual property rights, and public protests. Therefore, other factors seemed to play an equally significant, if not more significant, role in the policy-making process (Cao, 2018).

This subsection examines components associated with the fragmented authoritarianism (FA) framework underlying the GMO controversy in China. While FA factors generally played a role in promoting the dispute, they were different from the pattern displayed in hydropower controversy in which the bureaucratic fragmentation was salient. In the GMO controversy, although MOA did not have a robust bureaucratic challenger, the fragmentation existed among political ideologies, members of top leadership and different experts, as well as between activists and establishments. The degree to which this fragmentation existed was much broader and deeper than in the hydropower controversy and other controversies/social contentions, including the debates on nuclear power which I will explore in the next chapter.

4.4.3 Anti-GMO framing and mobilization

So far, I have used the political process theory to analyze China's GMO controversy as a social movement. Tarrow and other scholars maintain that political opportunity should not be considered a static social structure (Meyer & Minkoff, 2004; Tarrow, 1996). With this theoretical leniency, we can find that on the basis of the perceived agency weakness, Chinese leaders' policy disparity, and insecure science-politics alliance, China's opening to international NGOs, the shaking public confidence on food safety, the rise of Maoism in post-reform China, and media's commercialization formed a political opportunity structure favoring anti-GMO activism.

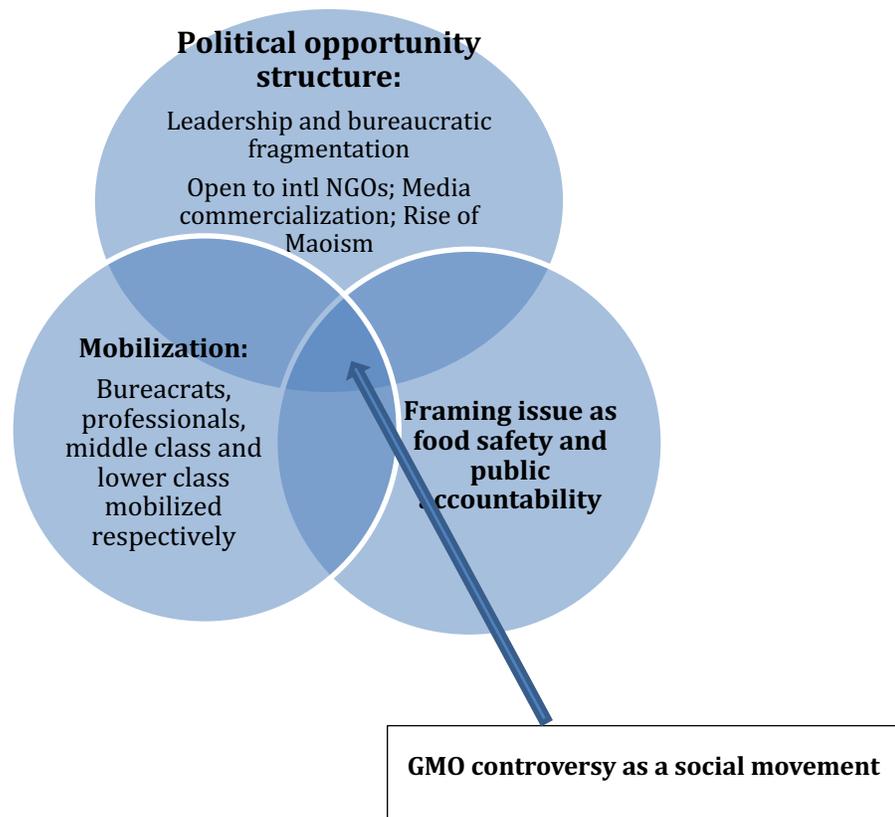
In terms of framing and cultural artifacts that Tarrow (2011) listed as the second dimension for political process theory, anti-GMO actors legitimized them within this political opportunity structure by framing themselves as either defending public interests, as revealed in Table 4-2, or inheriting the socialism legacy. Activists and dissenting experts effectively mobilized more public figures, civil resistance to GM foods through mass media, Maoist websites, and other media platforms discussed in the previous section.

Ordinary Chinese people may not be keen on abstract public accountability, but they were anxious about food safety. For years, scandals on food safety have been the No. 1 topic dominating the public opinion agenda. No other food safety issues are as concentrated in one term as GMOs, which, as Herring (2008) argued, has become an omnipotent negative frame. This frame, together with the political safety of the topic, has made anti-GMO become an ideal topic for public mobilization. On the other hand, the grave public concerns with the issue also lure more and more new activists and potential opinion leaders to come to the anti-GMO front to seek public attention. My WeChat public

account article analysis has revealed that in a given period, hot GMO articles spread across different types of public accounts ranging from lifestyle to cooking and religion. Similarly, while a group of diehard activists has been maintained and driven the GMO controversy, one can find new anti-GMO activists, and claims chronically rose in WeChat, Weibo and other non-official platforms, resulting in a sustainable social mobilization against GMOs.

Using the above material, figure 13 demonstrates the three social movement elements – political opportunity structure, framing, and mobilization – of the political process theory. The intersection of the three circles represents combined factors leading to China’s intensified GMO controversy.

Figure 13 Political opportunity structure, framing, and mobilization in China’s anti-GMO activism



(Source: Drawn by the author)

As I argued in the introduction chapter, social movement theories have a tremendous advantage in interpreting widespread public science controversies as they bring in actors and their strategic actions to deal with opportunities. In this process, communication factors such as the media and the Internet are instrumentally explored by activists to utilize opportunities. People's attention to the disputed topic is also an important parameter. In the GMO controversy, activists effectively used the attention and personal concern to boost public rejection of GM foods, which then brought more opinion-makers to tap the field.

But with only political and communication dimensions, one cannot fully understand why activists had intellectual confidence and necessary knowledge to challenge the claimed scientific consensus on the safety and economic prospect of GM crops. If the activists' side did not have the fundamental belief that they could counter orthodox knowledge, they might not have been able to perceive the emerging political opportunities. On the other hand, if policymakers and the public fully accepted the knowledge maintained by mainstream scientists about GMOs, then activists might not have been able to network and mobilize mass resistance. All these questions need further scrutiny, for which social movement theories *per se* cannot offer a ready answer and guidelines. I will examine these aspects in terms of the knowledge-control regime and civic epistemology in the following section.

4.5 KNOWLEDGE CONTROL AND CONTENTION

4.5.1 Knowledge-control regime in China's GMO controversy

In the previous section, I indicated the importance of knowledge in shaping political opportunities for the GMO debate. The knowledge-control regime concept clarified by

Hilgartner (2017) can be highly relevant here. Although the GMO controversy took place more in public spheres than in labs, the idea of various control regimes still holds. According to Hilgartner (2017, p. 14), knowledge-control regimes do not *determine* action but structure the categories, routines, identities, rules, expectations, menus of options, and other resources that actors draw on to interpret situations and guide action. As we can expect, for most "regular" sciences, their knowledge production and application can be *routinely* performed within such a structure often supported by political power (Jasanoff, 2004a). But, the widespread public controversy on GMOs toppled such "routines, identities, rules, expectations" and "menus of options" at the societal level of knowledge-control regime, even though scientists had primarily maintained their knowledge-control regime within the professional biotechnology circle.

Given agriculture's political and symbolic importance in China, China had actively developed modern agricultural biotechnology since the 1970s when it began to open the door. Deng Xiaoping even concluded that the ultimate solution to agriculture could only rely on biotechnological engineering (X. Deng, 1988/1993b). A knowledge-control regime was developed to place technical supremacy over conventional cropping (INT20161118, INT20160816). The scheme was extended to agricultural economics which calculated economic, and farmers' health benefits of planting GM cotton China commercialized in 1997 (Pray, Huang, Hu, & Rozelle, 2002) and confidently projected such benefits if China commercialized GM rice (J. Huang, Hu, Rozelle, & Pray, 2005).

At the very beginning of the regime formation, no effort was taken to deal with science and technology controversies (INT20161118). A senior science journalist put it straightforwardly. "Scientists thought they can handle political leaders and completely

ignored the possible public resistance" (INT20170723). In promoting their disciplines, these scientists seemed intentional to distinguish their research from conventional breeding, observed another senior science journalist who had long reported biotechnology advances in China (INT20160816).

Agricultural biotechnology scientists also ignored the effort to introduce biosafety governance pushed by ecologists and botanists (INT20161215). To social and humanities sciences, pro-biotechnology scientists even showed their contempt. "GMO scientists disdained to have a dialogue with we social science scholars," said a leading Chinese rural sociologist based at an agricultural university (INT20161114).

Indeed, what Chinese GMO scientists did was nothing beyond regular science where major scientific breakthroughs are followed by an effort to model their applications and project their benefits based on an optimistically estimated adoption rate. In the process, various aspects of knowledge, such as local knowledge or hidden social structures, are routinely neglected. When there is no significant controversy, neglected knowledge may be ignored. But GMO controversies which had accompanied the technology when China began to develop it made many aspects of the neglected knowledge salient, continuously stoking the disputes, similar to the situation in the West as observed by anthropological scholars (G. D. Stone, 2010).

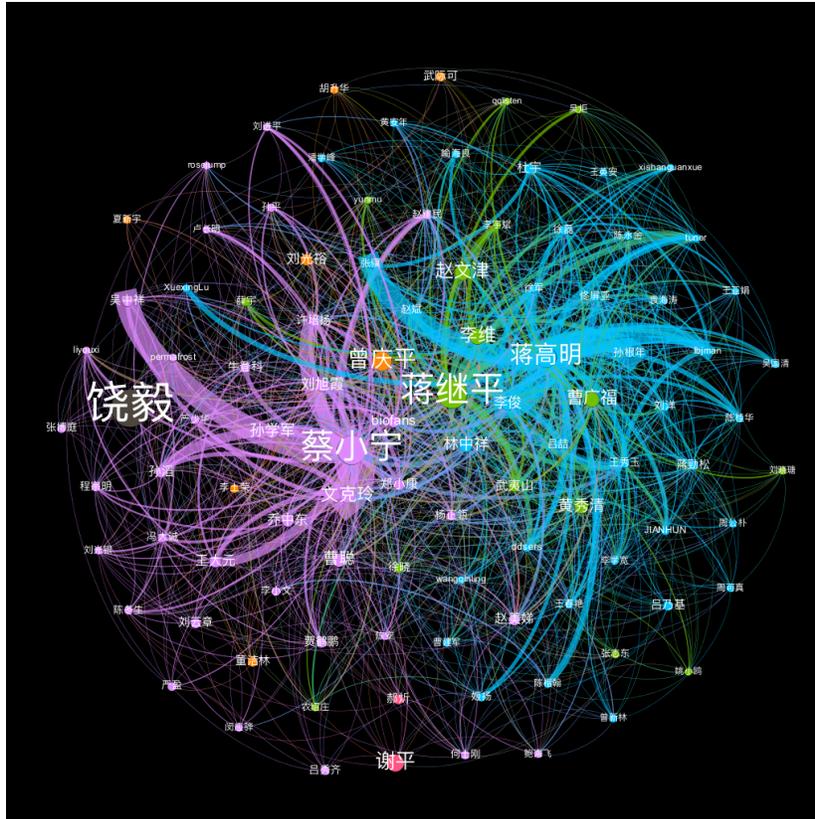
The above mentioned rural sociologists' studies on the structural decline of Chinese countryside in the face of labor and capital outflow to coastal manufacturing centers belonged to this type of knowledge. The worry that imported GM soy would severely impact soy farmers in northeast China (indeed the impact had already happened) was another type of consideration largely neglected in GM scientists' analytical modeling. But

in the Chinese public sphere, the salience of rural decadence and impacts on farmers were at least equal to agricultural technical progress, if not more salient. In the sense of knowledge-control regime, at the societal level of such a regime, “routines, identities, rules, expectations” and “menus of options” are simply out of biotechnology scientists’ control.

One cannot be an expert in every field. When these rural sociologists, international trade analysts, STS scholars, ecologists, and other dissenting experts raised GMO issues, they often publicly mentioned the technology's potential risks, though most of them did not have the professional background to study its health and environmental risks. This knowledge insufficiency was often quickly taken by the biotechnology side to attack them.

As compared with their reluctance to dialogue with external knowledge, Chinese biotechnology scientists spared no effort to maintain orthodox conclusions on the safety and benefits of GM crop and food. On ScienceNet.cn, a leading website primarily targeting scientists but also publicly accessible, a social network analysis on the blog comment relationship of ScienceNet.cn users shows that a high majority of network nodes were from people supportive of GMO, with only one biotechnology-negative node, a botanist and organic farming advocate (see figure 14 below).

Figure 14 A social network analysis of blog comments on GMO on ScienceNet.cn



(By courtesy of Dr. Li Yang)

On ScienceNet.cn and other Chinese public platforms, articles and texts to refute the dissenting studies on GMO safety – such as the rejected Séralini et al. (2012) – were widely circulated among peer scientists and science communicators. After the 2009/2010 controversy on the biosafety certificate of GM rice, agricultural biologists’ efforts to reject domestically published papers (e.g. Z. Zhang et al., 2015) were also enhanced (INT20161215, INT20170617).

Partly due to the enormous controversy surrounding GMOs, Chinese science communicators and science journalists nearly unanimously united in the pro-biotechnology side, many thinking defending GMOs as an essential task of maintaining the authority of science and some using whether to support GMOs as a distinction between true or false

science communicators (journalists) (Jia & Li, 2016).

Utilizing the report and censorship mechanism of leading social media platforms in China such as Weibo and WeChat, scientists and science communicators consistently requested that these platform operators censor the rumor posts and public account articles with false content regarding GMOs. On many occasions, the request was valid. A recent Chinese study also showed that more than 77% of WeChat-based public account articles were positive to GMOs (Jin, 2017). While my above analysis of the most recent 50 highest read articles shows different results, Jin's (2017) result is reasonable, because it might reflect the fact that most science communicators and writers are biotechnology supporters who, together with the establishment media, produce the most significant number of GMO-related WeChat articles. But due to the widespread public concerns about GM food safety, those negative articles were more likely to attract the audience to read.

Despite the effort, polls showed public acceptance of GM food continued declining (Cui & Shoemaker, 2018) and anti-GMO public opinions remained rampant (Jin, 2017). In a recent advance in January 2019, activists widely reported and celebrated that a classic nutrition textbook – *Nutrition and Food Hygiene* – newly added “negative” GMO contents (Changfeng Zhao, 2018). The four-page materials (one section of chapter 9), named GM food management, contained nothing more than describing the potential risks of GM food and saying that therefore, labeling was needed.

Why has Chinese biotechnology scientists' successful management of the consensual statement on GMO safety not been transformed into public support and consensual statement across different disciplines? Once again, we can apply the idea of multiple knowledge-control regimes. For regular science, a consensual statement in a

central professional circle may naturally transform to broad support, possibly through trade and negotiation hidden to outsiders (Galison, 1997). Modern knowledge is featured with its specification and professionalization (Adhikari & Sales, 2001). A routine practice might include some components while excluding or ignoring minor dissenting ideas such as the ones contained in *Nutrition and Food Hygiene*.

But given a widely attended controversy, activists tend to grasp and amplify the differences. On the other hand, once GM food became a publicly salient issue, food nutrition experts found that to maintain the governing frame of their knowledge-control regime (in food nutrition), which means "an organized set of schemata that provides a template that actors employ to guide action and interpretation" (Hilgartner, 2017, p. 12), they had to address issues relevant to the public concerns, such as the safety of GM food. Otherwise, it could be a sign that the control of their fields less authoritative (INT20161115).

In the GMO controversy, different knowledge branches were sooner or later enlisted in the social argumentation against GMOs. In terms of knowledge-control regime, the biotechnology side has no prowess to control the spread of anti-GMO argumentations, despite the expert consensus on GM food safety and optimistic economic prospects.

To view the GMO controversy only from this knowledge-control regime perspective, however, is not enough, for any dispute might experience a similar process, but few of them are as sustained as in GMO case. Civic epistemology offers another perspective for our understanding, especially if we place this perspective in the dynamic communication process of public science controversies.

4.5.2 Civic epistemology and conspiracy theories

Given the sustained civil resistance to GMOs, it is necessary to investigate the dispute from the perspective of civic epistemology (Jasanoff, 2011b), which represents the stylized, culturally specific ways in which the public expects the state's expertise, knowledge, and reasoning to be produced, tested and put to use in decision-making. Due to the long historical memory of food shortages and social unrests caused by the deficiency, generations after generations of Chinese leadership placed maintaining sufficient food supplies onto their top policy agenda. In the 1980s, and then across the first two decades of the new century, most of the annual No. 1 Documents of the CCP Central Committee, symbolically the most important policy of the year, dealt with the so-call *Three Nong* (countryside, agriculture, and peasants) affairs. Although the percentage of agricultural outputs in gross domestic product (GDP) had decreased from the 1980's 24.6% to 1997's (the year when China commercialized GM cotton) 18.3% and then to 2018's 7.2% (National Bureau of Statistics of China, 1981, 1998, 2019), the symbolic importance of agriculture did not.

For ordinary Chinese, due to the long-time propaganda linking national prosperity and science and technology progress, most welcome high-tech development of agriculture. People see parallels in the support for high-tech adoption in agricultural production, national food security, and their concern about food safety. To them, it is necessary to develop science and technology to promote social progress, but the development should not threaten personal food safety, or even just bringing potential threat.

In the early days of agricultural biotechnology development in China, the public showed strong support for the technology (J. Huang et al., 2006; L. Lü, 2009). But as a

result of anti-GMO activists' continuous effort to negatively frame GMOs as morally stigmatized, the public support for biotechnology as a specific high-tech solution dramatically decreased and the concern for the technology's negative impacts on food safety continuously increased.

Amidst the repeated exposure of food and plant scandals in contemporary China ranging from using industrial pigment for food to industrial material melamine added in milk, people of different social status developed their own "culturally specific ways" to understand GMOs. The middle class had great concern about food safety. A national poll in 2009 found that more than 50% of the middle class felt intense anxiety about food safety (Ouyang, 2010). The survey was confirmed by my interview with an organic food activist (INT20160823) and by two recent polls that found people either with graduate school degrees (Cui & Shoemaker, 2018) or with higher biotechnology knowledge (Ren et al., 2016) had more concerns about GM foods than other social groups. Though the two subsamples may not completely match, they can represent the overall status of the middle class.

Although the middle class might have basic biotechnology knowledge or the potential to get it, they still chose to believe some rumors. The most widely circulated ones were the lists of GM fruits and vegetables in the market. Most foods in the list, such as grape tomato and colored pepper, were not genetically modified at all.

While the rich and middle class tried to avoid GM food with their money, many people in China embrace conspiracy theories. Guangxi He et al. (2017) indicated that more than 40% of the Chinese public believed that GMOs were a conspiracy of the Western powers to control China. Following the wide public protest against the biosafety certificates

of GM rice and GM corn in 2010, three best-selling books – *GMO War* (Gu, 2011), *Secrets of Freemasonry* (X. He, 2011) and *Unrestricted Biological War: The Conspiracy of GM Foods and Vaccines* (Chai, 2011) – were published in China. They unanimously claimed that GMOs were a conspiracy of the Western ruling class to control the world (the difference is they defined different groups as Western ruling class).

It is naive to link the public's embrace of a GMO conspiracy to their low scientific literacy. Adopting the concept of civic epistemology, one may understand the embrace of conspiracy as the historically and culturally shaped ways for many disadvantaged people to understand GMOs. Indeed, Guangxi He et al. (2017) found those aged over 50 and those with lower education were more likely to believe a conspiracy theory in the GMO issue. Left behind in China's fast and state capitalism-driving economic growth, this group of the population was the direct followers of Maoist activists' anti-GMO campaigns.

Another logic of the civic epistemology underlying the mass perception of GMO conspiracy is political polarization specific to China. "The logic is, Chairman Mao is against the United States; GMO is thought to be a US strategy against China, so following Mao means opposing to the United States and GMOs," a communication scholar told me during an interview (INT20170828).

Combining the different findings, we find a convergent public opinion to avoid using biotechnology for food production. In the above analysis of the civic epistemology of Chinese citizen regarding GMOs, a common feature is that scientific knowledge did not shape people's attitude to GMOs. Instead, a combination of political, socioeconomic and cultural considerations dominated both dissenting experts and ordinary people's decision-making process, echoing civic epistemology's rejection of a public understanding of

science (PUS) model as a way to deal with science policies (Jasanoff, 2011b).

This civic epistemology perspective goes hand in hand with the knowledge-control regime analyzed in the previous subsection. Because the scientific community's regime failed to control knowledge production and transmission at the societal level, the public was more likely to encounter messages alien to the progress belief (e.g., that technology is an essential solution to food safety). On the other hand, when some radical experts and opinion leaders sensed the high public attention to and concerns about GMOs, they were more likely to link their publicly expressed views to the controversial technology to snatch more attention resources.

4.6 CHAPTER CONCLUSIONS

This chapter examined factors triggering and sustaining the GMO controversy in China from the perspectives of communication, social movements, and knowledge control. Media commercialization and the rise of social media, the political opportunity structure allowing penetration of NGOs and emerging Maoism and suffering bureaucratic fragmentation, and GM scientists' failure to monopolize knowledge-control regimes all contributed to the long-lasting GMO controversy. Meanwhile, GMOs being framed as a food safety and public accountability issue and high public attention highlighted scientific uncertainties and disparities, motivated opinion leaders and other allies with different knowledge equipment, and helped activists mobilize various resources against the technology.

To better understand China's GMO controversy, the three dimensions – communication, social movements, and STS scholarship have to be integrated. Media provided an arena for contention which was made possible due to the specific political

opportunity structure listed above. The media platforms contributed to the development or breakdown of knowledge-control regimes. The public knowledge arising from these regimes provided legitimacy to both biotechnology scientists and anti-GMO activists.

A specific theoretical contribution of this chapter is the communication factors in the political opportunity structure and knowledge-control regimes in the public attention market. A higher public concern of GM food safety amplified through communication channels created a broader opportunity structure to activists and other actors and mobilized more otherwise neglected "routines" to become salient. There seemed to be a positive feedback loop, making GMO controversy the most prolonged and most intensive S&T contention in contemporary China.

Chapter 5 Nuclear power debate in a narrow political opportunity structure

5.1 INTRODUCTION

In the past 30 years, nuclear power has achieved tremendous progress in China. According to the National Energy Administration (NEA), by the end of 2017, 37 nuclear power reactors were in operation in the Chinese mainland, and 19 reactors were under construction, with a total capacity of 21.87 million kilowatts. The number of nuclear reactors under construction in China ranked first in the world (National Energy Administration, 2017).

Despite the significant progress, nuclear power also experienced controversies in China, although the intensity is far below other science and technology disputes such as GMOs, hydropower, and waste incineration. Street protests halted the proposed construction of two nuclear fuel recycling facilities in Guangdong Province's Jiangmen and Jiangsu Province's Lianyungang in 2012 and 2016 respectively. Between 2016 and 2018, the Chinese government did not issue any new construction permit to any nuclear power plant (NPP).

How should we understand the situation surrounding nuclear power contention in China that is so different from patterns of GMO and hydropower controversies? Is there any political opportunity structure in the country that can fuel anti-nuclear campaigns? Has the knowledge control pattern played a role in nourishing nuclear power controversies? This chapter will examine how communication, sociopolitical, and knowledge control factors jointly shape the unique situation of the social contention surrounding nuclear power.

5.1.1 Media framing, public attitude, and anti-nuclear social movements

Partly due to its military origin, the civil use of atomic energy attracted protests worldwide at the beginning of its debut (Gamson & Modigliani, 1989; Rudig, 2014). The 1960s' ebb of the initial protests can be associated with the decline of overall public concern during this decade (Kasperson et al., 1980), which was associated with the media's widespread framing of the technology as a significant scientific progress (Gamson & Modigliani, 1989).

The public attitude toward nuclear power was both shaped by the media (Mazur, 1981, 1990) and influenced by organized social movements. In the latter half of the 1970s, anti-nuclear power campaigns became the central focus of social movements in Western Europe and the United States.

Like other science and technology controversies, the public disputes against nuclear power started or at least echoed the internal disagreement among experts (Nelkin, 1971, 1995). Despite the disagreeing experts' views, the regulators like the Atomic Energy Commission (AEC) seemed to favor more industrial interests due to the agency's deep links to the industry (Jasper, 1992). The policy impact of anti-nuclear movements in terms of halting or delaying the proposed plant construction was often limited (Giugni, 2007; Giugni, McAdam, & Tilly, 1999).

Structural analysis showed that anti-nuclear campaigns' emergence, development, and policy effect were mostly bounded within the so-called political opportunity structures. According to (Kitschelt, 1986), institutional arrangements and historical precedents for social mobilization of the United States, West Germany, France, and Sweden resulted in different political opportunity structures, facilitating the development of protest

movements in some instances but constraining them in others. For example, the more open political representativeness in Sweden and the United States assisted anti-nuclear activists to adopt more lobbying processes while France and Germany's more formal political structures led to more street politics (Tompkins, 2016). Political opportunity structures have also impacted the policy effects of anti-nuclear movements in the four democracies.

In former Soviet Union nations, the emergence of anti-nuclear activism was associated with a rise of nationalism and the pursuit of national independence from the control of Soviet empire (Jane I. Dawson, 1995; Jane I Dawson, 1996) or a revolt against the Soviet techno-bureaucracy (Schmid, 2004). However, after the collapse of the Soviet Union, the anti-nuclear movement quickly dissolved. The best explanation, according to Dawson, is that the anti-nuclear movement offered a surrogate for nationalism and anti-communism. Similarly, in Taiwan, the anti-nuclear movement became a surrogate for political struggle in the newly democratized society (M.-S. Ho, 2003).

The Chernobyl accident in 1986 primarily triggered the anti-nuclear power activism in the former Soviet Union. Indeed, the major nuclear accidents – Three Miles Island, Chernobyl, and Fukushima – severely impacted public attitudes to nuclear power (Bolsen & Cook, 2008; Y. Kim, Kim, & Kim, 2013; Rosa & Dunlap, 1994; Siegrist & Visschers, 2013; Visschers & Wallquist, 2013), but in most cases, the accidents' impacts were short-lived, and other variables, such as institutional trust and prior support, played a more constant role in deciding public attitudes (Siegrist & Visschers, 2013; Visschers & Wallquist, 2013). For example, Slovic, Flynn, Mertz, Poumadere, and Mays (2000) found that the French nuclear plants that partly caused the higher public acceptance of nuclear power in France than in the United States were all financially supported by the State-owned

sector (notably Électricité de France (EDF)) while in the United States, the dominant players were all private investors.

5.1.2 Nuclear controversy from the STS perspective

Given the considerable controversy surrounding nuclear power, STS scholars and science communication academics have paid attention to the controversial technology, enabling nuclear power to dominate their research agenda for decades (Suerdem, Bauer, Howard, & Ruby, 2013). According to them, because few other technologies raise so many social costs – proliferation, terrorist^[1] abuse, routine health damage, the social perception of 'low probability-high damage' accidents, civil liberties and obligations to future generations – opposition to nuclear power could be reasonable and legitimate (Bickerstaffe & Pearce, 1980).

Wynne's (1992) classic study on the disputed contamination of Cumbrian sheep farms in England by Chernobyl disaster's radioactive pollutants can be taken as an empirical example of this direction. The study revealed that sheep farmers' lay know-how of airflow and topography triumphed over the professional knowledge of radioactive experts commissioned by the government, demonstrating the problems with the government's ban on sheep sales and breaking the knowledge monopoly by experts in the highly professional field.

In East Asia, STS scholars found that in Japan, techno-nationalism that drove Japanese elites to seek to catch up with the West in economic and military terms as rapidly as possible offered the essential momentum for nuclear development (Fujigaki & Tsukahara, 2011; Kelly, 2015). Similarly, in South Korea, the introduction of nuclear power was considered a modernizing and empowering force that would develop and strengthen

the nation (Hong, 2011). As noted in the first chapter, South Korean's progressive sociotechnical imaginaries for nuclear power were sharply different from the US imaginaries that nuclear needs to be contained (Jasanoff & Kim, 2009, 2013). There is no doubt that nuclear power enjoys similar positive sociotechnical imaginaries in China.

Anti-nuclear power campaigns have led to the stigmatization of nuclear power (Tannenwald, 2005), but Schmid (2015) found that although people widely linked the Chernobyl accident to poor management, the Soviet Union's nuclear industry workers were, in fact, a high-quality, self-disciplined, and proud group. The accident was a result of a systematic failure of the technology. Schmid's depicting of high-quality nuclear power workers is relevant to the study in this chapter.

5.1.3 Public attitude toward nuclear power in China

Accompanying China's great leap forward in nuclear power, Chinese scholars have performed several surveys on public views about atomic energy (Guizhen He, Mol, Zhang, & Lu, 2013; Guizhen He, Mol, Zhang, & Lu, 2014; Y. Wu, 2017). Generally speaking, the public acceptance of nuclear power was high, ranging from 74% of respondents in the southern Chinese city of Shenzhen in 2008 (Z. Chen, Kong, & Geng, 2009) to 72% of participants in 2015 (Y. Wu, 2017). Nearly 68% agreed that nuclear power's benefits outweighed its harm (C. Zhang, Huang, & Ren, 2016). The support rate was much higher than the 28% support rate in 18 IAEA (International Atomic Energy Agency) countries and 20% in OECD (Organization for Economic Co-operation and Development) members (Y. Wu, 2017). An earlier study on public risk perception also found that the Chinese had less concern about high-technology such as the radioactive threat from nuclear power plants (NPPs) (Xie, Wang, & Xu, 2003). However, the Chinese public had a quite low knowledge

of atomic power (Y. Guo & Ren, 2017; Yu et al., 2012), and the knowledge level had a significant impact on their acceptance of nuclear power both in general terms and in their hometown (L. Deng, Zheng, & Zhou, 2016).

As in other countries, in China the Fukushima nuclear accident dramatically decreased Chinese acceptance of nuclear power and increased their risk perception (Guizhen He et al., 2014; L. Huang et al., 2013; C. Sun, Zhu, & Meng, 2016), but it also enhanced people's knowledge about nuclear power (L. Huang et al., 2013). Though immediately after the accident, the public trust in government lowered (L. Huang et al., 2013), the confidence on government and scientists to deal with a nuclear crisis remained high and showed no significant change from before the disaster (Guizhen He et al., 2014). Several years after Fukushima, the public support for nuclear power largely resumed (Y. Wu, 2017), and the Chinese public generally maintained a high trust in the nuclear information provided by government (in general), nuclear regulators and scientists (L. Deng & Tu, 2016; Guizhen He et al., 2013; Guizhen He et al., 2014; Y. Wu, 2017). Echoing the public's high trust in government was the Chinese people's more significant concern about risks that threaten social stability and economic development (Xie et al., 2003).

The general high trust in government was not always translated to actual supports for nuclear facilities in one's backyard. Studies found that two NIMBY (Not In My Back Yard) campaigns that suspended a proposed NPP in Rushan, Shandong Province in 2009 and a proposed nuclear fuel recycling plant in Jiangmen city, Guangdong Province in 2013 could largely be attributed to inappropriate engagement measures by local governments and insufficient disclosure by industry (J. Dai et al., 2015; Zeng et al., 2015). In both cases, social media platforms (BBS in Rushan and Weibo in Jiangmen) (R. Huang & Sun, 2016).

Thus, well-organized public engagement and communication activities could contribute to a higher social acceptance of nuclear power (L. Deng, Zhou, & Zheng, 2016; Guizhen He et al., 2013). On the other hand, case study and media stories show that unlike in other NIMBY activities such as those against trash incineration facilities (Standaert, 2017) and Para-xylene plant (Jia, 2014) where street protests dominated the agenda, some local anti-nuclear power campaigns have shown high level of elites-led public deliberations, which are generally rare in authoritarian China (L. Deng & Jia, 2019; D. Yan & Li, 2014).

These studies reveal China's high public acceptance of nuclear power for the sake of national interests and strong public belief in the government's capacity in handling nuclear safety at a time when the public trust in government on food safety issues was declining (X. Lü & Zhao, 2009). The acceptance and belief, possibly arising from the pride in China's independent development of the atomic weapon, constitute the national sociotechnical imaginaries underlying the nuclear controversy examined in this chapter.

5.2 CONTEMPORARY NUCLEAR CONTENTIONS IN CHINA

5.2.1 China's national memory of nuclear power

To investigate China's nuclear disputes, one cannot separate the earlier history of atomic weapons and the contemporary civil use of nuclear energy. With the term “Two Bombs, One Satellite,” the successful explosions of an atomic bomb in 1964 and a hydrogen bomb in 1967, together with a successful satellite launch in 1970, in technically and economically extremely poor conditions were portrayed as the biggest ever scientific progress in China, making the country become what Deng Xiaoping described as an “internationally influential power” (X. Deng, 1988/1993a, p. 279). Even today, the achievement is still widely memorized as a symbol of national independence and the basis

for China's science and technology progress (Yuan, 2019).

In 1974, nuclear power enterprises which later became China National Nuclear Corporation (CNNC) began to construct Qinshan NPP in the coastal province of Zhejiang. In the 1980s, China purchased French technologies to build Dayawan NPP near Shenzhen, neighboring Hong Kong. Based on the Dayawan plant, China General Nuclear Power Corporation (CGNPC), the nation's second largest nuclear power firm, which focused on civil nuclear power, was established in 1994.

In the mid-2000s, China began to develop nuclear power positively. Although after the Fukushima accident, China launched a comprehensive safety check of all nuclear projects and a temporary moratorium on further construction, on 24 October 2012, the State Council, China's cabinet, approved China's Medium- and Long-term Nuclear Power Development Plan (2011–2020) and Nuclear Power Safety Plan (2011–2020), mainly resuming the momentum for nuclear power construction.

In 2018, China became the only country to simultaneously host all three major types of the so-called third generation pressurized water reactor (PWR) technologies – French EPR (European Pressurized Reactor), the US AP1000, and Russia's VVER1200 (WVER in English: water-water energetic reactor). China also developed its third-generation technology Hualong (HPR1000) and developed a Chinese modified version of AP1000 – CAP1400.

Since the 1950s, particularly since late 1970s when the country began to develop civil nuclear power plants, China has developed sophisticated nuclear power decision-making, development and supervision system, consisting of an 'iron nuclear triangle' of national governmental agencies, nuclear industries, and research organizations. The public,

media, and NGOs are neither informed nor involved (Guizhen He et al., 2013). Within the governance system, the National Development and Reform Commission (NDRC) and its affiliated National Energy Administration (NEA) are responsible for energy policymaking and planning. National Nuclear Safety Administration (NNSA) under the Ministry of Ecology and Environment (MEE, formerly the Ministry of Environmental Protection (MEP), and before 2008 known as the State Environmental Protection Administration (SEPA)), is responsible for safety regulation, radioactive surveillance and nuclear waste management.

One key element of the NNSA, formerly under the State Science & Technology Commission (predecessor of Ministry of Science and Technology) when it was established in 1984, was placed under SEPA/MEP in 1998's government agency reshuffle. As I will analyze below, the arrangement, aimed to improve nuclear safety by separating it from the nuclear industry and research (Z. Sun, 2013), is a crucial factor influencing China's anti-nuclear activism.

5.2.2 Emerging anti-nuclear power campaigns

Despite the iron triangle governance, nuclear power has not been free from controversies and NIMBY protests. In 1986, after the Chernobyl accident, more than 1 million residents in Hong Kong protested the neighboring Daya Bay NPP (Mai, 2011). Deng Xiaoping decisively insisted on continuing the plant, while urging the nascent nuclear power industry to increase public communication efforts. CGNPC dispatched a group of experts to appease Hong Kong residents and set up one of the earliest public relations (PR) departments among China's state-owned enterprises (SOEs).

In the Chinese mainland, with the exception of Rushan NIMBY activity against a

proposed CNNC plant launched by the retiree community (rather than the original local residents) in the coastal city in Shandong Province in late 2000s (INT20161229b)(Zeng et al., 2015), the nuclear power industry enjoyed a peaceful development until the Fukushima accident in March 2011. Soon after Fukushima, a posthumous book allegedly written by a former engineer of Fukushima Daiichi NPP became a bestseller in China (Hirai, 2011). The book, depicting how the nuclear power industry lowered safety investment for profits, was prefaced by Jiang Xiaoyuan, a leading STS scholar at Shanghai Jiaotong University critical of technologies, including GMOs.

But STS scholars and critical intellectuals did not become the main actors in anti-nuclear activism as they had in the GMO controversy. Instead, local elites and energy experts' role was more salient in the nuclear dispute. Inland Pengze NPP supported by State Nuclear Power Technology Corporation (SNPTC) in Pengze County of Jiangxi Province became the first target. The protest, however, rose in Wangjiang county in Anhui Province across the Yangtze River.

In a dramatic scene, Wangjiang county leaders, feeling local dissatisfaction with their inaction against Pengze NPP, "accidentally" posted a document red-stamped by Wangjiang government denouncing Pengze nuclear project on Weibo in February 2012 (L. Deng & Jia, 2019). The regularly classified government document immediately attracted media interest. Four retired county leaders – the former chairman of the county's CPPCC (the Chinese People's Political Consultative Conference) branch, a former county judge, the former deputy director of its County People's Congress, and a former director of the county site – became the center of local anti-nuclear activism. The debut of the four retired officials *per se* – widely respected as “Wangjiang Four Seniors” – became a dramatic plot

due to imperial China's long tradition of local self-governance by renowned gentlemen (Fairbank, 1983).

The Four Seniors tried to reach a top CAS scientist He Zuoxiu and his former doctoral student Wang Yinan, a senior research fellow at the government's leading think tank Development Research Center of the State Council (DRC) who later became China's leading anti-nuclear power activist. He Zuoxiu is a CAS academician and theoretical physicist who partially won his academic recognition with his involvement in his early years in atom bomb research and his public fame as an anti-pseudoscience campaigner.

After He and Wang's visit to Wangjiang, in July 2012, the Four Seniors submitted via He a policy petition to Premier Wen Jiabao, appealing to be highly cautious when planning inland nuclear power projects. Three months later, the newly released Medium- and Long-term Nuclear Power Development Plan (2011–2020), though continuously encouraging NPP construction, did not mention starting construction of inland nuclear power projects in the 12th five-year plan period (2011-15) (Luo, 2014). The Wangjiang anti-nuclear activism had achieved a significant milestone victory.

Wang soon emerged as a leading public figure questioning nuclear power's rapid development. She published a series of commentaries in *China Economic Weekly*, affiliated to the CCP's mouthpiece *People's Daily*, opposing to inland NPPs. These articles warned against NPPs in the Bohai Sea (which was surrounded by metropolitan areas like Beijing and Tianjin), blamed Westinghouse (the world's primary nuclear technology developer) for its manipulation of China's nuclear market, and disclosed nuclear regulatory loopholes. She also highlighted the potential risks of AP1000's fuel loading (the final step before an NPP's regular operation) and warned about the possible US embargo of nuclear technology

(INT20171221). News portals and industrial websites redistributed some of her articles. A small group of dissenting experts joined her fight, though their voices and influence were much lower.

Meanwhile, Wang reportedly submitted policy petitions through various channels to the central leadership, including Xi Jinping, before she published the main points in these petitions (INT20171221). Top Chinese leaders' comments, reportedly urging relevant agencies to investigate the claims, heavily pressured the industry (INT20170616, INT20170616b, INT20161229b). With new NPP permissions being halted and ongoing construction delayed, industrial organizations and government agencies like China Nuclear Energy Association (CNEA), National Nuclear Safety Administration (NNSA), State Administration of Science, Technology and Industry for National Defense (SASTIND) as well as industrial media and individual experts were more and more active in fighting back (An, 2018; C. Lin, 2017; B. Tang, 2017; Chengkun Zhao, Zhou, Mao, & Wang, 2016).

Wang and other experts' accusations were limited to elite circles, but they were amplified by Wu Hui, a Maoist lecturer at a local agricultural college in Hunan Province. In 2015, Wu published the article "Nuclear power destroys China" on Weibo, claiming a central policy goal of the United States was to dump its nuclear wastes to China. The conspiracy argument attracted more attention, reportedly resulting in five million visits overnight (H. Wu, 2018).

Elite activists were isolated from NIMBY movements against nuclear power. In July 2013 and August 2016, street demonstrations in Guangdong Province's Jiangmen and Jiangsu Province's Lianyungang resulted in the suspensions of the two proposed CNNC nuclear fuel recycling facilities respectively (Buckley, 2016b; C. Yang, 2013). No anti-

nuclear elite activists were involved in these street protests, though during the protest local protesters were found to distribute Wu's article "Nuclear power destroys China" (INT20161011).

Elite appeals seemed to result in a policy effect. In November 2016, the 13th Five-Year Plan of Power Industry released by NDRC and NEA did not mention inland NPPs. Between 2016 and 2018, no construction permit was issued to any new NPP (F. Jiang, 2019). More strikingly, the two NPPs – Sanmen in Zhejiang Province and Haiyang in Shandong Province – adopting AP1000 technology remarkably postponed their fuel loading from scheduled August 2017 to April and August 2018, costing tens of millions of yuan losses.

However, in spring 2018, the policy tone towards nuclear power suddenly became positive. In April, the license to load fuels in Taishan NPP adopting French EPR technology and Sanmen's AP1000 were issued, then for Haiyang's AP1000 fuel loading in August. In particular, President Xi Jinping and visiting French President Emmanuel Macron witnessed the issue of the Taishan license. In June 2018, CNNC and Rosatom of Russia agreed to build a total of four VVER1200 nuclear reactors at the Tianwan Nuclear Plant in Lianyungang (where anti-nuclear street protests suspended the proposed nuclear recycling facility) and Xudapu NPP in Northeast China's Liaoning Province (Chu, 2018). On January 29, 2019, after three years' suspension, the Chinese government issued construction permissions to four HPR1000 reactors CNNC and CGNPC respectively.

Summarizing China's nuclear power controversy, one can find a very different pattern from those of hydropower and GMOs. Although the postponing of inland NPP constructions and AP1000 loading were widely considered associated with the challenges

raised by Wang and other dissenting experts, the policy effect was limited as compared with hydropower and GMO controversies. The nuclear dispute was also low profile and limited mainly to elite circles. Except for the Four Seniors' action in Wangjiang, the Chinese media reported few other debates. Unlike in hydropower, nuclear power industry's reaction was overall quick, though as compared with GMO contention, which involves a large number of both activists and pro-GMO science communicators, few external experts joined the debate.

5.3 MEDIA AND NUCLEAR CONTROVERSY IN CHINA

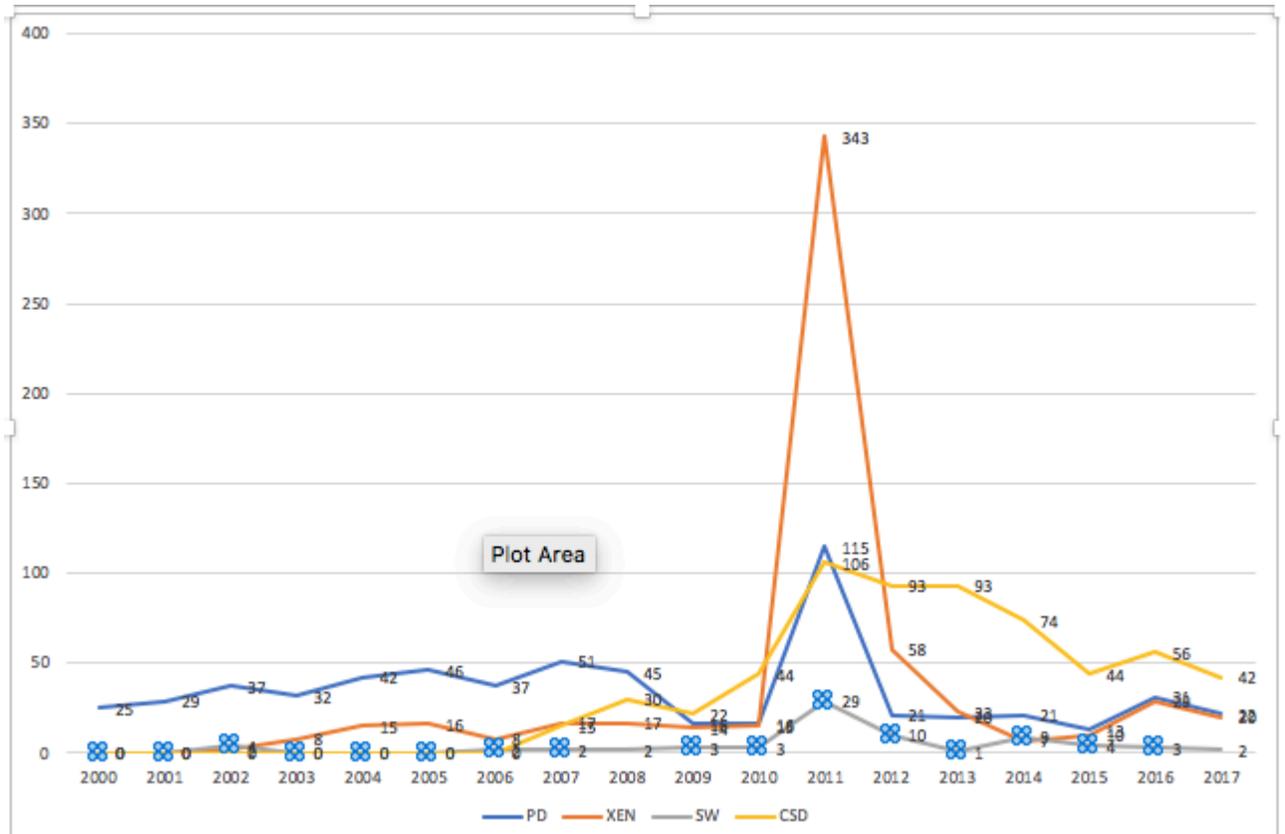
5.3.1 Examining conventional media reporting of nuclear power

As discussed in the above section, China's nuclear controversy was low profile, and most of the disputes seemed not to have received intensive media reporting. Figure 15 charts the four sampled media outlets' coverage of nuclear power (see chapter 2 for sampling rubrics). A striking feature was the sudden surge of media stories in 2011 when the Fukushima accident occurred. Given Fukushima's disastrous character, this is understandable but what makes nuclear power reporting different is that except for the timing for the Fukushima disaster, no other news event has significantly pushed higher the number of nuclear power stories.

Media outlets had different reporting strategies. As an urban tabloid in Shanghai, XEN had a low daily reporting of nuclear power before the Fukushima disaster. According to Table 16, before the Fukushima accident, regular XEN reporting of atomic energy was mostly in the business area, as Shanghai is a manufacturing center of nuclear power equipment. Due to nuclear power's low relevance to urban life, this may also be the only significant link between the sector and XEN. But after the accident, residents in coastal

Shanghai's high concern about the radioactive leaks drove XEN to increase nuclear power reporting dramatically. The dominant theme of such reporting changed to nuclear safety. After the Fukushima accident, XEN's coverage of domestic atomic power remained positive or at least neutral, mostly in economic frames.

Figure 15 Number of the sampled media articles on nuclear power in China (2000-2017)



(Source: Collected and cleaned by the author; PD: 2000-2017; SW: 2002-2017; XEN: 2002-2017; CSD: 2007-2017)

Table 16 Xinmin Evening News' nuclear power coverage (2002-2017)

	Before 2011	After 2011	Total
Positive reporting	17	40	57
Negative reporting	16	267	283
Neutral	81	182	263

Nuclear power safety	18	310	328
Business & economy	47	41	88
Development	5	2	7
Environment & ecology	10	9	19
Engineering and technique	10	7	17
History & culture	3	13	16
International treaty & military nuclear	1	16	17
Science popularization	3	15	18
Politics & national interests	5	13	18
Regulatory & public accountability	7	60	67
Science & technology	5	3	8
Sum	114	489	603

(Source: Author's collection and coding)

Table 17 shows that PD, as a CCP mouthpiece, dominantly reported nuclear power as a symbol of China's science and technology progress, independent innovation, and economic growth. The Fukushima disaster dramatically halted the tone and pushed PD to focus more on promising the safety of domestic nuclear power facilities in addition to blaming Japan's poor behaviors. However, as China began to export atomic power technologies (Masood & Buckley, 2013), “nuclear power goes outside” became a new propaganda theme for PD to praise the sector.

Table 17 People's Daily' nuclear power coverage (2000-2017)

	Before 2011	After 2011	Total
Positive reporting	166	44	210
Negative reporting	11	61	72
Neutral	199	137	336
Nuclear power safety	31	115	146
Business & economy	117	41	158
Development	21	9	30
Environment & ecology	16	6	22
Engineering and technique	63	11	74
History & culture	18	6	24
International treaty & military nuclear	36	12	48
Science popularization	10	9	19
Politics & national interests	16	20	36
Regulatory & public accountability	18	4	22
Science & technology	30	9	39

Sum	376	242	618
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(Source: Author's collection and coding)

My data collection of CSD, unfortunately, started in 2007, later than the other three sampled media outlets, due to a database availability constraint. CSD focused on science and technology aspects of nuclear power, including fusion research such as ITER (International Thermonuclear Experimental Reactor) in which CAS, the publisher of CSD, has been heavily involved. The Fukushima accident seemed to increase the newspaper's interest in nuclear energy. Table 18 shows the themes of CSD's nuclear power reporting. Besides Fukushima-related stories, CSD intensively reported senior scientists' appeals to increase China's nuclear power development despite Fukushima and their promise of its safety. Among the four sampled outlets, if we do not consider one censored story in SW, CSD is the only medium among the four sampled newspapers to have interviewed anti-nuclear activists and dissenting experts, indicating the elite nature of the nuclear debates.

Table 18 China Science Daily' nuclear power coverage (2007-2017)

	Before 2011	After 2011	Total
Positive reporting	63	169	232
Negative reporting	7	117	124
Neutral	41	221	262
Nuclear power safety	6	88	94
Business & economy	25	83	108
Development	8	7	15
Environment & ecology	13	53	66
Engineering and technique	13	71	84
History & culture	12	16	28
International treaty & military nuclear	1	4	5
Science popularization	0	28	28
Politics & national interests	1	5	6
Regulatory & public accountability	0	50	50
Science & technology	32	102	134
Sum	111	507	618

(Source: Author's collection and coding)

As I pointed out in previous chapters, SW as a liberal media outlet heavily reported negative aspects of hydropower development and initiated China's anti-GMO activism, but when reporting nuclear power, its style shifted. While the Fukushima accident impelled SW to include negative reporting about nuclear safety and public accountability frames, it was about Japan's nuclear power industry. When shifting back to China, SW took a neutral tone to examine competition between nuclear enterprises, nuclear waste site location and safety challenges in the business frame, rather than in its long-used public accountability frame for investigating regulatory loopholes. The liberal media did not quote any domestic anti-nuclear power activist in its news stories. On June 19, 2014, SW published a Q&A with Wang Yinan to criticize inland nuclear power development, but Guangdong Provincial Propaganda Department censored the story (X. Hu, 2014) (INT20160923b). To balance the article, on June 20, 2014, SW published another opinion article written by a nuclear supporter to defend the industry against Wang's criticism (W. Zhang, 2014). Table 19 reports the basic coding results of SW nuclear articles.

Table 19 Southern Weekend' nuclear power coverage (2002-2017)

	Before 2011	After 2011	Total
Positive reporting	3	8	11
Negative reporting	2	20	22
Neutral	11	30	41
Nuclear power safety	2	9	11
Business & economy	9	18	27
Development	1	5	6
Environment & ecology	1	5	6
Engineering and technique	0	0	0
History & culture	0	0	0
International treaty & military nuclear	0	1	1
Science popularization	0	2	2
Politics & national interests	1	5	6
Regulatory & public accountability	0	12	12
Science & technology	2	1	3
Sum	16	58	74

(Source: Author's collection and coding)

Indeed, anti-nuclear activists repeatedly complained that the media could hardly report the anti-nuclear voices due to the alleged censorship as a result of the lobbying effort by nuclear power industry as a strong vested interest group (INT20160923b, INT20161229). But the claim might not be true. Besides Wu Hui's conspiracy claims, the only censored media article my field interviews can confirm is the SW's Q&A with Wang, perhaps because, in Guangdong Province, the ratio of nuclear energy to total electricity supplies is the highest nationwide (reaching 11.9% by 2020) (China Energy News, 2018).

Instead of being censored, journalists have widely avoided investigative reporting of nuclear power. One senior editor of an official science and technology newspaper stressed that she had never received any censorship directive from the Central Publicity Department on nuclear power coverage. However, "journalists were reluctant to report negative news about nuclear power because they worried about the military background of the nuclear power sector, the ingrained image that nuclear represents national prosperity and the long-held belief that there was no [significant] news in nuclear power industry" (INT20160925a). She was echoed by another senior journalist of the same newspaper who talked with me.

In a separate interview, a former science editor at a leading liberal news magazine confirmed a similar point: "An in-depth investigative story costs a lot of energy. Journalists would not touch [investigative stories of] nuclear power because they perceived there would be lack of public interests due to the small presence of nuclear power in the country" (INT20170106).

A third media source, a former environmental editor at the abovementioned Guangdong-based liberal media outlet, mostly shared the view. "We defend public interests,

but there seem not many news-making events in the nuclear sector" (INT20161022).

A fourth media source, a science journalist, working with a liberal news magazine famous of its journalist professionalism (where the second source used to work), said when reporting nuclear power issue, she has insisted on high rationality to avoid amplifying the potential but highly unlikely risks associated with nuclear power. She attended a debate joined by nuclear power experts and activists. "I was reluctant to interview and quote the activists because their claims on nuclear power risks seemed too extremist while nuclear industry experts' comments seemed more reasonable and evidence-based" (INT20161217).

On the other hand, official Chinese media outlets have every reason to positively report nuclear power due to its symbolic images of national science and technology progress, independent innovation, substantial economic return and most recently China's proud international expansion. Table 20 below provides evidence. According to Table 20, most articles of the four sampled media outlets on the history of nuclear power positively eulogized Chinese nuclear scientists' devotion and contribution to national independence (before Fukushima 80% positive and post-Fukushima 75.8%). Besides, among science and technology framed sample articles, 55% were positive (before Fukushima 59.5% and post-Fukushima 50.5%), and only 2% were negative.

Table 20 The sampled media articles on nuclear power in China (2000-2017)

	Article number	Theme percentage	Positive	Positive stories' percentage of the theme	Negative	Negative stories' percentage of the theme	Neutral	Articles with visible controversy or uncertainty	Percentage of articles with visible controversy within the theme
Nuclear power safety	58	9.1%	11	19.0%	22	37.9%	25	30	51.7%
Business & economy	203	31.8%	53	26.1%	2	1.0%	148	11	5.4%
Development	34	5.3%	26	76.5%	1	2.9%	7	1	2.9%

Chapter 5: Nuclear power debate

Environment & ecology	41	6.4%	27	65.9%	7	17.1%	7	9	22.0%
Engineering and technique	93	14.6%	55	59.1%	0	0.0%	38	6	6.5%
History & culture	35	5.5%	28	80.0%	0	0.0%	7	0	0.0%
International treaty & military nuclear	39	6.1%	3	7.7%	0	0.0%	36	11	28.2%
Science popularization	13	2.0%	5	38.5%	0	0.0%	8	2	15.4%
Politics & national interests	23	3.6%	8	34.8%	0	0.0%	15	3	13.0%
Regulatory & public accountability	26	4.1%	4	15.4%	4	15.4%	18	9	34.6%
Science & technology	74	11.6%	44	59.5%	1	1.4%	29	8	10.8%
SUM	639	100.0%	264	41.3%	37	5.8%	338	90	14.1%
After the Fukushima Accident (March 11, 2011)									
Nuclear power safety	522	40.9%	28	5.4%	295	56.5%	199	215	41.2%
Business & economy	178	13.9%	40	22.5%	30	16.9%	108	88	49.4%
Development	23	1.8%	15	65.2%	0	0.0%	8	6	26.1%
Environment & ecology	74	5.8%	12	16.2%	47	63.5%	15	23	31.1%
Engineering and technique	83	6.5%	39	47.0%	2	2.4%	42	11	13.3%
History & culture	33	2.6%	25	75.8%	5	15.2%	3	0	0.0%
International treaty & military nuclear	20	1.6%	2	10.0%	2	10.0%	16	7	35.0%
Science popularization	54	4.2%	13	24.1%	0	0.0%	41	23	42.6%
Politics & national interests	55	4.3%	7	12.7%	23	41.8%	25	24	43.6%
Regulatory & public accountability	126	9.9%	12	9.5%	58	46.0%	56	82	65.1%
Science & technology	109	8.5%	55	50.5%	3	2.8%	51	18	16.5%
SUM	1277	100.0%	248	19.4%	465	36.4%	564	497	38.9%

(Source: Collected and coded by the author; PD: 2000-2017; SW: 2002-2017; XEN: 2002-2017; CSD: 2007-2017)

Consistent with the media's restrained reporting of nuclear power is a restrictive media morphology. My field studies revealed that most official media outlets have a somewhat stable news team reporting the beat, by either science or business and energy reporters for a long time. In the hydropower case, energy reporters tended to report the sector positively, but environmental journalists often offset and outvoiced their effort due to the media's active pursuit of environmentalism agenda.

In the nuclear power case, however, few environmental journalists were involved in reporting the nuclear power sector, for reasons indicated above (INT20161022). The implication of this low diversity will be explored in the following section examining knowledge-control regimes.

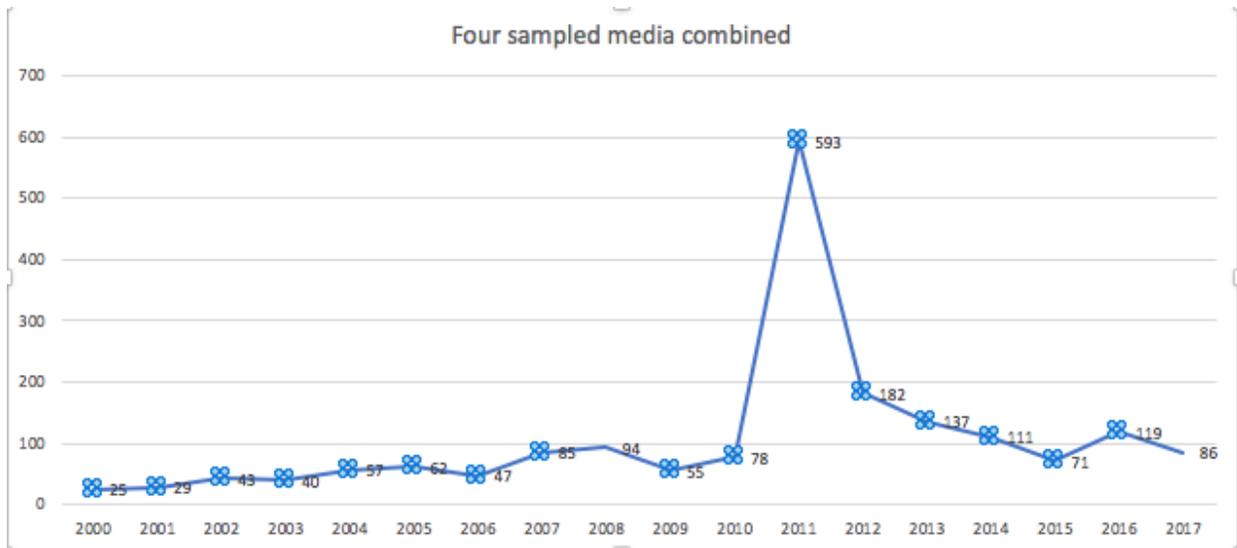
Taken together, the nuclear power industry's positive images, Chinese journalists' self-censorship partly due to their perceived limited audience interest, and the atomic industry's active public communication efforts have effectively restricted the media's role as a platform for anti-nuclear activism. Can the Internet and social media that have eroded the dominance of conventional media and decentralized the communication process topple the pattern?

5.3.2 Nuclear power controversy in the social media era

To examine Internet and social media's role in China's nuclear disputes, one can first investigate whether the sampled print media's reporting of nuclear power was comparable with people's online behaviors, including online searches and BBS postings. Figure 16 to Figure 19 present such information.

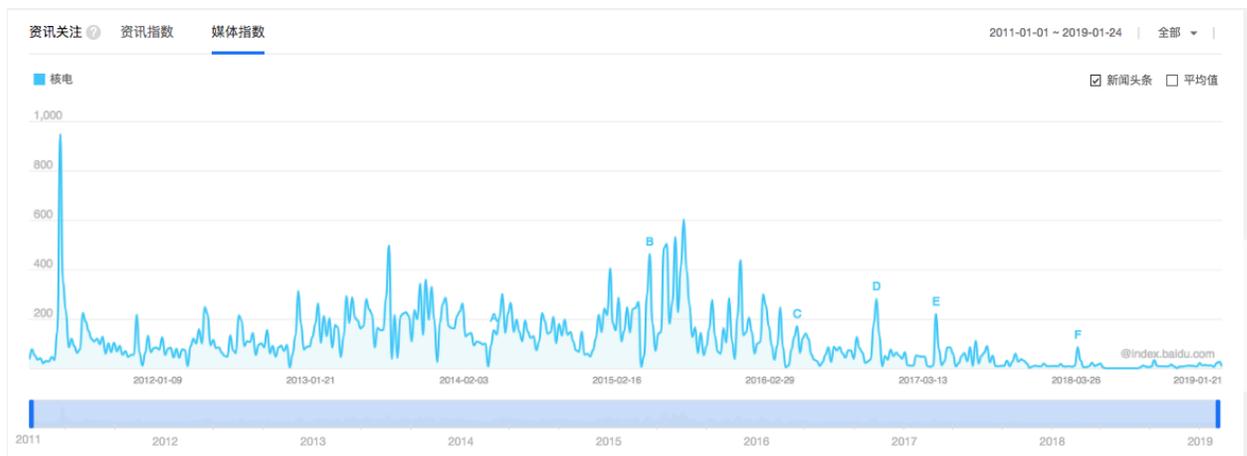
Figure 16 Combined four sampled Chinese media nuclear power articles (2010-2017)

Chapter 5: Nuclear power debate



(Source: Author's analysis; PD from 2000, CSD from 2007, XEN from 2002, and SW from 2000)

Figure 17 Chinese media articles mentioning nuclear power searched through Baidu Index (2011.01-2019.01)



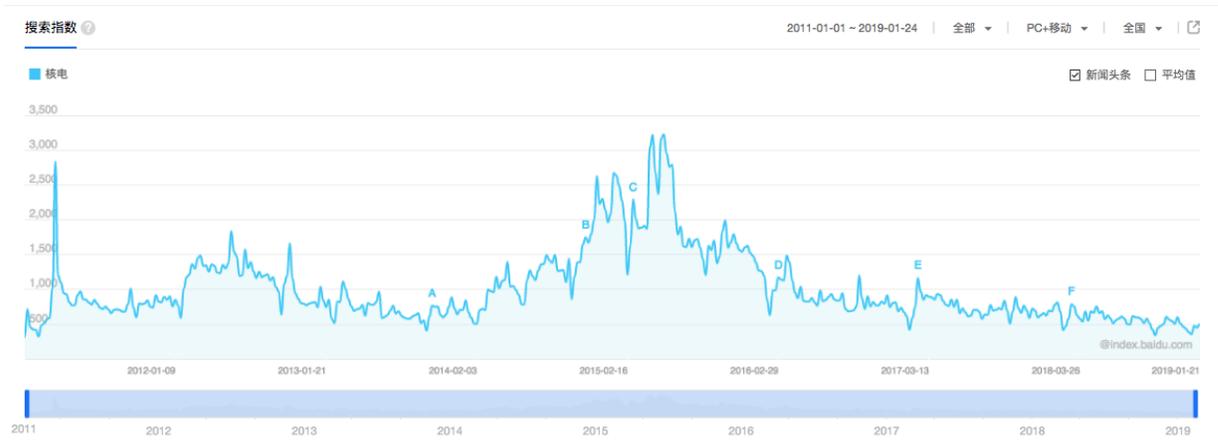
(Source: index.baidu.com searched on January 25, 2019; Url:

<https://index.baidu.com/v2/main/index.html#/trend/%E6%A0%B8%E7%94%B5?words=%E6%A0%B8%E7%94%B5>

)

Figure 18 Baidu users' online search of keyword "nuclear power" (201101-201901)

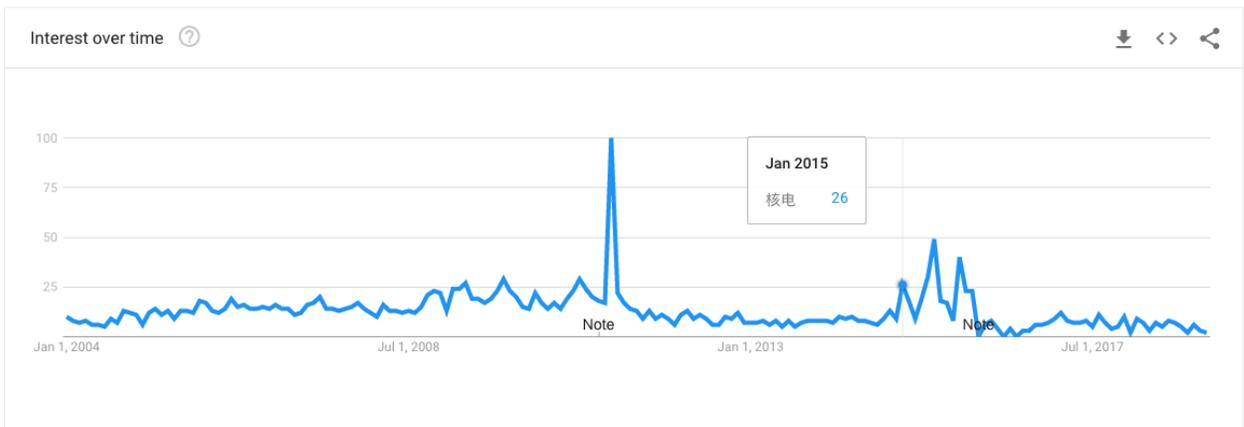
Chapter 5: Nuclear power debate



(Source: index.baidu.com searched on January 25, 2019; Url:

<https://index.baidu.com/v2/main/index.html#/trend/%E6%A0%B8%E7%94%B5?words=%E6%A0%B8%E7%94%B5>)

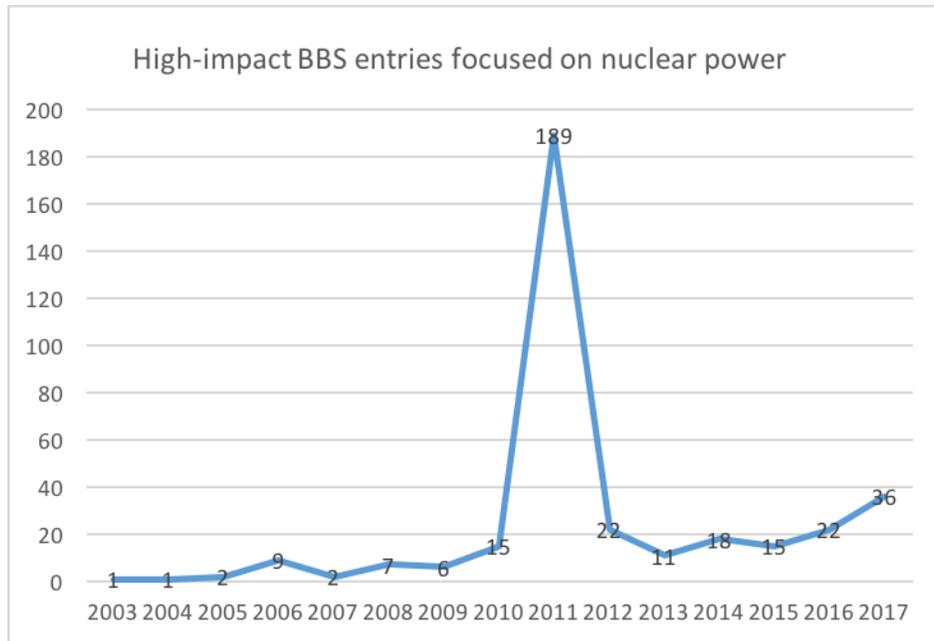
Figure 19 Google Trend showing the online search of the keyword "nuclear power" (in Chinese and China) (200401-201901)



(Source: Google Trends; URL:

<https://trends.google.com/trends/explore?date=all&geo=CN&q=%E6%A0%B8%E7%94%B5>)

Figure 20 The frequency of high-impact BBS post on "nuclear power" (in Chinese) on Tianya.com (2003-2017)



(Source: bbs.tianya.cn collected by courtesy of Kai Liu)

Data embodied in the above graphs are not entirely satisfactory. Baidu.com introduced its Baidu Index service covering media trends only after 2011, while Google does not offer a media trends service. On the other hand, Google’s Chinese search data is likely minimal since 2010 when its search engine was blocked in China, and Chinese residents needed to use a virtual private network (VPN) to cross the Chinese Internet wall, hence dramatically reducing the number of Chinese users. But comparing the Baidu Index, Google Trends can provide a chance for triangulation. Baidu search and Google search seemed to have comparable morphology though their time scales were different.

All media and search data showed a high wave around March 2011 when the Fukushima accident occurred. There were several significant waves in the Baidu search data, such as in December 2014 (December 1-7) and January (January 12-18), April (April 20-26) and May 2015 (May 18-24). In terms of the weekly unit of Baidu search (Figure 18) and Baidu media index (Figure 17), the two roughly matched (e.g., they matched in three

of the four periods except January 12-18, 2015). But when I manually checked the sampled media data, I found the wave crest of the sample media stories did not correspond to the waves in search results and Baidu media index.

I further searched Baidu news search engine (news.baidu.com) for the above periods (December 1-7, 2014; January 12-18, 2015; April 20-26, 2015; and May 18-24, 2015). The search returned results ranging from 47 to 85. No article reported blockbuster nuclear news, such as new disasters or anti-nuclear campaigns such as the NIMBY street protests in 2013 and 2016. Although I did not make a systematic coding, a skim was enough to judge there was nearly no adverse reporting except the tiny amount on the leftover issues of Fukushima. Instead, dominant stories were the appeal to recover nuclear power momentum before Fukushima, new technology or engineering advances, and events to celebrate the 60th anniversary of China's nuclear power industry (1955-2015). No anti-nuclear activists or dissenting experts were quoted in these articles.

Although the analysis on the data obtained from Baidu news index and Google search engine was far from systematic and representative, it confirmed the finding of my systematic coding of the four sample media articles. Nuclear power's progress and technological innovation rather than its safety concerns drove people's interest in the sector, as revealed in their online search behaviors.

However, the interest in nuclear power based on its progress seemed limited and short-lived. The Baidu search data demonstrated that maximum daily search, including during Fukushima accident, was around 3,000, while the average daily search across the past eight years was just 1,010. The lack of mass interest no doubt restricted the public impact of anti-nuclear power activism, which has been marginalized by the established

mass media. The status also frustrated activists' efforts to utilize social media platforms ranging from blogs to Weibo and WeChat.

Searching the two major blog portals – Sina blog and BlogChina – with the key terms "nuclear power" and "nuclear energy" for bloggers returned with about 330 bloggers. Known activists or dissenting experts operated none of them. Two blog accounts were linked to local anti-nuclear activism in Rushan of Shandong Province and Xinxiang of Henan Province, both with less than five articles and stopping updates in 2008. Searching the names of crucial activists or dissenting experts, I only found blog accounts belonging to the grassroots anti-nuclear activist Wu Hui and the senior scientist He Zuoxiu who sharply criticized inland nuclear power. Among the 34 blog posts in the scientist's account in BlogChina.com, six were dedicated to nuclear power. As of January 26, 2019, the average views of each nuclear power articles were 4,661, and per capita, comments were six.

Wu posted 146 blog articles since he opened a Sina blog account in 2009 (he had another Sina blog account that was closed in 2008, without any nuclear power relevant articles), including 12 articles dedicated to anti-nuclear power, all posted after Fukushima. The average visit of these articles, as of January 26, 2019, was 4,568. The comments and republishing posts were higher, 60 and 100 respectively, partly because the activist has concentrated more on a locally relevant campaign against the proposed Taohuajiang NPP in his hometown Hunan Province. Despite the more significant number of comments, there was no evidence that his blogs have mobilized local opposition to the plant that was strongly supported by the local government.

The small number of views and comments indicate low public response to the

nuclear power issue, including anti-nuclear activism, especially if we consider the fact that most blog articles were published not long after the 2011 Fukushima disaster. The low number of visits seemed not caused by little public interest in the bloggers as they also published articles on other topics, winning dozens of thousands of views.

As compared with the low-profile activists in the blog world, the nuclear industry was active. Nearly all major nuclear power plants or proposed projects had their official blog accounts. Several leading public communicators of nuclear power and radioactive science, both individual and institutional, also had their presence.

On the other hand, although in the public blogosphere little anti-nuclear activism was visible, on ScienceNet.cn, published by CAS and operated by CSD, which is noted for its blogs written by thousands of scientists (X. Huang & Zhan, 2010), a number of severe blog articles questioning nuclear power can be found, some with more than 10,000 visits. As ScienceNet.cn's primary readers are scientists whose number is much fewer than the audiences of public media, the 10,000-visit is a pretty high number. This fact, together with CSD articles quoting major dissenting experts on the nuclear power issue, indicates the elite, professional feature of China's anti-nuclear activism.

Moving from blogs to the more popular Weibo, one can identify more impassive public reactions to the nuclear power issue. Combining keyword searches, topic searches (with hashtag # and the keyword "nuclear power"), and targeted search in key actors' Weibo accounts, I selected four nuclear-negative tweets among the total (only) 12 negative tweets I found eligible for Weiboreach.com analysis (over 30 forwards) and all the four such available positive tweets. I input them for Weiboreach.com analysis. The four negative tweets produced altogether 670,000 independent views, much fewer than the four high-

impact nuclear-positive tweets, whose total reader numbers reached 3 million. Although the two sets of Weibo tweets might not be genuinely comparable because they were posted at a different time in varying contexts, the big difference between the view number for the two types of tweets showed the lack of market for anti-nuclear debate on social media.

On the other hand, the highest viewed nuclear power topic on Weibo was worth further exploration. A former nuclear engineer with a Tsinghua master's degree started his own business of instant noodles, claiming the reason for his entrepreneurship: "Nuclear power is safe, but food safety is less satisfactory!" Since its debut in early December 2018, the Weibo topic has attracted 12.8 million views and 7,300 comments by the time of my data collection in late January 2019.

Weibo was indeed used in anti-nuclear NIMBY activities (R. Huang & Sun, 2016), but the dominant social media platform has not become an arena for regular anti-nuclear power activism. People's anti-nuclear emotion as revealed in their Weibo tweets was far less than the industry's use of it as a promotion nuclear power's legacy and positive image.

Finally, a brief examination of WeChat revealed similar results. My field observation on WeChat only identified two WeChat groups focused on anti-nuclear activism, each with only a dozen members. A January 7, 2019 search of the 100 highest read WeChat public account articles with gsdata.com found none of them had a clear anti-nuclear tone. Then I specifically searched activists and dissenting experts' names to see their WeChat public account articles. The search on January 27 returned with 14 different articles, with the earliest dates back to March 2015 (gsdata.com only supported search in recent three months from the search time). Except one 2015 piece questioning inland nuclear power whose views reached 13,000, all other articles were read by less than 5,000

readers. Nearly all anti-nuclear power articles were accompanied by refutations, either by official nuclear power organizations or individual atomic engineers.

Like Weibo, the lukewarm reaction to WeChat-based anti-nuclear articles reflected the low public attention to the issue. A triangulation across blogs, Weibo, and WeChat showed that nuclear power is far from a hot topic in most time in China. This low interest has led online editors to not spend their energies in promoting such tweets or posts. "Unlike GMOs, the audience's few views result in an algorithm naturally avoiding recommending this type of contents," said an editor at an algorithm-based media (INT20170725).

Although anti-nuclear power voices can be heard on social media, their low public attention, together with conventional media's friendly tone to the energy, inhibited mass mobilization against it. But the media alone cannot reach this effect. Instead, the inhibiting political opportunity structure should be the primary force curbing regular anti-nuclear activism in Chinese society.

5.4 EXAMINING NUCLEAR CONTENTION AS A SOCIAL MOVEMENT

5.4.1 Restrictive political opportunity structure

Taking China's nuclear power controversy as a social movement, we can find that the three dimensions – political opportunity structure, frames, and mobilization (Tarrow, 2011) – driving social movements were relatively restrictive in the case of anti-nuclear activism. Among them, the political opportunity structure plays a central role. Due to China's lack of institutionalized democratic bodies which Kitschelt (1986) found essential in Western democracies' anti-nuclear movements, we have to investigate both the political establishments and sociopolitical elements forming political channels.

Due to its unique importance, the nuclear power industry has enjoyed a much higher

political status than average sectors. For example, the top leader (normally chairman and Party secretary) of CNNC has always been a member of the 200-member CCP central committee, usually consisting of ministers and governors. With political power only less than the Politburo, CCP central committee is China's main policymaking body. Its members coming from industry are commonly less than 10, shared by the nation's top bank leaders, presidents of two petroleum giants, CNNC head and defense industry top executives.

Among China's political establishments, Chinese People's Political Consultative Conference (CPPCC), China's "upper house" which plays a vital role in its consultative Leninism (Tsang, 2009), has not raised any open debate against nuclear power. My field study only identified one CPPCC delegate who openly questioned nuclear power's development. However, without other delegates' attention, he can hardly raise the nuclear power issue into group discussions at the political body's annual plenary meetings. Without the endorsement of more members, he had to personally submit his policy proposal to relevant agencies, such as NEA and NNSA, through their offices for letters and visits⁵, which makes it hardly possible to produce any policy impact (INT20170730).

By contrast, the nuclear power industry has a much more concentrated presence in CPPCC. In 2018, CNNC alone contributed to seven delegates to 13th CPPCC in its economics and science and technology groups. The appearance was complemented by

⁵ Different from NPC where 30 representatives' endorsement is needed to submit a motion, CPPCC proposal does not require other members to endorse. However, the one-member proposal is often considered trivial and organizationally neglected. All government agencies in China have offices for letters and visits to deal with public complaints. Policy proposals through these offices are often unattended (Thireau & Linshan, 2003)

business executives in CGNPC and other power firms, as well as scientist delegates who studied high-energy physics and other nuclear-related disciplines. For example, two scientists at the CAS Institute of High-energy Physics (IHEP) were elected CPPCC members (IHEP, 2018). Although the total number was small as compared with CPPCC's 2100 plus delegates, their concentration in the science and technology group (112 members) and business & economy group (130 members) seemed enough to raise pro-nuclear power proposals and block any potential anti-nuclear proposal. During NPC and CPPCC annual plenary meetings, jointly held in March, the nuclear industry represented by CNNC and CGNPC often convened press conferences to brief their new CPPCC proposals or NPC motions.

CPPCC and NPC are examples of the arenas where the political opportunity structure does not open wide enough for anti-nuclear activism. In a broader sense of the structure (Meyer & Minkoff, 2004), China's specific sociopolitical and economic condition also contributes to constrained anti-nuclear activism.

In the previous section, I analyzed Chinese media's reluctance to initiate and amplify the nuclear power controversy. In terms of political opportunity structure in an undemocratic nation, this also means the lack of political channels for anti-nuclear activism.

Among other elements, the nuclear power sector's resource concentration and power monopoly, which rendered the industry a primary target of social movements in Western democracies in the 1970s and 1980s (Kasperson et al., 1980; Opp, 1986), instead have played an inhibiting role for the social movement in developmentalism-dominated China. "A nuclear power project easily reaches 30 to 50 billion yuan [in investment], which will significantly promote the local economy and tax revenues of hosting cities. Therefore,

local government will try every effort to attract a nuclear power plant and then ensure its successful construction and operation," said a senior journalist affiliated with the official Xinhua Agency who has reported nuclear power industry for years (INT20160923a). His remark was consistent with the economic and business frame dominating Chinese media's non-Fukushima nuclear power reporting, as shown in Table 5-5. The frame accounted for 31.8% of the sampled media reporting of nuclear power before the Fukushima accident, the largest. After the Fukushima disaster, the frame's percentage decreased to 13.9%, the second largest after nuclear safety's 40.9%. The nuclear safety frame was mostly applied to situations related to Fukushima accident and post-disaster impacts and rescue.

Unlike a hydropower dam which is often located in remote southwestern provinces, all NPPs in China sit in affluent coastal areas – particularly Guangdong, Zhejiang, Jiangsu, and Shandong (the four richest Chinese provinces in terms of GDP) – where local governments have extensive resources and high capacity to advance major industrial projects. The nuclear power industry, on the other hand, does not merely wait for or rely on local host governments. According to an industry insider, while maintaining a high intensity of regular public education, the industry usually spent massive efforts making sure the planned nuclear power projects were written into the provincial five-year development plans to ensure legitimacy. After that, nuclear power investors would mobilize officials from the provincial level to host local governments. Local opinion leaders would also be invited to model atomic power plants – normally Qinshan NPP for CNNC and Dayawan NPP for CGNPC – to feel how beneficial an NPP to residents (INTINT20161023).

The governance structure of China's nuclear power industry further shut down the

organized resistance to the industry. Nuclear power safety is governed by the National Nuclear Safety Administration (NNSA) under SEPA/MEP/MEE, the most critical government agency behind environmental activism such as the anti-hydropower movement. It is widely acknowledged that ENGOs generally consider SEPA/MEP as one of their few government allies (Y. Sun & Zhao, 2008) and are reluctant to turn hostile to the agency by provoking the nuclear power sector. Although most ENGO sources I interviewed did not admit this, they walked away from anti-nuclear activism. Funding could be another factor. A former China representative of a European environmental foundation said despite the organization's anti-nuclear stance in Europe, it has not introduced such activism to China or funded local ENGOs for this activity.

In addition to political opportunity structure, anti-nuclear activists in China also found it hardly possible to win the frame competition, another critical element Tarrow (1996) identified for a successful social movement. The previous section has revealed the media's cold attitude to anti-nuclear activism. But activists themselves had to avoid an overall anti-nuclear image. Instead, they either targeted inland nuclear power, or focused on less efficiency of the energy, or opposed the great leap forward of the NPP construction or stress the possible management loopholes.

Two prominent factors make it hard for anti-nuclear activists to frame their actions as legitimate: the nuclear power sector's close ties with SEPA/MEP/MEE and its past glory and symbolic image of independent innovation. Nuclear power is strongly framed as a solution to China's environmental woes ranging from severe haze caused by air pollution to its high carbon intensity (Zhou, 2014). The link to the environmental agency indeed corroborates the frame, as experts and officials affiliated to MEP widely endorsed the claim

to place nuclear power as clean energy either in meetings, government documents and media interviews (W. Guo, 2014).

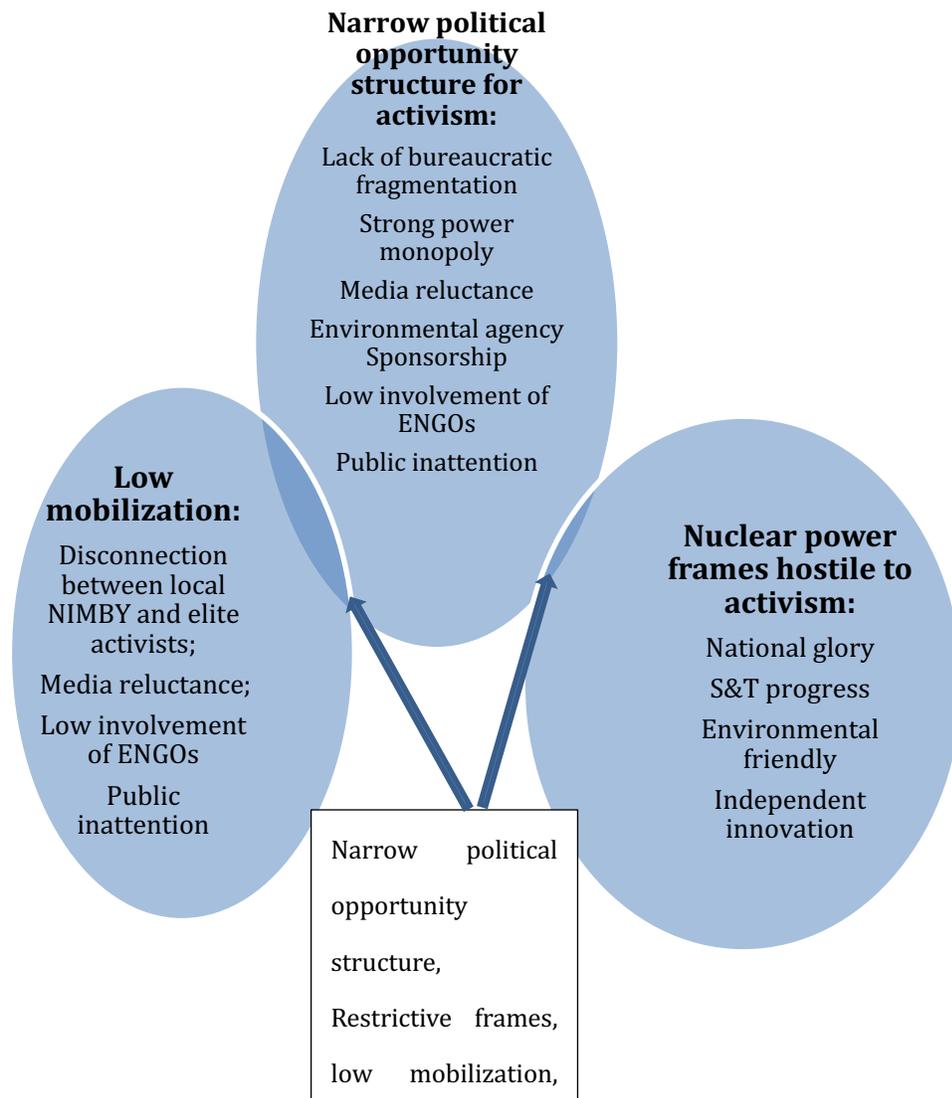
The sector's revolutionary legacies, a foundation for its positive sociotechnical imaginaries (Jasanoff & Kim, 2009), and its image of competence in serving the public (Siegrist, Cvetkovich, & Roth, 2000) shielded nuclear power from the growing public dissatisfaction. The nuclear power industry's revolutionary legacy to successfully make an atomic bomb from scratch and its later development of civil nuclear power result in an image of technological competence among the public and the media. The independent innovation frame enjoyed by nuclear power sector has won the appreciation of generations of Chinese leaders from Deng Xiaoping and Jiang Zemin to Xi Jinping and premier Li Keqiang. The latter even called nuclear power sector a highlight card for the exports of Chinese innovation (Party Committee of CNNC, 2017).

As shown in the previous chapter, the growing leftism movement joined hands to attack GMOs, which were framed either as a conspiracy of Western powers against China, or a capitalism symbol to exploit peasants. But the revolutionary legacy of nuclear power sector makes it nearly wholly free of this stigmatized frame. "Leftists cherishes Chairman Mao. One of the most notable achievements of Mao is his determination to develop the atom bomb. So, leftism-oriented nationalists tend to link the nuclear power industry to Mao's legacy, making it free from being branded as a Western conspiracy," said a Chinese communication scholar (INT20170828).

In summary, in addition to the narrow political opportunity structure, the clean technology frame of nuclear power endorsed by the environmental agency and the sector's revolutionary and innovation images have primarily inhibited activists from negatively

framing atomic energy. Meanwhile, MEP's endorsement of nuclear power has also limited established ENGOs' involvement in anti-nuclear activism. The absence of ENGOs, plus media workers' reluctance to make critical reporting of atomic energy, made social mobilization for anti-nuclear activism hardly sufficient. Figure 21 indicated the situation.

Figure 21 Narrow political opportunity structure, unfriendly framing and low mobilization for China's anti-nuclear activism



(Source: Drawn by author)

Despite these restrictive factors and limited impacts, there were still NIMBY events against nuclear power, even resulting in project suspensions. Activists and dissenting experts can always openly question the industry. In addition to the triggering role of the Fukushima accident, internal conflicts and fragmentation of China's nuclear governance, as revealed by the fragmented authoritarianism (FA) framework, also contributed to the occurrence of NIMBY events and controversies related to nuclear power.

5.4.2 Fragmented authoritarianism and anti-nuclear activism.

Although the political opportunity structure was narrow for China's anti-nuclear power activism, activists have desperately tried to explore the fragmentation to widen the opportunity structure. Wangjiang's civil movement against Pengze NPP in Jiangxi Province is a typical example of fragmented elements that can fuel certain activities against nuclear power (L. Deng & Jia, 2019).

As discussed above, a mighty host government can effectively constrain local protests within its jurisdiction, but Wangjiang belongs to the neighboring province of Anhui, which is on the other side of Yangtze River. After the Four Seniors raised the anti-Pengze NPP flag, Pengze county's officials requested to meet their counterparts in Wangjiang several times but were refused. Although the Chinese media are generally reluctant to tap negative news of nuclear power, two dramatic plots – Wangjiang government's official document against nuclear power and the Four Seniors' symbolic image of elite self-governance – attracted their attention (INT20161217).

On the Four Seniors' side, they effectively mobilized residents in Wangjiang's jurisdiction. Advertising boards against nuclear power were erected, and residents who worked for the preliminary construction of Pengze NPP were mobilized to inform about

the advance of the nuclear project. With the support of Wangjiang residents, the Four Seniors were able to charge that Pengze NPP staffs used valuable gifts to trade for Wangjiang stakeholders' endorsement in its public consultation process (INT20161206).

The privilege of experts who supported the Four Seniors to submit internal reports to top national leadership further enlarged the fragmentation. CAS members can directly brief top state leaders on science and technology issues. He Zuoxiu as a CAS member managed to submit relevant policy briefs to top policymakers, including President Xi Jinping and Premier Li Keqiang (INT20171221), a sign of China's bureaucratic fragmentation (Nathan, 1986).

By contrast, the pro-nuclear side seemed powerless in this aspect. According to an industry source (INT20170723), after NEA was set up in 2008, CNNC and other State-owned energy giants can only report to NEA to reflect their policy appeals, apparently to limit the expanding power of state-owned energy giants. The bureaucratic fragmentation made the nuclear power industry suffer a procedural disadvantage in political debates.

Nonmainstream knowledge and expertise within the nuclear power industry were other fragmented resources that activists and dissenting experts could utilize. Activists often stressed responsible engineers and experts within the sector empowered them to identify the problems of nuclear power. According to the above industry insider (INT20170723), the nuclear fuel recycling sector within the industry could be the primary expertise source for activists, because the latter's protests could highlight the importance of the long-neglected atomic fuel recycling.

But the nuclear fuel recycling side was blindsided by NIMBY activities in Heshan and Lianyungang. The fuel recycling portion did not have much public communication

experience as their NPP counterparts. Hence, they had not made any public opinion surveillance nor tried to appease local opinion leaders in host regions (INT20161023). When the online protests convened to push citizens to the streets (R. Huang & Sun, 2016), they were utterly unprepared.

Local governments in some host regions, then, also become somewhat fragmented parts in nuclear power development. When developmentalism dominated the agenda, bringing in nuclear projects best satisfied local officials' desire to pursue political achievements. But since President Xi Jinping came to the center of Chinese political power, the central leadership more and more stressed the importance of maintaining social stability rather than unusual economic growth (Lampton, 2015). Facing the potential risk to trigger social unrest, some local governments of host regions became less friendly to, or at least not wholeheartedly embracing of, nuclear power projects. The quick success of NIMBY activities in Heshan and Lianyungang resulted from this bureaucratic logic. An official of Guangxi Zhuang Autonomous Region's Fangchenggang city with an ongoing six-reactor NPP reported that resident relocation for the NPP has "nearly made his skin peeled off" (D. Yan & Li, 2014). "The rising risk awareness of local officials on nuclear power project's possibly causing street protests is changing their policy priority. Perhaps this is one of the policy impacts of China's anti-nuclear debates," said a Chinese communication scholar who has been following nuclear controversies across the country for several years (INT20170915).

In summary, despite the overall restrictive political opportunity structure, fragmentation within and outside the nuclear power industry still enabled activists and dissenting experts to initiate controversies. Activists never hesitated to utilize the

fragmentation. In their petition to higher government leaders against Pengze NPP, for example, Four Seniors hinted that mounting local dissatisfaction could lead to unwanted street protests, threatening political stability. No doubt this intentional effort contributed to the possibilities brought by fragmented bureaucracy associated with nuclear power governance.

On the other hand, although bureaucratic fragmentation played a role in facilitating anti-nuclear debates, the activism and its policy impacts were short-lived and limited, hardly enough to institutionalize the capacity to mobilize both elite and grassroots support. The weak strength explained the resumed momentum of the nuclear power industry in spring 2018. Theoretically, this is an indication that the emerging FA framework existing in and beyond nuclear power sector had to be subject to the more restrictive political opportunity structure.

As illustrated above, the nuclear power sector not only linked to a constrained political power regime but also co-existed with an effective knowledge-control regime. The regime strengthened the constraints affecting anti-nuclear activism.

5.5 STS INTERPRETATION OF NUCLEAR CONTROVERSY IN CHINA

5.5.1 Knowledge-control regime in China's nuclear power sector

Institutionalized knowledge monopoly. As compared with hydropower and GMOs, the nuclear power sector has evolved a much stronger knowledge-control regime. Starting from the atom bomb development era, China's nuclear scientists and engineers concentrated in remote, mysterious Gobi bases, which made them not only far from urban prosperity, but also free from the political turmoil of the disastrous Cultural Revolution in the 1960s and 1970s.

What was isolated was not only the geographical and spatial location but also knowledge production. The nuclear science and technology education was limited to top universities such as Tsinghua, Xi'an Jiaotong, and Shanghai Jiaotong universities, Hefei-based University of Science and Technology of China (USTC) and Wuhan-based Huazhong University of Science & Technology (HUST). The research was restricted to individual CAS institutes (such as institutes of Applied Physics in Shanghai, of Theoretical Physics in Beijing and Modern Physics in Lanzhou), China Institute of Atomic Energy (CIAE) now under CNNC, Tsinghua's Institute of Nuclear Technology (which has an undergraduate wing, the Department of Engineering Physics) and USTC. Many of these institutions are covered with mystery and named with a number. For example, Tsinghua's Institute of Nuclear Technology was named No. 200 in Changping District while CIAE is called Institute 401.

Although since the 1970s, China began to open its door to international collaborators to commercialize nuclear power, the quasi-isolation system remains active today, partly because nuclear knowledge production and learning are highly professionalized. By the end of 2017, China Nuclear Society has only certified 18 Chinese universities' nuclear programs. Among them, Tsinghua University enjoys a paramount status. In 2016, Tsinghua University's Department of Engineering Physics celebrated its 60th anniversary, announcing it had cultivated 20 generals and 32 CAS and Chinese Academy of Engineering (CAE) members. CNNC hosted 61 CAS or CAE academicians. CAS and CAE have honored a total of 2,400 academicians since 1956. CNNC announced in June 2018 that it would set up a Chinese University of Nuclear Industry in the coastal city of Tianjin.

Studies on the health impact of nuclear radiation are also concentrated in several institutions, including the National Institute for Radiological Protection (NIRP) under the Chinese Center of Disease Control (China CDC), Institute (Department) of Radiation Medicine under the Chinese Academy of Medical Sciences (CAMS), Beijing Institute of Radiation Medicine (BIRM) under the Chinese Academy of Military Medical Sciences (AMMS) and radiation medicine department at a very limited number of medical universities. Although radiation medicine is now widely adopted at Chinese universities and hospitals, few of these ordinary institutions have the privilege to examine NPPs' health impacts.

The institutional concentration contributed to the monopoly in knowledge production. Unlike in the hydropower field where experts of various backgrounds can comment on environmental issues and in the GMO case where food safety concerns push the unchecked distribution of false information, nuclear power knowledge production and certification are highly controlled within the small number of institutions and top experts. According to one Chinese communication scholar who studies nuclear power controversies, a leading nuclear safety modelling expert at a top university used to tell him that when the expert failed to model the desired nuclear facility safety indices and expressed a bit of suspicion on the current safety measures, his aging advisor – a CAS academician – warned him not to become a rebel of the nuclear power industry (INT20170915).

While the anecdotal evidence cannot be independently confirmed, it is clear that professionals and knowledge production in the field are somewhat disciplined. The self-discipline echoes Schmid's (2015) observation on the former Soviet Union's nuclear power industry. In China, disciplined knowledge production is associated with industry

professionals' self-confidence and their recognition of their past glory.

This past glory and its associated sociotechnical imaginaries can become a living component of the knowledge-control regime, just as it helps shield the nuclear power industry from many moralist attacks. In the knowledge-control regime, it maintains knowledge defenders' self-identity and their confidence, authorizes its legitimacy, silences dissenting voices and mobilizes necessary political resources when needed. Even He Zuoxiu, the senior CAS member, complained that his views questioning the feasibility of inland nuclear were not reflected in relevant CAE consultative reports and his attendance at the consultation process wasn't recognized with authorship.

Knowledge control in public engagement. While disciplining internal dissidents, the nuclear power sector is active in promoting nuclear safety ideas in the public sphere. In addition to the publicity departments of major industrial players such as CNNC and CGNPC, which are often staffed with several hundred employees to support science popularization, public relations, affected community appeasement, public and external publications, and academic sponsorship, two major industrial groups, China Nuclear Energy Association (CNEA), which mainly represents industry, and China Nuclear Society (CNS) that primarily represents academics, have proactive public publicity departments. Among the 210 national societies affiliated with CAST (which is legally the umbrella organization of all national natural science societies), CNS was one of the few organizations that continuously won CAST's annual award for science popularization.

In the early 2000s, several years before the NIMBY movements began to spread across China⁶, media articles promoting nuclear power's safety and efficiency were widely

⁶ In China, landmark NIMBY events were Guangzhou's protest against Lizhuang trash

published in the sampled media outlets, describing concerns about nuclear safety as irrational. "As compared with biotechnology experts, the nuclear power sector has a strong self-awareness in science popularization and strong organized capacity to implement it," said a leading science journalist of a Party mouthpiece (INT20170723).

He was echoed by a liberal news magazine's science editor. "Whenever I had a request or query, I can always find amiable nuclear experts to consult with" (INT20160816). The same magazine's energy reporter echoed: "Unlike other state-owned energy conglomerates, nuclear power enterprises' PRs are very capable. At news conferences, companies regularly prepared suggested questions for attending journalists. Many of these questions prepared by other industry players are nonsense. But in the question list prepared by nuclear companies' PR, you can nearly find every question a journalist wants to ask" (INT20170825).

Together with the favorable sociotechnical imaginaries that the nuclear power industry enjoyed, the cooperation regularly received friendly responses from the media, steering them to positively report the industry in standard time and balancing their reporting with the industrial voice when there were unfavorable events like the Fukushima accident or local NIMBY activities. This media orientation was corroborated by the abovementioned media morphology of keeping a stable "nuclear journalist" team for the beat. As media sociology scholarship has revealed, for both general media (Carlson, 2009) and science journalism (Schäfer, 2011), a closer tie between journalists and their sources produce more favorable reporting of these sources.

incineration plant and Xiamen's protest against a PX plant around 2008 (R. Huang & Yip, 2012).

Risk management and its socially constructed allies. In its effort to comfort the public, the Chinese nuclear power sector, and the worldwide nuclear industry alike, adopts a way to admit uncertainty and potential risks but to assure the public (and particularly officials and political leaders) that the uncertainty is an unavoidable feature of industrialization; the risk associated with nuclear power is the lowest or most controllable as compared with other conventional technologies/applications such as driving cars; and the nuclear industry has the complete capacity to control the risks. The preamble of the International Atomic Energy Agency (IAEA)'s basic safety principles for NPPs claimed that "safety is never absolute in any endeavor. All of life is hazardous in some way" (International Nuclear Safety Advisory Group, 1999, p. 1).

Science studies scholars have shown that admitting uncertainties/risks but assuring effective management of them is a strategy to increase the epistemic authority of science (Shackley & Wynne, 1996; Zehr, 1999). Nuclear power experts seek precisely this type of epistemic authority. Nearly every industry interviewee showed his/her embrace of this rationality. Correspondingly, rejecting or worrying about controllable low risk would be considered irrational.

Built on studies on the epistemic significance of uncertain/risk management, Jia et al. (2017) further explored how the societal forces – the media, the government, and policy agenda – interacted with scientists' uncertainty management. In China's nuclear power case, besides sponsorship by SEPA/MEP/MEE, journalists also helped strengthen the nuclear power sector's uncertainty/risk management, further securing its knowledge-control regime. "Nuclear power is not 100% perfect, but as compared with other energies, it is the most advantaged. Coal is heavy polluting; wind and solar energies are unstable and too

expensive; hydropower cannot assure water supply in winter. There are risks, but they are under control," said an energy reporter working for a leading business news magazine (INT20170825).

The situation is similar to the US media's effort to keep the GMO controversy from escalating through the professionalization of reporting the beat (M. C. Nisbet & Huges, 2006) or a "rational" tradeoff between potential risks and perceived benefits (Steiner & Bird, 2008). Both M. C. Nisbet and Huges (2006) and Steiner and Bird (2008), however, neglected the role of low public attention in influencing journalists' behaviors. Above I mentioned that low public awareness led journalists to perceive reporting nuclear power as less rewarding. Meanwhile, low public attention meant a low availability of alternative sources and experts' views to journalists, leading the latter to adopt the dominating agenda and risk management paradigm of nuclear power.

In mid-March 2011, after the Fukushima accident, widespread worry about radiation contaminants floating to China led the Chinese public to rush to buy iodized salt because taking iodine pills can reduce radiation harm. The buying rush, however, was depicted as an irrational behavior in various media and online articles, in which nuclear experts' claim of no radiation pollution from Fukushima paralleled science communication experts' comments on the public irrationality. Because salt's Chinese pronunciation (yan: 盐) is the same as "words" (言), which in Chinese are the second character of the term "rumor" (yaoyan: 谣言), a new Chinese word "rumored salt" (谣盐) was created, still pronounced as "yaoyan". The newly created term "rumored salt" was widely used in newspapers, websites, magazine, social media, and public education events, vividly and satirically indicating an irrational public and its poor scientific literacy (W. Liu, 2011). The

frame was so robust that it is still regularly used today to satirize the public's fear of rumored harms and its rejection of orthodox official knowledge (L. Xu, 2018).

The nuclear power sector's monopoly in knowledge production, its dominance in the public communication agenda and engaging media strategies, and its pragmatic uncertainty/risk management all resulted in (a) robust knowledge-control regime(s). When developing the concept using the example of the Human Genome Project (HGP), Hilgartner (2017) demonstrated that as compared with competing efforts, the knowledge-control regime(s) represented by HGP best matched the existing knowledge production practice, scientists' expectations and the public understanding of the genome sequencing. No doubt China's nuclear power sector had a similar situation.

Combining findings in the previous sections, one can find that the knowledge-control regime of nuclear power sector allied with China's political power, but its epistemic authority primarily did not rely on the political power's coercive force. Instead, a whole set of societal, institutional, and knowledge-making arrangements and a full set of social actors consciously and unconsciously enabled the regime to implement its knowledge control and strengthened the effect of such authority. Then, given the high strength of the control, why can we still hear the controversies and debates raised by outsiders, even though the policy impact was relatively limited? We can understand this by tracing activists' alternative knowledge building as a way to break the knowledge-control regime of the nuclear power sector.

5.5.2 Alternative knowledge and challenges to knowledge control

Alternative knowledge seeking. The lack of public resistance to nuclear power does not mean the Chinese public highly embraced atomic energy. Instead, according to

the idea of civic epistemology, which "refers to these culturally specific, historically and politically grounded, public knowledge-ways" (Jasanoff, 2011b, p. 249), the general public has not meaningfully examined the relevance of nuclear power and made rational choices about nuclear energy, due to their culturally, historically and politically bounded circumstances. The low connection of atomic energy to most ordinary people and their lack of attention to the energy/technology further corroborated the preference. In reality, the choice was epistemologically translated to the public's tolerance of nuclear power.

The activists and dissenters, as members of the public, initially did not explicitly take up anti-nuclear activism. Their challenge to the knowledge-control regime of nuclear power sector started from their encounter to the knowledge different from dominant views. STS scholars have well examined this alternative knowledge and their role to counterattack the orthodox regime (Irwin, 1995; Wynne, 1992). Chinese anti-nuclear activists adopted a similar strategy.

Among others, international sources of alternative knowledge were crucial to Chinese dissenters. Although in the early 2010s, when the Chinese actors debuted, global anti-nuclear power movements had dramatically declined (Joppke, 1991), legacies were embodied in environmentalism advocacy materials.

For example, the nuclear power knowledge of the Wangjiang Four Seniors primarily came from a series of books questioning nuclear power's promises ranging from economic efficiency to the fight against climate change after the Fukushima disaster. The book was introduced to China by Heinrich Böll Foundation, a Germany-based anti-nuclear charity.

Similarly, the abovementioned grassroots activist heavily relied on a classic US

textbook on the environmental study -- *Living in the Environment* – authored by G. T. Miller (2007) to construct his dissident knowledge system (INT20161127). He was commissioned to translate the book that raised the nuclear waste issue. It seemed to the activist that nuclear waste became an unsolvable issue. Later, when Maoism-oriented nationalism shaped his belief, he developed his version of a conspiracy theory: a central strategic goal of the US policies toward China is to control the latter with GMOs so that it can dump nuclear wastes to China.

Disadvantaged social groups often use conspiracy theory as a tool to protest dominant knowledge (Sunstein & Vermeule, 2009). The grassroots activist's undergraduate major was soil chemistry. He has not gone to graduate school. He found his academic training could not equip him for challenging the orthodox knowledge about nuclear power. But a conspiracy theory based on what he perceived as a widely-admitted fact (nuclear wastes cannot be entirely disposed) could empower him against the dominance of orthodox nuclear power knowledge. It could counteract the atomic energy sector's risk management strategy (there are risks beyond the sector's imagination), its credibility won by historical glory (China's nuclear power industry imported technologies from the West) and its environmental friendly frame (nuclear waste is a non-disposable and much more severe ecological woe than regular pollution).

Different from the grassroots activist, a dissenting computational physicist working at a top Chinese university said his involvement in the ITER project which explores nuclear fusion as an energy solution changed his initial belief on atomic power (INT20170619). According to the dissenting physicist, ITER participants heavily criticized current fission technologies. "I became aware that the current fission technologies weren't a good idea,

neither do the so-called next generations of nuclear power, such as traveling wave reactor promoted by Bill Gates. ITER's fusion technology cannot become a feasible energy solution either." Although not a nuclear engineer, his expertise still provided professional support to more proactive activists.

Others harvested the knowledge necessary to launch a more destructive attack: Questioning the legitimacy and reliability of the nuclear power sector. Such knowledge primarily came from the favorite alarmist book *A NPP Employee's Last Will* written by the past Japanese anti-nuclear activist Hirai Norio, who used to be a nuclear engineer (Hirai, 2011). The book depicted how Fukushima Daiichi tried to make profits by lowering safety investments and surveillance, hiring cheap, low-qualified workers, and exposing employees to high nuclear radiation. The greedy image of Japanese NPP managers gave activists an excuse to split commercial nuclear power developers from the historically glorious military nuclear enterprises, framing the former as vested interest groups.

Another type of alternative knowledge was reflective articles and memoirs, such as the autobiography *The First Nuclear Era* of Alvin M. Weinberg (1915-2006), Oak Ridge National Laboratory (ORNL) former director (Weinberg, 1994, 1996), and articles of former CNNC vice president Li Yulun (1940-2018) (e. g. Yulun Li, 2013) on nuclear safety management and potential risks. Both Weinberg and Li are hardly atomic energy skeptics. However, with their half-a-century working experience, both of them raised warnings against the dangers of organizational failures and human negligence. Weinberg even used the term "Faustian bargain" to describe the potential danger nuclear energy might impose on human society (Weinberg, 1994, pp. 175-200).

The alternative knowledge encouraged activists and dissenting experts to challenge

the nuclear power sector's knowledge monopoly. The challenging process also provided chances for them to network with each other. Although the alternative knowledge was not enough to topple the knowledge-control regime of the nuclear power sector, it helped initiate controversies in which activists adopted various discourse strategies to shake nuclear power's knowledge dominance.

Discourse strategies against knowledge control. In the previous section which examined social movement aspects of nuclear contention in China, I briefly described the internal disputes of the nuclear power industry, particularly the tension between power generation and nuclear fuel processing, as evidence to support FA framework.

Apparently, nuclear fuel processing engineers would not topple the whole industry when they raised the issue of higher unprocessed nuclear waste, but activists amplified and reframed the unharmonious voices from within the nuclear power industry, such as the potential safety management challenges, insufficient social organization to support massive atomic energy development, and accumulating nuclear wastes. The claims against potential risks raised by Weinberg, Li, and other engineers were alarms to peers, but activists took them as a powerful weapon – both as contrary evidence against nuclear power and as a symbol that the industry's founders betrayed it.

In their debates with the nuclear power industry, activists and dissenting experts took a strategy to reject the rationale of the industry's risk management. As mentioned above, the atomic energy industry has adopted a plan to admit potential low risks but demonstrate its high controllability. Citing Fukushima NPP's management flaws exposed by Hirai (2011) and Tokyo Electric's (Fukushima NPP's owner) poor disaster handling, Wang Yinan rejected the rationale by distinguishing nuclear power safety design from

management practice. “The blueprint of nuclear power is always preconditioned by on-site workers with perfect technological capacity, without discussing whether staff on site has such capacity,” she wrote (Y. Wang, 2015a). She further pointed out that vulnerability of the complicated pipe arrangement in NPPs, the lack of engineering experience in safety surveillance, the inevitable human errors, the unsafe storage of spent nuclear fuel, and the unprocessed nuclear waste have made atomic energy far from reliable as boasted by industrial experts.

Based on these claimed problems, Wang further quoted Premier Li Keqiang’s remarks to require "absolute nuclear safety" during his inspection at an HRR1000 demonstration plant in 2015 to challenge the nuclear power industry’s concept of controllable risks (Y. Wang, 2015c). According to the article, absolute safety means not only theoretical modeling but also wholly reliable engineering practice and highly qualified and responsible staffs.

Strictly speaking, politicians’ stress on absolute nuclear safety is at a different level from the technical sense of the atomic energy industry’s controllable risks. The former does not necessarily exclude manageable risks but required risk controllers to be entirely responsible, careful, and competent. However, by quoting political leaders’ slogans, Wang and other activists highlighted nuclear power industry’s profit-driving behaviors, questioned and downplayed Chinese nuclear power firms’ implementation capacity, and forcefully embraced new risk factors (e.g., terrorist attacks) which she claimed were neglected in the nuclear power industry’s risk management version. Thus, in terms of discourse strategy, activists utilized political discourse to overcome scientific discourses of the nuclear power industry, breaking its knowledge monopoly in nuclear safety.

In other channels, activists and dissenting scientist also challenged the nuclear power group's hegemony in terminology. For example, in a public commentary published in bilingual environmental site China Dialogue, He Zuoxiu used the reactor-year (the number of years all reactors operate) calculation adopted by the nuclear power industry to refute the industry's theoretical probability of nuclear disaster. He argued that based on the frequency of major atomic energy disasters from Three Mile Island to Chernobyl and Fukushima and China's expansion speed to build new NPPs, China is highly probable to suffer a significant nuclear accident by 2030 (Z. He, 2013).

His calculation was refuted by the industry as a too simple and layman method, as he has not considered the technological improvement, staff quality, and social characteristics. Chinese media almost did not notice the article. However, his simple and easily understandable method is another attempt to challenge the risk assessment practice dominated by nuclear power sector based on complicated models.

Thus far, in this subsection, I have summarized the alternative knowledge activists absorbed and the discourse contention they adopted to challenge the knowledge control regime of the nuclear power sector. With small networks based on WeChat chat groups, these activists and dissenting scientists exchanged their knowledge, expertise, and perceived loopholes of nuclear power knowledge-control regime. The networking and knowledge exchange strengthened individual activists' knowledge base and fueled their activism. For example, a proposal by the aforementioned anti-nuclear CPPCC member submitted to energy authorities seemed precisely based on the remarkable points raised in Wang Yinan's articles against inland (Y. Wang, 2015b) and Bohai Bay NPPs (Y. Wang, 2016).

5.6 CHAPTER SUMMARY

With the alternative knowledge and their dynamic discourse strategies, activists and dissenting scientists have indeed made significant achievements in shaking the knowledge-control regime of the nuclear power sector. However, the communication, political, economic, cultural (sociotechnical) and bureaucratic resources nuclear power enjoys in China have resulted in a restrictive political opportunity structure, a competitive cultural environment, and a weak network for realizing social mobilization for anti-nuclear activism. Although activists had chances emerging from fragmentation within the nuclear power industry, and sometimes between the industry and its local hosting governments, and although the FA framework associated with China's nuclear power sector has helped activism achieve specific policy effects, such as the delay of AP-1000 reactors' fuel loading and the moratorium of inland NPP construction, this fragmentation cannot topple the overall restrictive political opportunity structure in nuclear power governance. As a result, it is unlikely that the nuclear power industry will lose its expansion momentum.

If the major theories and concepts applied in this chapter can be presented synthetically, this chapter provides evidence to show that political process theory centered in political opportunity structure has the most potent explanatory role in analyzing nuclear controversies in China. The FA framework has a moderate role in understanding individual campaigns, but their policy impact has to be subject to the more general political opportunity structure.

China's overall authoritarian political system, in which the government ministries play the central governance role, may be blamed for causing the situation. As a result, when there isn't a deep bureaucratic schism like the one between SEPA/MEP/MEE and the

water/energy departments in the case of hydropower controversy, and when nuclear power has enjoyed a much more privileged status than other science and technology topics, the fragmentation existing within the nuclear industry or between nuclear industry and hosting governments cannot facilitate the final success of anti-nuclear activism. The fragmentation cannot fuel debates on nuclear power as a widespread and long-lasting science and technology controversy either.

But without a careful calculation of the role of knowledge and communication patterns, the political/social movement side is not enough for us to understand the nuclear controversy in China. For a complicated science and technology issue deeply rooted in China's modernization dream like nuclear power, knowledge is an integral component of the political dimensions of nuclear controversy. For example, the knowledge-control regime of nuclear power is closely associated with the restrictive political opportunity structure the anti-nuclear activists encounters. On the other hand, the restrictive political opportunity structure can corroborate knowledge-control regime. Similarly, the sociotechnical imaginaries about a progressive and proud nuclear power image also support the constraints on activism imposed by the restrictive political opportunity structure and inhibits the effect of activists' anti-nuclear framing effort. The current chapter is only an early step to explore this dynamic and interactive relationship.

Chapter 6 Comparing hydropower, GMO and nuclear power controversies

6.1 CASE SUMMARY

In the preceding chapters, based on three years' field study and participatory observation, I traced the development of significant science and technology controversies – resisting hydropower, GMO controversy, and nuclear power debate – in contemporary China and analyzed communication, sociopolitical and knowledge factors underlying their emergence and evolution. Consistent with a group of science communication and STS scholars (e. g. Irwin, 1995, 2014; Jasanoff, 2011a, 2017; Wynne, 1992), my study revealed that in China alike, major public science and technology controversies are far more than a product of poor public understanding of science or emotional rejection of potentially hazardous technologies.

Instead, both the widespread GMO controversy and the relatively more elitist campaigns against hydropower and nuclear power resulted from a combination of factors ranging from the changing media environment, emerging political opportunities, and the evolving knowledge-control regime to the strategic actions adopted by activists and the public distrust of scientific experts and officials behind them. These factors and activists' strategic efforts to utilize the opportunities associated with them lead to varying patterns of science and technology controversies in the domain of social movements that are worth communication and STS scholars' attention (Epstein, 1996, 2008).

More concretely, the public resistance to hydropower controversy was a concentrated reflection of the rising environmentalism and ENGOs which have effectively utilized emerging public environmental awareness, bureaucratic fragmentation,

publicness-pursuing media, and the shackled knowledge-control regimes, though given the remoteness of the protesting sites and limited public attention, anti-hydropower activism did not show a high level of public participation (Tilt, 2014). The GMO controversy, on the other hand, was widely spread in Chinese society, although few established civil society groups were involved, and scientists increased their efforts to maintain knowledge control. The fragile science-politics alliance, the fragmentation within central leadership and widespread public concerns all created a favorable political opportunity structure for anti-GMO activists. By contrast, the nuclear power controversy showed both narrow political opportunity structure and robust knowledge-control regimes, thanks to nuclear power's link to military purpose, its past glory, and its strong business-politics alliance, as well as lack of public attention.

Below in this chapter, while addressing the working research questions, I will first re-examine the most crucial elements in the media and communication system, social movement angle and knowledge control aspect of the three sample controversies. Then a comparison of theoretically important components underlying these controversies will be provided. Finally, I will discuss the possibility to integrate different aspects of these factors to achieve a comprehensive understanding of public science and technology controversies.

6.2 MEDIA AND SCIENCE CONTROVERSIES

The first set of research questions is about the role of communication elements, such as the media and Internet, in developing the GMO, hydropower, and nuclear power controversies. China's media commercialization and partial liberalization have played an important, if not always central, role in promoting, amplifying, sustaining and in some case even triggering the hydropower, GMO and nuclear power controversies in the country.

However, in different disputes, media involvement and communication patterns differed from each other.

In the hydropower controversy, organized resistance of ENGOs (whose early members were originated from or closely linked to the media) to dam building was consistently supported by the mass media and the anti-dam activism also accompanied the media outlets to exploit environmental reporting as a symbol to fulfill the media's watchdog role for public interests. With the regular beat reporting covering power industry succumbing to the rising environmental agenda, the developmentalism that dominated the Chinese press until the early 2000s gave way to the discourses of environment conservation and public accountability.

Similarly, Chinese media were active in reporting GMO controversies and even initiated the early debates regarding the technology. Their reporting of GMOs shared the public accountability frame they used for hydropower coverage, but food safety issues replaced the environmentalist agenda. Despite the lack of organized involvement of NGOs, widespread public concerns about food safety pushed a diversified media reporting of GM food.

The nuclear power controversy experienced an entirely different media scenario. The media stories were generous in framing atomic energy development as the symbols of national honor, science and technology progress, and independent innovation. Journalists structurally avoided news topics questioning nuclear power. Although the Fukushima accident brought widespread concerns on nuclear safety, this did not change the Chinese media's general tone to report domestic nuclear power development, and few of them offered platforms for anti-nuclear activism.

The media performance was associated with the actors' behaviors. The hydropower industry's failure to deal with the media resulted in an imbalanced media picture, strongly favoring activists' environmentalism claims. Despite their initial impassiveness, biotechnology scientists later increased public communication, but their effort was countered by mushrooming anti-GMO campaigns, mingling serious intellectual challenges with rumors and conspiracy claims. The nuclear power industry started its risk communication long before nuclear became a controversy within China. Their active public communication effort won support from most media outlets.

In both the hydropower and GMO controversies, journalists have not only received messages from activists but also worked as activists, initiating disputes with their stories. However, in the debate on nuclear power, it was hardly possible to identify any journalist actively involved in the activism against nuclear power.

While the nuclear power sector has relatively made a stronger effort in media communication and public relations, the reasons for more negative reporting of hydropower and GMOs than nuclear power could be structural factors. The hydropower controversy met the media's environmentalism agenda (the inadequate response of the sector fueled the trend) while the escalated media interest in reporting GMOs was associated with the extensive public attention to food safety and the media's effort to snatch the attention. In the nuclear power case, lack of public awareness interacted with journalists' risk avoidance to produce low media attention.

Together with conventional media, the Internet also became a significant promoter of science and technology controversies. By timely distributing controversy-inducing articles from print media, highlighting and organizing debates, and collecting background

information in science and technology controversies, online portals harvested visits while fueling and intensifying controversies. G. Yang and Calhoun (2007) outlined the interaction between the media, Internet, and civil society groups in China's advancing green politics.

The arrival of social media intensified the communication pattern of the print media era. Strong public attention and concerns enabled the GMO controversy to remain a hot issue on Weibo or WeChat, offsetting scientists' media training efforts and the government's media censorship. Social media continued to host positive frames related to nuclear power and the general public's impassiveness to the topic inhibited anti-nuclear debates from spreading online.

Although hydropower, GMO and nuclear power controversies in China were not possible without the media, Chinese media's facilitating or inhibiting these controversies was often a result of the role other sociopolitical and knowledge factors played in structurally triggering and shaping science and technology controversies. Correspondingly, the media have become an integral part of the process. For example, due to the lack of institutionalized democracy in China, the media have played a role within the political opportunity structure.

6.3 COMMUNICATION PATTERNS

In 6.2 section of this chapter, I summarized the role of media in the science and technology controversies. Now I will further consider the communication patterns involved in science and technology disputes. As examined across the empirical study chapters, public attention and associated issue cycle are an essential backbone factor underlying science and technology controversies. Significant public awareness encouraged more newcomers and more diversified topics, such as in the GMO case, while in a less

concentrated public attention setting, such as in the hydropower controversy, activists had to create new public problems. The necessary time and travels of activists to create these new issues regarding southwestern dams resulted in periodically hot media events. By contrast, low public attention in nuclear power setting inhibited anti-nuclear debates from becoming a hot public issue.

Consistent with public attention was the actors' strategies for dealing with their perceived public awareness. In the nuclear power case, event-driven journalists and editors avoided investigative reporting of the nuclear power sector because of a tradeoff between high potential risks and low rewards (low public attention). The beat covering practice for highly professional areas intensified journalists' avoidance behaviors. Reporting the less attended nuclear power sector was dominated by senior energy and science journalists preferring to ally with the industry (and academics behind it) while similar professional beat coverage of hydropower was replaced periodically by environmental journalists. During the peak time of the GMO controversy, generalist journalists replaced science journalists to become the main actors to report the controversial technology, precisely opposite to the phenomenon revealed by M. C. Nisbet and Huges (2006) in their studies on the US elite media.

Communication technology change has profoundly shaped the pattern of science and technology controversies too. Scholars have widely recorded the impact of the fast growth of the Internet, social media and mobile communication on disputes, including the hydropower (G. Yang & Calhoun, 2007), GMO (J. Fan et al., 2013; Q. Xu et al., 2018) and nuclear power (R. Huang & Sun, 2016) controversies in China, but my dissertation exemplifies the interaction of this technology change and other factors such as public

attention and knowledge control/monopoly patterns. The intention of Internet editors to attract more online visits promoted the initiation of online forums/special topics for hydropower and GMO debates and allowed these editors to tolerate false but sensational news on GMOs spreading online, but the same editors avoided initiating such online forum on nuclear power. Wang Yinan, the anti-nuclear elitist activist, was never involved in such debates, possibly because Internet editors shared the reward/risk logic with conventional journalists. The media behavior is also related to the knowledge-control regime that shaped public knowledge of nuclear power.

6.4 TRACING SOCIOPOLITICAL ROOTS OF SCIENCE CONTROVERSIES

6.4.1 Political opportunity structure for science controversies in China

Political opportunities arising in a gradually opening society. The second set of research questions is about the relevance of social movement theories to China's hydropower, GMO, and nuclear power controversies. Of various theoretical components, the political opportunity structure is the most crucial element.

My study indicates that science and technology controversies occurred in loosening political control amidst China's gradual opening-up and market-oriented reform (Cao, 2018; Y.-W. Lei, 2018; Mertha, 2008; Zeng et al., 2015). These policy shifts created political opportunities in the sense that public science and technology controversies had an apparent policy and political implications.

As early as the mid and late 1980s, the debate on Three George Project (TGP) initiated the first large-scale science and technology contention in which dissenting experts, if not activists as in more recent period, challenged the central government's decision to build the massive dam (Lee, 2013a). In the process, science and technology issues were

primarily understood as a non-political issue, allowing authorities to tolerate harsh debates. Throughout the contentions, few dissenting experts and activists were physically punished if they were not involved in other politically salient protests. However, this is also because most debate participants carefully maintained the boundary between science (or environment) and politics.

The loosening political atmosphere in China resulted in more participating actors. Among these actors, NGOs, the media, and dissenting experts are the most important. The post-TGP hydropower controversy became a real battlefield of China's local ENGOs while Greenpeace was the most potent initiator and promoter of GMO contention in China. In the case of nuclear power, dissenting elites arose as the main actors.

The Chinese media, too, are a significant component of the political opportunity structure. In the hydropower and GMO cases, the media not only timely reported activists' challenges against dams and GM foods, but also organized and participated in various contentious events. For example, Wang Yongchen of China National Radio arranged numerous journalistic inspections along the Upper Yangtze and Yellow rivers, and these inspections accompanied activists' ongoing protests against dams in Dujiangyan, Nu River and Jinsha River. For GMOs, Southern Weekend (SW) 's 2004 cover story (J. Liu, 2004) questioning scientists' interests under their effort to commercialize GM rice had practically postponed GM rice commercialization in China. Many activists, such as Wang Yongchen and Liu Jianqiang of SW, author of the SW cover story, among many others, turned out to be leading activists in environmental movements (H. Wang, 2016).

Academic allies of activists also provided fuel for public science and technology controversies, while the increasingly diversified Chinese society enabled experts directly

involved in internal and professional debates to voice their concerns publicly. ENGOs often initiated experts' views. Some academics, such as Fan Xiao of Sichuan Geological Survey, became activists themselves.

External resources were often crucial to the formation and evolution of science and technology controversies. Internationally funded Greenpeace was the central actor in activism against GMOs while international funding and expertise from partner organizations such as International Rivers and professional materials such as those in the book *Silenced River* (McCully, 1996) significantly supported ENGOs' anti-dam activism.

Political opportunity structure and fragmented authoritarianism. While in the circumstances of authoritarian China, loosened political control, liberalizing media, emerging ENGOs and dissenting experts can all be called political opportunities, these circumstances or their combination do not certainly constitute a political opportunity structure (Meyer & Staggenborg, 1996). In Kitschelt (1986), a political opportunity structure was narrowly defined as a political structure for policymaking, but Tarrow (1996, 2011) seemed to take a more lenient view on the definition of political opportunity structure. In this dissertation, I adopted an eclectic approach. As long as the political, social, and knowledge opportunities, including the ones listed above, can combine to facilitate or block science and technology controversies structurally, I would apply the political opportunity structure concept for analysis.

As for structural factors underlying social movements, including science and technology controversies examined in this dissertation, the bureaucratic fragmentation in China has played a crucial role in promoting them, due to China's authoritarian regime. Given China's authoritarian nature, the bureaucratic fragmentation should be considered

an essential form of the analytical framework of fragmented authoritarianism (FA) (Mertha & Brødsgaard, 2017), though it was suggested that FA should embrace more actors such as journalists and activists (Mertha, 2009) and even scientists (Brødsgaard, 2017). The existence of fragmentation itself does not mean that a social movement can be naturally facilitated. The bureaucratic fragmentation has to be combined with other factors to promote or inhibit the evolution of scientific controversies.

In the hydropower controversy, the schism between the hydrological department and the environmental agency as well as hydropower developments' conflicts with construction, historical conservation, wildlife protection, and agricultural agencies enabled the ENGOS' actions, helped mobilize supporters, and in many cases directly halted dam construction (as in the Xiaonanhai case). But one shouldn't consider that bureaucratic antithesis was automatically translated to rejection of dam buildings. After all, most planned dams in China were constructed and put to operation. Instead, the bureaucratic schism offered necessary political opportunity structure for activists to concentrate resources, exert influence, and obtain knowledge to target specific hydropower projects. Indeed, what made the hydropower controversy more salient is the effect of activism. After the unsuccessful attempt against TGP, most other dams that raised intense debates – Nu River dams, Yangliuhu in Dujiangyan, Xiaonanhai, and Tiger Leap Gorge – were suspended or halted. The bureaucratic fragmentation had to work with other elements, such as active ENGOS, effective framing, and knowledge control factors to drive or block major public science and technology controversies.

In the GMO controversy, there were many minor traces of bureaucratic schisms, such as the initial struggle of SEPA (State Environmental Protection, upgraded to the

Ministry of Environmental Protection (MEP) in 2008 and the Ministry of Ecology and Environment (MEE) in 2018) to dominate biotechnology governance with the goal of implementing China's commitments to the Cartagena Protocol on Biosafety. But, as chapter 4 examined, SEPA never put serious effort into the struggle for the dominance, and anti-GMO activists did not ally with SEPA as in the hydropower case. Another internal fragmentation – the protests from Maoist princelings – also played a role by pressing individual members within the top leadership and by legitimatizing grassroots protesters. In terms of political opportunity structure, this was a less clear structure. However, the Ministry of Agriculture (MOA)'s relatively weaker or at least perceived weaker power, as indicated by the media's opening impugning its incumbent vice-minister, may be considered a sign of a less restrictive political opportunity structure. No matter whether MOA was weak, given food safety/security's supreme importance to Chinese politics and its people, any single ministry cannot withstand and control enormous public opinion pressure caused by people's widespread concerns about GM foods, enabling grassroots activists to rise to dominate anti-GMO activism.

In the nuclear power controversy, although elitist activists and dissenting experts against the nuclear power industry were visible and the debates they raised produced some policy effects, there was not a political opportunity structure friendly to anti-nuclear activism. The glorified national sociotechnical imaginaries about nuclear power, the sector's concentrated power and resources, its military links, SEPA/MEP/MEE's alliance with the industry, media's reluctance to be involved, and stable knowledge-control regimes of nuclear power all structurally inhibited controversies from being expanded and amplified.

But the fragmentation within the nuclear power sector also provided opportunities to activists and some NIMBY activities. These opportunities can also be considered structural, as they were related to structural and institutional arrangements. However, these opportunities were offset by factors such as bureaucratic integration and the State's desire to promote nuclear power as a symbol of national innovation capacity. As a result, activism around nuclear power controversies only produced limited policy impact.

Examining hydropower, GMO, and nuclear power controversies, one can find that putting the FA framework into political opportunity structure has the most efficient explanatory power. Fragmentation, no matter whether it is a bureaucratic one or involves many new actors, creates essential opportunities, but it is still constrained in a macro-political structure and influenced by activists' framing strategies, the establishment's knowledge control, and other sociotechnical factors.

6.4.2 Framing and mobilization in the public attention market

Public accountability frames across settings. Successful framing is considered by one branch of social movement scholars as a central element to social movements (Snow, 2013; Snow et al., 1986). For Tarrow and other promoters of political process theory, framing is essential but is not considered as central. According to previous chapters of this dissertation, framing seems an element subject to the political opportunity structure, but this does not mean it is less critical. Instead, within a specific political opportunity structure, framing can still play a crucial role.

In the hydropower, GMO and nuclear controversies, activists framed these controversies primarily as public credibility issues. Hydropower companies, GMO scientists and the nuclear industry were framed as vested interest groups, putting public

interests at risks. Correspondingly, the media frequently adopted a public accountability frame when reporting GMO and hydropower topics. But the frame was not so useful in the nuclear controversy due to journalists' self-censorship to avoid risk, positive national sociotechnical imaginaries of nuclear power, and the knowledge-control regime of the nuclear power sector (to be discussed below).

Under the umbrella of a public accountability frame, environmentalism agendas dominated anti-hydropower efforts while GMOs were dominantly considered a food safety issue. As analyzed in chapter 3, most media articles that framed hydropower as an environmental issue showed a negative tone or visible controversy. This framing was related to the fact that the main anti-hydropower force was ENGOs, which effectively mobilized the media. It was also caused by China's increasing embrace of environmentalism in its rapid economic progress that caused severe environmental woes. On the other hand, nuclear power was free from the attack of environmentalism frames. SEPA/MEP's alliance with the nuclear power sector largely exempted the industry from being attacked by ENGOs as well as environmentalism frames.

For GMOs, the early effort against the technology, initiated by Greenpeace and supported by other more elitist international groups such as Third World Network, framed it as an environmental issue, threatening biodiversity. However, activists soon found the frame was not appealing in China. Utilizing the broad public concerns about food safety and the general dissatisfaction with government transparency, anti-GMO activists forcibly adopted a public accountability frame and reached their desired effect. In addition to food safety concerns, Maoist activists further stigmatized agricultural biotechnology with a conspiracy theory, claiming GMO was a US conspiracy to control or conquer China. This

frame, though logically ridiculous, was even accepted by 40% of the population (Guangxi He et al., 2017).

Social mobilization during controversies. With the omnipotent public accountability frame, activists achieved effective social mobilization in the hydropower and GMO debates. SEPA/MEP/MEE's relatively friendly attitude to a civil society fueled the development of ENGOs, which mobilized environmental and ecological research organizations and scientists against dam building. Frequent experts' seminars targeting journalists and regular journalists' field inspections in the Yangtze and Yellow rivers guided and joined by environmental, geological and wildlife protection experts united to form an amplified anti-dam tone. A mobilization network of activists-experts-journalists-environmental officials created strong and consistent public opinion pressure on hydropower side.

The mobilization of anti-GMO forces demonstrated an entirely different scenario. GMO debates were participated in by a large portion of the population, though established local ENGOs were generally less involved. Greenpeace initiated the discussion, involved the ecological scholars and consistently provided debate material with its surveillance of illegal planting of the first GM rice in central China and then GM corn in northeast Chinese provinces.

Following Greenpeace, Chinese STS scholars questioned the credibility of biotechnology science, legitimized public concerns and mobilized dissenting experts (including a few scientists and much more agricultural economists and rural sociologists). Maoist activists expanded the anti-GMO fronts by engaging red princelings, some military generals and leftist organizations and continuously generated anti-GMO messages often

stuffed with conspiracy theories. Fast-developing Internet and mobile communication enabled various activists to cross-refer and modify different sources of information (such as graft a conspiracy claim onto Séralini's retracted study on GM corn (2012)) to expand their influence. As a result, the Chinese government postponed commercialization of all GM crops after GMOs became a widespread public controversy.

Compared with hydropower and GMOs, the mobilization of anti-nuclear activism was far less successful. There is none organization involved at the national level. The impromptu organizers of NIMBY events never connected to anti-nuclear activists or dissenting experts. These activists and experts' voices were seldom amplified by the media to recruit more new participants. The established Chinese ENGOs were not involved in any anti-nuclear activity, both in terms of producing and transmitting articles and in actual operations. Although activists and dissenting experts had a chance to submit their appeals to the top leadership, the lack of social protests as a result of poor mobilization did not exert any pressure, so that the leadership could still make its decisions based on professional judgment primarily offered by the nuclear power sector.

Public attention as a movement moderator. Examining the framing and mobilization process involved in hydropower, GMO, and anti-nuclear controversies, one can find public recognition was also a factor which was not negligible. Here the Downs' (1972) issue-attention cycle, which describes cyclical waves in media attention and historical shifting among different frames of an issue (M. C. Nisbet & Huges, 2006), can be borrowed to help illustrate the phenomenon.

In developmentalism-dominated China, an environmental agenda has trouble attracting public attention. Utilizing the black-and-white image of dam building proved

successful to attract public attention. However, at the time of rising anti-dam activism, nearly all dam building was located in remote southwestern China, so protesting dams and organizing journalists to report the protest involved much time and resources. This situation resulted in a highly periodical issue cycle and significant issue concentration (primarily focused on environmental and ecological affairs) in the hydropower controversy. The lack of public attention and high involvement costs also inhibited the participation of average public citizens. As a result, only the targeted dam projects were halted, while most hydropower developments that have not been problematized continued.

When activists successfully framed the GMO controversy as a food safety issue, the public began to devote much more attention. These grave public concerns and perceived public awareness triggered more and more actors to get involved, and their involvement brought increasingly diversified topics and events, ranging from protesting vested interest groups to complaints against lack of transparency. The claims that MOA-affiliated kindergartens did not use oil made from GM crops and that at the 2008 Beijing Olympics GM food ingredients were forbidden were all topics brought in by grassroots protesters. The escalated public attention thus resulted in the consistent controversy on GM foods, with new material repeatedly being brought into the debates.

The nuclear power controversy suffered the lowest public attention given its closed nature, elitist agenda, and little perceivable environmental impact. The situation could explain the reluctance of the media to devote investigative reporting in the area. The Fukushima accident temporarily changed the low-attention status, but the public attention quickly faded as there was no report of irradiation contamination from Japan to China. Together with the fading public awareness is the diversion of some public intellectuals,

such as STS scholar Jiang Xiaoyuan, from the field. Thus, only a few diehard activists and dissenting experts remained in the area. Although some activists and experts had channels to submit reports to the central leadership so that the controversy could be maintained in the policy domain, the controversy's public impacts remained low. The low public attention enabled policymakers to make decisions based on professional suggestions primarily.

The above summary of framing strategy and mobilization effort in hydropower, GMOs and nuclear power controversies show that in public science and technology controversies, activists' framing and mobilization strategies are often associated with perceived public attention. The interaction of these elements within specific political opportunity structures has shaped the different evolution patterns of science and technology, which I will summarize below.

6.5 EXAMINING KNOWLEDGE-CONTROL REGIMES

The third set of research questions is about the relevance of various STS concepts, such as knowledge-control regimes, civic epistemology, and national sociotechnical imaginaries, to China's hydropower, GMO and nuclear power controversies. Of the various ideas, the knowledge-control regime is used most widely in this dissertation.

Knowledge stands in a central position in science and technology controversies. The public debates about any controversial science and technology issue, including hydropower, GMO and nuclear power examined in this dissertation, are primarily about the credibility of individual knowledge claims, the claim-makers and the claimed application of the knowledge in question (Jasanoff, 2017). However, without taking consideration of social movement angles, scholars may lose sight of how actors' actions promote, reject, maintain and diffuse this knowledge credibility (Breyman et al., 2017;

Epstein, 1996).

Using the hydropower, GMO and nuclear power controversies for case studies, this dissertation finds that major STS concepts regarding knowledge, particularly knowledge-control regimes (Hilgartner, 2017), civic epistemology (Jasanoff, 2011b) and national sociotechnical imaginaries (Jasanoff & Kim, 2009), are deeply embedded in the controversy process. Meanwhile, the strategic actions by actors of both sides to mobilize various knowledge resources to overcome knowledge barriers profoundly influenced the development of controversies.

For hydropower development, the publicly visible knowledge-control regime was mainly embodied in the hydropower industry's effort to maintain developmentalism discourse (Lee, 2014), ensure engineering credibility and publicize technological achievements. In terms of the knowledge of engineering side (including sediment and hydrological studies), post-TGP hydropower sector has maintained an active control, but the industry seemed to take an only minimal effort in environment-related knowledge production in the 1980s and early 1990s. However, during the southwest hydropower debates starting in 2003, environmental knowledge became the main debating point. Emerging ENGOs avoided engineering knowledge and mobilized broad environmental expertise in the debates on dams' impacts on ecology, biodiversity, fish habitats, earthquake, and local households. Because of the increasing salience environmental studies enjoyed in contemporary China, environmentalism triumphed over the developmentalism and engineering credibility of hydropower side in the public sphere.

The knowledge control strength of the hydropower sector was rather weak in the public domain. Like other State-owned conglomerates, hydropower companies maintained

a good relationship with reporters covering the beat of hydropower and water resources. These journalists regularly reported on the engineering achievements and developmentalism embodied in them. However, within media outlets, hydropower controversies were dominated by environmental or public affair journalists rather than energy reporters. When the anti-dam campaign became a nationally hot media event, environmentalists often had a more fundamental ability to speak within the media outlets.

Compared with hydropower, nuclear power's knowledge-control regime has enjoyed a more favorable condition. Nuclear science's sophisticated requirements of knowledge production, higher safety concerns, and the sector's military link caused natural isolation in its education and knowledge production system. Meanwhile, the vast quantities of nuclear science-related senior academicians, as represented by CAS and CAE members, helped the sector win a dominant role in the knowledge production system, which was supported by the sociotechnical national imaginaries of nuclear power as a symbol for science and technology progress, independent innovation, and national prosperity. SEPA/MEP's role as a nuclear safety regulator resulted in an alliance between environmental governance and the nuclear power industry both in policymaking and knowledge production. Together with the keen publicity awareness of the nuclear power sector, these factors jointly maintained nuclear power's reliable, safe, innovative, and clean images in China's public sphere. Chinese journalists' avoidance of launching investigative reporting of the nuclear power industry due to low perceived rewards of such reporting further increased the strength of the nuclear power sector's knowledge-control regime.

Similar to hydropower and nuclear power sector, China's biotechnology scientists also attempted to set up a knowledge-control regime by seeking political allies. Meanwhile,

its promoters meticulously maintained and highlighted a scientific consensus. However, when activists rose to challenge GMOs from the perspective of public accountability in the food safety issue, the scientific consensus quickly paled amidst attacks ranging from questioning scientists' credibility (hence the credibility of scientific consensus the defamed scientists insisted on) and worrying about peasants' fate (suffering impacts of imported GM corn and soy) to conspiracy theories and various rumors linking GMOs to health harms.

In the view of civic epistemology, food safety, the "US conspiracy," and peasants' fate were considered by the public as much more important than scientific consensus on GMOs and science and technology progress embodied by biotechnology. It turned out that science-politics alliance, as well as the knowledge-control regime endorsed by such alliance, could be easily broken when politicians felt the massive pressure from public protests. The continued and intensified public attention to food issues, which can be traced to the long historical memory of famines and disasters, also allowed various new actors to bring various debating issues into GMO controversies, further inhibiting the ought-to-be power of scientific consensus.

Summarizing this section's discussion, one can see that the knowledge-control regime has played an essential role in facilitating or inhibiting public debates on science and technology issues. However, the effect of this regime was also influenced by macro political factors, civic epistemology and sociotechnical imaginaries of the science in question, the science-media relationship, and the level of public attention and participation.

6.6 COMPARING DIFFERENT PATTERNS

In the above sections, I summarized the evolution of hydropower, GMO, and nuclear power controversies from the perspectives of social movement theory and STS

frameworks such as knowledge control and national sociotechnical imaginaries. Clearly, each of these theoretical frameworks can explain part of the patterns of these controversies.

Based on the above analysis, I present their variant patterns per different academic traditions.

Table 21 Different patterns of hydropower, GMOs and nuclear power controversies

		Hydropower	GMOs	Nuclear power
Basic patterns of controversies		Collective efforts of ENGOs to resist hydropower projects	Long-lasting and massive public rejection.	Low-profile internal elite strife. No organized anti-nuclear campaigns
Social causes of S&T controversies		Growing public concerns about uncontrolled technologies; Competing for knowledge claims; the rise of environmentalism and civil society; the rise of mass media, Internet, and social media; Scientists' slow response to the public concerns. Decreased public trust in the government and official science.		
The level of public trust in orthodoxy science (and technology)		Low	Low	Generally high except the short period after Fukushima accident
Media factors: Mass media		Media actively reported hydropower controversies to highlight its environmental agenda.	Media actively reported GMO controversies to win public attention.	Media positively reported domestic nuclear power, refusing to offer platforms for controversies.
Internet and Social Media		News portal editors actively promoted hydropower controversies. Social media debates on hydropower were inactive.	News portal editors actively promoted GMO controversies. Social media diversified public rejection of GMOs and intensified controversies.	Few news portal editors promoted nuclear power controversies. Social media debates on nuclear power were untraceable.
STS	Knowledge (kn)-control regimes	Moderate	Moderate to weaker	Strong
	Sociotechnical imaginaries and civic epistemology	No universal sociotechnical imaginaries of hydropower	Sociotechnical imaginaries of food more for substance than for innovation	Sociotechnical imaginaries of atomic power as national independence, social prosperity and S&T progress
Social movements	Political opportunities and political opportunity structure	Moderate opportunities and favorable structure for activism	Many opportunities and moderate structure for activism	Few opportunities and unfavorable structure for activism

Chapter 6: Compare controversies

	Activists' frames of targeted S&T subjects	Lack of public accountability in the environment.	Lack of public accountability in food safety.	Avoid a robust anti-nuclear frame; public accountability frame not dominant in the media.
	Mobilization of activists	Periodically effective mobilization among elites and activists	Successful mass mobilization	Unsuccessful mobilization
	Fragmented authoritarianism (FA) framework	Broad FA framework, with visible bureaucratic fragmentation between hydropower and environmental agencies	Bureaucratic fragmentation less salient, but actors' massive participation brings extensive fragmentation.	Only minor bureaucratic fragmentation, and small FA within the industry
Results of S&T controversies as social protests		Successfully halted targeted dams.	Entirely successful in halting commercialization of all GM crops in China.	Initiated controversies but achieved limited success (delayed new construction permits for three years)

(Source: Author's summary)

The above table shows that within different theoretical frameworks, the hydropower, nuclear, and GMO controversies present different patterns. Using these frameworks – social movement theories, knowledge-control regime, and fragmented authoritarianism – one can "predict" the result of these controversies. For example, in both the hydropower and GMO cases, activists enjoyed a favorable political opportunity structure for their activism while such structure was highly closed or unfriendly to anti-nuclear controversies. Compared with the hydropower controversy, the GMO controversy experienced a more significant number of political opportunities, loosely defined. As a result, anti-hydropower activism succeeded in halting nearly all targeted projects but the hydropower controversy as a whole elapsed quickly. Anti-GMO activists did better to stop the commercialization of all GM crops. By contrast, anti-nuclear power activities could only achieve minimal, unsystematic success by halting new NPP construction for three years.

Meanwhile, when applied in the hydropower, nuclear and GMO controversies, theories of different traditions were entirely consistent with each other, so that one can be

used to supplement others in making "predictions." For example, the nuclear power sector's stronger knowledge-control regime is coherent with the narrow political opportunity structure for anti-nuclear activists while hydropower sector's lower level of knowledge control in the environmental area seemed to link to the bureaucratic fragmentation between hydropower sector and environmental agency, fueling anti-dam activities. In the case of GMO, biotechnology science enjoyed high scientific consensus on GM food safety, but the knowledge-control regime for scientific conclusions was dwarfed by mass protests featuring various claims from both different expert groups and grassroots activists. As a whole, the knowledge-control regime was weakened, resulting in GMO activism's most significant success among the three controversies in question. So, the knowledge-control regime can be used together with social movement theories to "predict" activism results.

But I used quotation marks for "predict/prediction" here because unlike quantitative research which tries to measure every variable "exactly," the application of either social movement theories or STS concepts in the controversies studied is rather context-dependent. For example, the FA framework in hydropower was mainly reflected as a bureaucratic fragmentation while in the GMO case, the less salient bureaucratic fragmentation gave way to an enormous fragmentation across the society. This fragmentation existed among different knowledge claim makers (e.g., between scientists and STS scholars and rural sociologists), different interest holders (agricultural biotech firms versus organic farmers) and various political lines (Maoists are diehard anti-GMO members as compared with other political groups). So, both GMO and hydropower enjoyed a high level of FA, but their FAs were different.

6.7 PATTERN DIFFERENCE AND THEORETICAL DEVELOPMENT

In the above sections, we can see that the three controversies demonstrated apparent differences in all theoretical frameworks – the communication patterns, social movement theories, and knowledge-control regime – adopted in this dissertation. As a result, they had different consequences. In the hydropower case, activists successfully suspended all controversial dams; in the GMO controversy, no new GM crop has been commercialized since 2007; yet in the nuclear power case, the construction of new NPPs resumed in 2019, after three years' pause.

Have the different fates perfectly reflected the predictions suggested by the adopted theories, or have they primarily been a result of various characteristics of the selected cases? One may say anti-GMO debates are so salient simply because people are worried about their food, while nuclear power's low impact on their life may cause its low visibility, and the periodical hydropower controversy is associated with the remote location of dams.

Throughout this dissertation, I have not denied the case differences and their role in causing different evolution patterns of the controversies. For example, the relationship of the disputes to people's daily life results in different public attention, which is an essential component in both social movement theories and the framework of the knowledge-control regime. However, the case difference alone cannot sufficiently explain their different consequences. As indicated in the first chapter, other similar controversies have not resulted in a similar outcome to the studied ones. For example, Chinese citizens also have a widespread concern about food additives, but this has never been translated to a massive controversy as GMOs had. Meanwhile, ordinary people living in cities feel equally little impact from hydropower and nuclear power, yet hydropower has experienced

much more severe disputes than nuclear power.

The reasons for the different case consequences include the actors involved, their different sociopolitical situations, and the various knowledge-making processes. All these elements are theoretically relevant. In previous sections of this chapter and earlier chapters of this dissertation, we have repeatedly examined how different factors identified by theory result in different evolution patterns of the cases. I will not repeat these arguments. One point to be stressed here, however, is that the case characteristics interact with the case's sociopolitical situations, its knowledge-making ways, and actors involved.

Indeed, elements of different theoretical traditions also interact with each other. I will discuss this theoretical perspective in the next chapter.

Chapter 7 Conclusion: Science and technology controversies examined in a multidisciplinary lens

The previous chapter shows that different theoretical frameworks are consistent with each other in "predicting" the development of the selected controversy cases – the anti-hydropower movement, the GMO controversy, and nuclear power debates. Indeed, these variant frameworks are not only mutually supplemental but also interact with each other. Only by tracing interactions among sociopolitical, knowledge, and communication factors underlying public science and technology controversies and by combining different theoretical traditions, can we deeply understand the specific evolution pattern of various disputes. I will explore this point below to deepen the application of interdisciplinary theoretical exploration and to illustrate a significant academic contribution of this dissertation.

7.1 INTERACTIONS OF DIFFERENT THEORETICAL FRAMEWORKS

7.1.1 Interaction of different theoretical components in China

So far, in this dissertation, I have examined China's hydropower, nuclear, and GMO controversies using communication, social movement, and STS theories. Components from communication studies, social movement theories, and STS concepts interact with and strengthen each other, suggesting that they should not be separated. For example, in the hydropower case, activists organized journalists to carry out Yangtze and Yellow rivers inspections with the guide of ecology and environmental scholars. In the process, activists, journalists, and ecological and environmental experts formed a mobilization network against hydropower development or individual dams. This process represents an essential

aspect of Tarrow's (2011) political process theory. Meanwhile, the networking activities were closely associated with the effort of competing with the hydropower establishments' knowledge-control regime. On the other hand, as analyzed in chapter 3, the relative openness and salience of environmental knowledge-making also helped weaken the knowledge-control regime of the hydropower establishments. The weakened regime no doubt encouraged activists and journalists to adopt more offensives against dam-building when necessary.

Nuclear power offers another, yet reverse example. The stronger knowledge-control regime of the nuclear power sector cannot be separated from its stronger political power and hierarchic governance structure. The latter can relatively easily inhibit social movements against the nuclear power sector as it can both mobilize coercive forces against activism and cut off potential internal allies of external activists. Nuclear-friendly media outlets offered another example. Journalists' reluctance to make investigative reporting into nuclear power was both caused by lack of public attention to nuclear power, the inhibiting political power, and real and perceived knowledge monopoly.

In the GMO controversy, the high scientific consensus on GM food safety was not translated to a stronger knowledge-control regime, because without the endorsement of political power, the biotechnology sector has a low capacity to control knowledge in the public sphere. In 2015 when the propaganda department decided to manage adverse reporting of GMOs, the rise of social media platforms and widespread rumors offset the policy effect. Hence, media change further weakened the knowledge-control regime for GMOs.

There are many other examples across the three cases showing the interaction

between communication, social movement, and knowledge factors. It is interesting to notice that although these factors are categorized differently, they overall are consistent or mutually strengthening rather than mutually offsetting. To better understand their interaction, we will also need to consider how different theoretical frameworks interact with each other.

7.1.2 Interaction of different theoretical frameworks

The call to utilize social movement theories to investigate controversial science and technology issues has been made for up to three decades (Breyman et al., 2017; Epstein, 1996; Hess et al., 2008; Martin & Groth, 1991), and in the first chapter of my dissertation, I also set this as a goal for my research. The study here justified this call while bringing fresh evidence and material to the scholarship.

Based on the three controversy case studies, one can safely conclude that social movement studies first of all help solve the question that given similar low public knowledge of science, why some controversies can grow out of academic circles to produce social impacts while others remained hidden from public attention. They also address the question why, among those publicly salient science and technology controversies, some can produce significant policy impacts (such as GMOs) and others go relatively unnoticed by policymakers (such as nuclear power concerns). The three cases – hydropower, nuclear and GMO – are all in the public domain, but the three cases can be combined to compare with other controversies, such as nanotechnology, which has never raised media attention and produced significant policy impact in China.

Taking account of social movement theories can also enable science studies scholars to deeply observe how actors involved in public science and technology

Chapter 7: Conclusion

controversies perceive, utilize, or miss macro political opportunities. Moreover, this approach also illustrates how actors use cultural resources to frame themselves and their opponents. Delborne's (2008) study of UC (University of California) Berkeley scientist Ignacio Chapela's strategic consideration of protesting strategies after his controversial *Nature* paper on Mexican maize's GMO contamination was retracted is precisely one of these cases.

At their core, science and technology controversies are about the credibility of knowledge and have been widely examined by STS scholars with various concepts including Hilgartner's (2017) knowledge-control regime. It is well known that such knowledge-control regimes are about power; but using social movement theories, one can more dynamically examine the role of power in knowledge-control controversies. The current dissertation makes an initial effort for the dynamic examination of such a regime.

Meanwhile, STS and communication studies on knowledge can contribute to social movement theories as well. Compared with STS scholars, conventional social movement scholars remained less interested in examining knowledge issues (Breyman et al., 2017), just as 30 years ago when Martin and Groth (1991) made such a claim. Yet nearly all social movements/controversies involve knowledge issues, though the knowledge may not be about a narrowly defined science.

In the cases in my dissertation, hydropower and GMOs were widespread public controversies in China, and many actors without any science background or any link to the science community have been involved, but from the very beginning, without internal dissenting scientists/experts' widely broadcasted critical views, they might not have become controversies at all. Chapter 3 found that the southwestern hydropower debates

Chapter 7: Conclusion

started from dissenting experts' seminars on the Dujiangyan and Nu Rivers. Chapter 4 demonstrated that the concerns about biodiversity loss caused by GM crops initiated the GMO controversies that continued and later focused on food safety. In the social contention process, no matter whether the dispute is about narrowly defined science, certification and decertification is a pair of mechanisms widely involved in the social movement (McAdam et al., 2001), and these mechanisms are related to knowledge.

My study of the nuclear power protests' less successful fate also involved knowledge factors, one of which being the nuclear power sector's firm knowledge-control regime. The successful knowledge-control regime of the industry isolated activists from potential supporters, such as the journalists.

Other STS concepts, such as national sociotechnical imaginaries, also play an essential role in influencing or even shaping social movements. If such imaginaries are full of the expectation for science and technology progress and national dependence, as the nuclear power case shows, or full of modernist imaginations of convenience and immediacy, such as mobile phones, controversial concerns such as mobile phones' potential health harms may never become a real public controversy. Frames, which are vital for mobilization in social movements, are also contingent on knowledge and its production and distribution (e.g., whether a grassroots activist has a chance to utilize particular expertise claims to develop his/her frame against controversial science and technology items).

The discussion here is not to try to set up an all-inclusive model to enlist all sociopolitical and knowledge factors one by one in all circumstances. Contexts matter. Disciplinary boundaries are inevitable. But the current discussion and the empirical studies

in this dissertation can pave the way for a more systematic calculation of sociopolitical, knowledge, and other factors such as economic forces.

7.2 GENERALIZING STUDY FINDINGS

This dissertation traced the hydropower, GMO, and nuclear power controversies in contemporary China and identified a body of interactive sociopolitical, knowledge, and communication factors that have jointly shaped the evolution of these controversies. One major conclusion is that, just like other social and political disputes, public science and technology controversies can be considered social movements, with actors actively and strategically seeking political opportunities – which are structurally caused by a batch of sociopolitical and economic factors – to expand their impacts or the impacts of their viewpoints.

The second conclusion is that the control of knowledge, conceptualized as the knowledge-control regime, in a controversial case is central in enhancing or inhibiting the public controversy's evolution, but the regime is not just about knowledge. Instead, it is the product of a collection of sociopolitical and epistemic factors, which vary in different controversy settings. On the other hand, the knowledge-control regime, its effect in controlling the knowledge production and flow, and activists' perception of the regime are all critical portions of the political opportunity structure.

The third conclusion is that communication factors – including the public attention to controversial issues, media and journalists' roles in promoting public debates, and the rise of new media – are essential to both political opportunity structures and knowledge control. These factors are structurally embedded in the controversy evolution. For example, in the nuclear power case, the Chinese media were either active in positively framing the

energy or reluctant to make investigative reporting of the sector. This action increased the effect of the knowledge-control regime of the nuclear power sector and resulted in relatively more restrictive political opportunity structure.

As revealed in chapter 6, Chinese media and journalists' reluctance to report negative news on China's domestic nuclear power industry was partially related to the perceived military link of the nuclear power industry, resulting in journalists' risk avoidance behaviors. This finding, like many others in this dissertation, highlights the authoritarian nature of the Chinese regime. Further, this raises the question of the generalizability of this study's findings and conclusions.

In a sense, the question is legitimate. China's authoritarian regime enables macro political power to play a more significant role in fueling the science and technology controversies examined in this dissertation than might have been true in less authoritarian countries. However, the essence of the above conclusions is not about the degree to which political power was involved in science and technology disputes, but that these controversies should be treated like other social movements that interact with knowledge factors. This finding is highly generalizable and consistent with previous findings on scientific dissenters' strategies for entering controversies (Delborne, 2008; Martin, 1998, 2010).

Another generalizable finding is the role of sociopolitical factors in constituting the knowledge-control regimes of the controversy cases. In different instances, sociopolitical factors involved in forming knowledge-control regimes may vary, but what remains unchanged is that the type of knowledge control also depends on a combination of sociopolitical and epistemic factors.

A third generalizable finding is that the communication factors listed above have to regularly considered in the pattern or dynamics of science and technology controversies (Martin, 2014). Not all scientific debates demonstrate the same dynamics. Actors adapt their behaviors depending on the audience attention and the media agenda.

Although these findings are internationally generalizable, the three controversy cases systematically examined in this dissertation are not enough to reveal the more detailed generalizable mechanisms underlying controversies. The nature of the three studied cases as significant public science and technology controversies also prevents us from directly applying the conclusions to more elitist scientific disputes. We need more research in this direction.

7.3 LIMITATIONS AND FUTURE STUDIES

This dissertation's first limitation lies in its research focus on China. Indeed, China has a sharply different political system and environment from Western democracies on which both the mainstream STS and science communication scholarships are built, which makes some theoretical findings of this dissertation challenging to generalize.

I admit this limitation, though would not frame it as a problem. Instead, I want to justify my research conclusions despite the limitation. First, across all three science and technology controversies I examined, a heavy influence of political institutions can be easily identified. For example, activists and orthodox scientists alike in the hydropower, GMO, and nuclear cases tried their best to brief top leadership. However, if we set aside the surface differences, we can compare this with policy lobbying in the Western democracies. The difference is not that Chinese science and technology controversies are political while the West's are not. The difference is that politics in Chinese cases are less

institutional and occur with much less transparency. So, while the effort to re-examine the application of this dissertation's conclusions in different contexts is necessary, it does not mean these conclusions are not applicable. Similarly, while the efforts of actors to depoliticize the frames for controversies may come from their widespread worry about political prosecution that does not apply in non-authoritarian nations, yet the pursuit of political correctness is everywhere. Therefore, behaviors caused by the concerns about the political challenges can be compared with a similar effort in the West for political correctness.

Second, the development stage of China and its political system bring up priorities different from the West. For example, except for Greenpeace's initial attempts, the GMO issue was not framed as an environment/ecology/biodiversity issue. Food safety and science and technology progress were the two dominant frames with different directions in terms of framing the disputed biotechnology. The first is related to many generations' memory in China of hunger and famines, and the latter is associated with Chinese people's eagerness to achieve national strength. The opposite of the coin for this is widespread belief in the Western conspiracy. But my justification for claiming generalizability is that although the frames are different, we may consider their similar impacts on social movements and knowledge-control regime.

As with all qualitative studies, there are other limitations. As a whole, the discussions on embracing transferability versus generalizability by many qualitative study methodologists (Lincoln & Guba, 1985; Tracy, 2010) point to issues relevant for my study.

Another major limitation is that, despite my extensive interviews, I still feel a lack of access to many data/sources, such as State and ministerial leaders or top industrial

executives. I tried my best to understand their intentions. I also tried to triangulate my observations as much as possible. Sometimes I was lucky to have two separate sources to compare, for example, in the case of top leadership (Hu Jintao-Wen Jiabao era)'s attitude to GMOs. But on most other occasions, I did not have such luck. I tried to avoid making any definitive remarks.

The final limitation is the insufficient quantifiable Internet data. To assure rigorous enough conclusions, I need more big data mining and analysis, but I am constrained in terms of both methods and data availability. As a doctoral student, due to the limited resources, I had access to, the current version of the dissertation has only partial Internet data, which I hope I can offset shortly after completing my doctoral program.

7.4 CONCLUDING REMARKS

So far in this concluding chapter, I have summarized the communication factors, social movement theories and various knowledge-related concepts' application in interpreting China's hydropower, GMO and nuclear power controversies have compared the different evolution patterns of these controversies, discussed the integration of social movement theories and STS concepts in understanding social contentions, and explored the relevance of communication patterns to these controversies. A general conclusion seems redundant here: public science and technology disputes are the results of a body of interactive sociopolitical, knowledge, and communication factors. We should consider public science and technology controversies as social movements, with actors actively and strategically seeking political opportunities to expand their impacts. The control of knowledge, resulting from epistemic, communication, and sociopolitical factors, allows or inhibits the evolution of public scientific controversies.

Chapter 7: Conclusion

Underlying these claims is my goal to push ahead the application of social movement theories and STS concepts in offering a broad interpretation to knowledge-related social unrest. Communication studies are necessary to support this interpretation.

The theoretical significance of this dissertation is therefore embodied in the elaboration of various theoretical components and their combined application in understanding complex reality rather than developing a theory. For this latter task, further research based on the current dissertation is needed. If raising the necessity of and possibility for performing further in-depth studies is an essential requirement for a dissertation, then I am confident that this dissertation has met this expectation.

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Appendix 1: Interviewee description and code

No.	Profession	Location of interview	Estimated age	Interview time	Interview code
A0	Journalist-turned anti-GMO activist, founder of an organic food group in Beijing	Beijing	40-50	Tuesday, August 23, 2016	INT20160823
A1	Anti-nuclear activist, energy policy researcher	Beijing	40-50	Friday, September 23, 2016	INT20160923b
A1	Ibid	Beijing	40-50	Second interview: 2016-12-29	INT20161229a
A1	Ibid	Beijing	40-50	Third: interview: 2017-12-21	INT20171221
A10	Anti-nuclear activist, retired local official	east China	60-70	Tuesday, December 6, 2016	INT20161206b
A11	Anti-nuclear activist, retired local official	east China	70-80	Wednesday, December 7, 2016	INT20161207a
A12	Anti-nuclear activist, retired local official	east China	70-80	Wednesday, December 7, 2016	INT20161207b
A13	Journalist-turned environmental activist	east China	40-50	Tuesday, December 13, 2016	INT20161213
A14	Environmental activist	Shanghai	30-40	Thursday, December 15, 2016	INT20161217
A15	Journalist-turned anti-dam activist. Head of local ENGO	Beijing	60-70	Sunday, December 18, 2016	INT20161215
A16	Environmental anti-dam activist, self-claimed scientist. Head of local ENGO	southwest China	50-60	Thursday, December 22, 2016	INT20161221
A17	Environmental anti-dam activist, local scientist	southwest China	60-70	Thursday, December 22, 2016	INT20161222
A18	Journalist-turned environmental activist. Head of local ENGO	southwest China	50-60	Friday, December 23, 2016	INT20161223
A19	Scholar-turned environmental activist. Head of local ENGO	southwest China	50-60	Sunday, December 25, 2016	INT20161225
A2	Journalist-turned environmental activist, former international	Beijing	30-40	Monday, September 26, 2016	INT20160926

Appendix

	ENGO member				
A20	Young environmental activist	Beijing	20-30	Wednesday, January 11, 2017	INT20170111
A21	Young environmental activist	Beijing	20-30	Friday, January 13, 2017	INT20170113
A22	Journalist-turned environmental activist, former international ENGO member	East China	40-50	Friday, March 10, 2017	INT20170310
A23	Environmental activist, former international ENGO member, former head of local ENGO	Overseas	40-50	Monday, May 15, 2017	INT20170515
A24	Anti-nuclear activist, CPPCC member, a billionaire	South China	60-70	Sunday, July 30, 2017	INT20170730
A3	Environmental activist, international ENGO member	Beijing	30-40	Tuesday, September 27, 2016	INT20160927
A4	Anti-GMO activist, self-claimed scientist	Beijing	70-80	Thursday, September 29, 2016	INT20160929
A5	Head of local ENGO	Beijing	30-40	Tuesday, November 22, 2016	INT20161120
A6	activist and activist-turned-journalist	Beijing	30-40	Sunday, November 27, 2016	INT20161122
A7	Anti-GMO & anti-nuclear activist, leftist	South China	40-50	Saturday, December 3, 2016	INT20161127
A8	anti-hydropower activist, former liberal	Beijing	60-70	Thursday, December 8, 2016	INT20161208a
A9	Anti-nuclear activist, retired local official	east China	70-80	Tuesday, December 6, 2016	INT20161206a
G1	incumbent agricultural official	Beijing	40-50	Thursday, November 10, 2016	INT20161110b
G2	Promoter of hydro project, former scientist, retired senior official	east China	60-70	Monday, January 9, 2017	INT20170109
G3	incumbent propaganda official	Beijing	40-50	Thursday, January 12, 2017	INT20170112
G4	Former agricultural official	Beijing	60-70	Wednesday, August 23, 2017	INT20170823

Appendix

I1	PR official of a nuke giant	South China	40-50	Sunday, October 23, 2016	INT20161023
I10	PR official of a nuke giant	Beijing	40-50	Friday, June 16, 2017	INT20170616
I2	Engineer of a nuke giant	South China	unknown	Sunday, October 23, 2016	INT20161023b
I3	Engineer of a nuke giant	South China	unknown	Sunday, October 23, 2016	INT20161023c
I4	Engineer of a nuke research institute	Shanghai	30-40	Tuesday, December 20, 2016	INT20161219
I5	Head of local medical website	Shanghai	40-50	Tuesday, December 20, 2016	INT20161220
I6	PR official of a nuke giant	Beijing	40-50	Thursday, December 29, 2016	INT20161229b
I7	Nuke engineer-turned nuke PIOs	Shanghai	30-40	Thursday, December 29, 2016	INT20161229c
I7	Ibid	Shanghai	50-60	Second interview time: 20170615	INT20170615
I8	The main spokesperson of hydropower industry	Beijing	50-60	Friday, January 6, 2017	INT20170106
I9	Engineer and VP of a nuke plant	east China	50-60	Friday, June 16, 2017	INT20170616b
J1	Science journalist	Beijing	40-50	Tuesday, August 16, 2016	INT20160816
J10	Science journalist	Beijing	40-50	Sunday, September 25, 2016	INT20160925
J10b	Science journalist	Guangzhou	40-50	Sunday, October 16, 2016	INT20161016
J11	Science journalist	Guangzhou	40-50	Saturday, October 22, 2016	INT20161022
J12	Science journalist	Beijing	40-50	Thursday, November 17, 2016	INT20161115
J13	Science journalist	Hangzhou	50-60	Monday, December 19, 2016	INT20161218
J14	Former Science journalist	Hangzhou	40-50	Monday, December 19, 2016	INT20161219
J15	Former Science journalist	Hangzhou	40-50	Sunday, January 8, 2017	INT20170106
J16	Former Science journalist	Beijing	30-40	Monday, January 9, 2017	INT20170108

Appendix

				2017	
J17	Former news portal & social media science editor	Beijing	30-40	Monday, January 9, 2017	INT20170109
J18	Environmental journalist	Beijing	20-30	Tuesday, January 10, 2017	INT20170110
J19	Former Science journalist	Beijing	30-40	Saturday, January 14, 2017	INT20170114
J2	Former Science journalist	Beijing	30-40	Saturday, August 20, 2016	INT20160820
J20	Former Science journalist	Beijing	30-40	Tuesday, July 25, 2017	INT20170725
J21	Environmental journalist	Beijing	50-60	Wednesday, August 30, 2017	INT20170830
J3	Former senior journalist	Shenzhen	60-70	Wednesday, November 2, 2016	INT20161102
J4	journalist	Beijing	50-60	Friday, September 23, 2016	INT20160923a
J5	Science journalist	Beijing	20-30	Saturday, July 23, 2016	INT20170723
J6	Science journalist	Beijing	30-40	Monday, September 19, 2016	INT20160919
J7	Science journalist	Beijing	40-50	Wednesday, September 21, 2016	INT20160921b
J8	Environmental journalist	Beijing	30-40	Wednesday, September 21, 2016	INT20160921a
J9	Science journalist	Beijing	40-50	Sunday, September 25, 2016	INT20160925
J5	Science journalist	Beijing	50-60	Sunday, July 23, 2017	INT20170723
J22	Science journalist & web editor	Beijing	40-50	Friday, December 16, 2016	INT20161216
J23	Science journalist	Beijing	30-40	Saturday, December 17, 2016	INT20161217
J24	Energy journalist	Beijing	30-40	Friday, August 25, 2017	INT20170825
P1	PIO	Beijing	30-40	Sunday, August 21, 2016	INT20160821
P2	PIO	Beijing	40-50	Sunday, September 25, 2016	INT20160925c

Appendix

P3	PIO	Central China	40-50	Tuesday, December 27, 2016	INT20161226
K1	Science communication expert	Beijing	30-40	Wednesday, September 28, 2016	INT20160928
K2	Science communication expert	Beijing	50-60	Friday, December 30, 2016	INT20161230
R1	STS professor	Beijing	50-60	Tuesday, September 20, 2016	INT20160920
R10	STS professor	Beijing	50-60	Monday, May 15, 2017	INT20170515
R11	STS professor	Beijing	50-60	Thursday, May 18, 2017	INT20170518
R12	STS professor	Beijing	50-60	Saturday, May 20, 2017	INT20170520
R13	STS professor	Beijing	30-40	Sunday, June 18, 2017	INT20170618
R14	Senior science policy researcher	Beijing	50-60	Monday, June 19, 2017	INT20170619
R15	STS professor	UK	40-50	Friday, July 21, 2017	INT20170721
R2	Senior science policy researcher	Beijing	50-60	Thursday, September 22, 2016	INT20160922
R3	Senior researcher, science policy	Ningbo/UK	50-60	Monday, April 24, 2017	INT20170424
R10	Senior agricultural policy researcher	Beijing	50-60	Monday, November 14, 2016	INT20161114
R4	Senior researcher, science communication	Beijing	40-50	Tuesday, October 11, 2016	INT20161011
R4	Ibid	Beijing	40-50	Second interview: 20170915	INT20170915
R6	STS professor	East China	40-50	Saturday, November 19, 2016	INT20161117
R7	STS professor	Beijing	50-60	Sunday, November 20, 2016	INT20161119
R8	STS professor	Beijing	30-40	Thursday, December 8, 2016	INT20161208b
R8	Ibid	Beijing	30-40	Second interview: 20170715	INT20170715
R9	Communication scholar, ENGO	Beijing	20-30	Monday, January 9,	INT20170109

Appendix

	intern			2017	
R16	Communication scholar	Beijing	30-40	Thursday, September 28, 2017	INT20170828
S1	Senior agricultural scientist	central China	60-70	Sunday, October 9, 2016	INT20161009
S15	Ecology scientist	Beijing	50-60	Thursday, December 15, 2016	INT20161215
S10	Senior environmental scientist	Beijing	50-60	Friday, February 10, 2017	INT20170210
S17	Space scientist and active science communicator	Guangzhou	50-60	Tuesday, March 28, 2017	INT20170328
S18	Ecology scientist	Beijing	50-60	Saturday, June 17, 2017	INT20170617
S19	anti-nuclear physicist	Beijing	50-60	Monday, June 19, 2017	INT20170619
S20	Senior hydropower scientist	Beijing	50-60	Friday, June 30, 2017	INT20170630
S21	Senior agricultural scientist, former CPPCC member	Beijing	60-70	Wednesday, November 9, 2016	INT20161110a
S3	Senior agricultural scientist	Beijing	50-60	Friday, November 18, 2016	INT20161118
S5	Senior life scientist	Beijing	60-70	Wednesday, December 21, 2016	INT20161221
S6	Senior environmental scientist	southwest China	70-80	Friday, December 23, 2016	INT20161222
S7	Senior environmental scientist	central China	70-80	Monday, December 26, 2016	INT20161227
S8	anti-nuclear physicist	Beijing	80-90	Friday, December 30, 2016	INT20161230
S9	Senior hydropower scientist	Beijing	50-60	Wednesday, January 11, 2017	INT20170111