\<a\> Adaptive Governance in Open Data Ecosystem: Experiences and Insights on the Role of Sociotechnical Arrangements

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ABSTRACT

The accelerating development of open data infrastructure across the world brings economic and social promises but also increasing complexities in coordinating large-scale open data ecosystem that involves citizens, communities, policy makers, institutions, and private actors. Following the formation of an open data ecosystem in Shanghai longitudinally (2015-2020), this paper delineates how adaptive governance is effective in addressing the initial void of data governance in the ecosystem, and the competing logics of data as a social resource over time. The case study highlights that adaptive governance in open data ecosystem undergoes continuous experimentations of governance form, which choices are largely shaped by the different views of data as a resource. Foregrounding the digital dimension of governance, this study also brings attention to the role of sociotechnical arrangements in shaping the form of adaptive governance by unfolding how actors in the ecosystem strategically use daily communication technologies as an experimental field for governance form.

KEYWORDS

Open data, adaptive governance, governance form, governance via knowledge sharing technology, data governance

<b> INTRODUCTION

In the past decade, the accelerating development and deployment of data infrastructure has reinstated *open data* movements across the globe to make public data accessible for various socio-economic gains, including increased transparency, efficiency of public services, innovation, and entrepreneurship (Corrales-Garay et al., 2019; Janssen et al., 2012). With these promises come uncertainties, such as the ambition of innovation around open data-based applications, and complexities in coordinating a large-scale open data ecosystem that involves citizens, communities, policy makers, institutions, and private actors.

The uncertainties and complexities are challenging for existing governance approaches. On the one hand, the control-oriented governance approach that is oriented towards stability through command-and-control measures, such as defining, enforcing, and monitoring data activities, often fails to respond timely to the evolving sociotechnical complexities around open data across jurisdictional boundaries (Wang & Staykova, 2019). On the other hand, the community-driven approach that emerges from informal networks while capable of addressing ad hoc contextualised situations through fast learning, can also suffer from issues such as representation or transfer of knowledge in its long-term transition to more stable governance form (Wang et al., 2020).

Adaptive governance (Chaffin et al., 2014; Dietz et al., 2003) that was originally introduced as an alternative governance approach to address large-scale problems in socioecological systems in a flexible, responsive, yet stable manner, is therefore particularly relevant for examining the governance in complex sociotechnical systems such as open data ecosystems (Janssen & van der Voort, 2016; Wang et al., 2017). In this study, I follow the development of open data movement in Shanghai between 2015 and 2020 and the local governance experiences to exemplify how the concept of adaptive governance can help envision a new form of data governance that can potentially strike a balance between change and stability and learning and control.

Resonating with the existing discussion on stability and change in adaptive governance (Chaffin & Gunderson, 2016), our findings suggest that while informal networks are important in the learning process across open data ecosystem, continuous experimentations of governance form play a critical role in addressing the need for control as complexities of ecosystem evolve. Foregrounding the role of technology, this study particularly brings attention to the mediating role of *daily* communication technologies, and how actors in the ecosystem strategically use them as an experimental field for governance. Moreover, I also emphasise the role of data resource as a governance subject in shaping the choice of governance form in the long-run. I

argue that long-term choice of governance form is largely influenced by the different views of data as a social resource.

In the following, I will start by introducing open data, the challenges it brings to the current governance approaches, and how the current understanding of adaptive governance in sociotechnical system may help to relieve the open data related governance challenges. Drawing on critical institutionalism, I present our conceptualisation of adaptive governance in open data ecosystem as a process of institutional bricolage on governance form that is contingent on the logics of data as a governance subject, and constituted by sociotechnical arrangements around identity, working norms, decision-making authority, and ownership. Based on a longitudinal study on the governance of local open data ecosystem in Shanghai, I explore the concept adaptive governance empirically through four questions: What are the governance dilemmas in the open data ecosystem? How did adaptive governance emerge in an open data ecosystem and address this dilemma? How to understand adaptive governance as a sociotechnical arrangement? What can we learn about adaptive governance by looking into the context of sociotechnical ecosystem? In this case study, I follow the change in the governance form of the open data ecosystem and the practices lead up to these changes as the main empirical subject. Looking at the governance practices, I draw on three primary data sources that were collected between 2015-2020: my participant observation in the offline meetups and online chats and in-depth as well as semi-structured interviews with leaders in the open data ecosystem.

Along this line, this study contributes to the understanding of adaptive governance by exemplifying its manifest in an open data ecosystem and bringing new insights to its conceptualisation by foregrounding the mediating role of sociotechnical arrangements (i.e., people's engagement of daily communication technologies and data as a social resource), which is relevant for understanding the adaptive governance of socioecological systems as well.

<b> BACKGROUND
<c> Open Data and Governance Challenges
Technology development has always been a challenging object of governance due to its uncertainties and complexities (Mandel, 2009; Moor, 2005). While the uncertainties are associated with the potential benefits and risks of technologies, the complexities have to do with the range of actors and how they are implicated in the conceptualisation, development, and implementation of technology.

Today, one of the prevalent examples of uncertain and complex of technological development can be found in information technology. In the past decades, we have seen an exponential

growth of internet-based, data driven technologies, such as big data, machine learning and artificial intelligence. With the prevalence of these data-based technologies, open data movement, which advocates data can be accessed, used, or shared by anyone, came into being amidst different ideas of data as a social resource (Baack, 2015; Hess & Ostrom, 2006). Open data movement is influenced by two paralleled movements: big data and open source; each advocate for a different view of data ownership, knowledge, and the agency and rights of human actors. One the one hand, open data is related to big data, which focuses on how big data technologies and algorithms generate knowledge using the digital traces of systems and people's behaviours. Data generated this way are often not re-contextualised into the experience of everyday life, thus impede data generators to act in an agentic manner. Data in this context is commonly processed by specific organisations or actors and considered as privately owned assets. They are used for generating values that benefit the data utilisers, such as companies and governments (Kitchin, 2014; LaValle et al., 2011; Wamba et al., 2015). On the other hand, open data is closely associated with open-source movement, which is fundamentally concerned with rights to access and distribute knowledge. Different from the focus in big data, open source focuses on voluntary participation and collaboration, granting access to the source code of software and incorporating contributions from potentially everyone. In this sense, the generated data, especially the ones through public service, is considered a shared social resource at a societal level (Willinsky, 2005).

These divergent movements provide a complex picture of who owns data and data infrastructure as important social resources in the emerging open data ecosystem. As data is processed through a diverse and evolving range of actors, depending on how data is created, mediated, and used, these actors may perceive themselves as the owner of data thus entitled to decide on the data-related standards. For example, when citizens use a public service, citizens, government, and private service providers may all feel like they are the legitimate owner of data resources. This also means that actors, each from their own perspective, may have different perceptions of data related benefits and risks, and thus engage in different ways of controlling the flow of data. Private entities may be interested in opening their data as a way of generating value for innovation that can be converted into market benefits, while NGOs may be interested in ensuring the citizens' rights and privacy are not infringed. In addition, open data also concerns technical infrastructure that need to be coordinated at a societal level, such as how data infrastructure is set up, what types of data should be open, in what way and to which degree data should be open. Divergence in the perception of technical needs and standards by different data actors thus can create obstacles for open data to materialise at a large scale.

Governance of open data ecosystem, that is the ways of coordinating resources and decision-making around open data at a societal level, thus presents a quandary for existing governance approaches, including 1) the good governance approaches perspective which focuses on the principles of a properly functioned state and government operations; 2) the New Public Management approach that focuses on the efficiency and efficacy by involving non-state actors and introducing private management principles to government operations; 3) the corporate IT governance approach that focuses on the control of data as an asset via designed distribution of decision-making rights and accountability to generate future profits; 4) multi-level governance that distributes the decision-making power vertically across bureaucratic structures within government and horizontally across boundaries of government agencies and non-government organisations and actors; and 5) network governance that emphasises the use of informal networks within a social system (Osborne, 2010; Wang, 2019).

The good governance approach and the new public management approach take a specific stance by focusing on either government operations or involving non-state actors, thus fail to capture the complexity in the range of actors and the evolving nature of open data as an emerging sociotechnical system. Corporate IT governance approach that focuses on command and control assumes the existence of closed range of stakeholders and considers data primarily as privately owned resources – assets. Although multi-level governance takes into consideration of the range of involved actors in a sociotechnical system, its focus on enforcing structures and process design does not address the rapid changes associated with sociotechnical systems. Network governance, though focusing on the emergent coordination practices among informal social networks, neglected the interaction with formal control mechanism such as regulation and bureaucracy.

Emerging open data ecosystem, thus, requires balancing act that supports continuous learning about the stakeholders' interests and interactions as well as the ownership of data and data infrastructure while keeps control of technical needs and sharing standards. Recently, there has been an increasing focus on developing alternative governance philosophy for sociotechnical systems, that is adaptive governance that focuses on governing complex systems. Below I will briefly describe the origin of adaptive governance in the context of socioecological system and explain why adaptive governance a suitable philosophy for open data ecosystem is.

<c> Adaptive Governance in Sociotechnical Systems

Adaptive governance is a governance philosophy that addresses how human cope with forms of complexity and uncertainty in socioecological systems (Brunner et al., 2005; Chaffin et al., 2014; Chaffin & Gunderson, 2016; Cleaver & Whaley, 2018; Juhola & Westerhoff, 2011).

Overall, adaptive governance argues for an *experimental* approach, which consists of testing policy as hypotheses, *learning* from the test and adapting according to changing contexts. Adaptive governance systems focus on *resilience* instead of *efficiency* and is characterised by emerging and evolving networks of stakeholders that promote social learning, power sharing and flexible institutions capable of accommodating and responding to changes and uncertainties arising from both environmental and social sources. Overall, adaptive governance scholars argue against the *command-and-control* approaches to manage complexity and uncertainty in socioecological system.

Recently, adaptive governance has been introduced to address sociotechnical complexity and uncertainty in the context of digital government (Janssen & van der Voort, 2016; Wang et al., 2017). The proponents argue that in the face of rapid technological development, there are increasing demands from stakeholders and digital technologies to which existing governance mechanisms need to adapt. For instance, while technological innovation requires some freedom in legislation for trial and error without liability, technologies also pose risks that are difficult to foresee but require timely control. Existing control-oriented governance mechanism such as legislation and procedures are reactive and inflexible, and lagging behind the expectations of businesses and citizens, posing requests for governments to transform their way of engaging with technological development.

Adaptive governance scholars have made prescriptions on how adaptive governance can help to balance between the demands of different stakeholders in the digital realm, by focusing on social learning through decentralized bottom-up decision-making, efforts to mobilize internal and external capabilities, "wider participation to spot and internalize developments, and continuous adjustments to deal with uncertainty"(Janssen & van der Voort, 2016, p. 4). Some have proposed that adaptiveness in the governance of public digital transformation can arise from the decoupling of decision-making power and accountability between public and private stakeholders (Wang et al., 2017). Some focused on how adaptive governance is increasingly mediated by information and communication technologies, such as social media in crisis response (Chatfield & Reddick, 2017) and large-scale collaborations (Wang et al., 2020). Some also embarked on how adaptiveness in regulation can arise from decoupling between liability and accountability (Wang & Staykova, 2019) as well as decentralisation (Hong & Lee, 2018). Nonetheless, less attention has been given to the specific technological context such, as open data ecosystem, and how adaptive governance can address different logics of data as a resource. This question is particularly important for the development of adaptive governance as a concept, as the foundation of adaptive governance is built upon public resources as commons (Hess & Ostrom, 2006; Ostrom, 1990). To engage with this inquiry, it is important to understand not

only how adaptive governance principles are manifested but also how different governance practices interplay with different views of data as a resource.

UNDERSTANDING ADAPTIVE GOVERNANCE AS INSTITUTIONAL BRICOLAGE

This study draws on the approach of critical institutionalism (Cleaver & Koning, 2015; Cleaver & Whaley, 2018) to understand governance as collective arrangements that are subject to human contingency and "a mix of economic, emotional, moral and social rationalities informed by different logics and world-views (Cleaver & Koning, 2015, p. 4)." I specifically use the concept of institutional logics and institutional bricolage as sense-making devices to conceptualise the emergence of governance arrangement in an open data ecosystem.

As I have mentioned previously, the idea of open data is influenced by several paralleled movements including big data and open source. These movements gave rise to distinctive views of data as a social resource, and how it should be governed accordingly. From an institutional logics perspective, "socially-constructed, historical patterns of material practices, including assumptions, values, beliefs and rules (Thornton et al., 2012, p. 2)" provide actors with guidelines for how to make decisions on particular issues, determine which of these issues demand managerial attentions, and frame possible solutions (Gawer & Phillips, 2013; Thornton, 2002). Similarly, actors in an open data ecosystem may have different imaginaries and practices of data depending on their professional or individual experiences. For instance, during my fieldwork in the Shanghai open data ecosystem, I have observed two divergent views of data as a social resource among my informants: data as private assets for generating financial values (Birch & Muniesa, 2020), and as commons shared between relevant actors in the society (Beckwith et al., 2019).

Subsequently, these views influence how actors consider data as a governance subject by framing what they consider as data associated issues, and how these issues should be solved appropriately in terms of sources of legitimacy, authority, collective identity as well as norms, attention, and strategy (Thornton et al., 2012). For instance, some of my informants who are a member of open knowledge community considered data as a community resource that is meant to be freely used by citizen groups. Thus, they would see municipality's interests in owning and controlling open data infrastructure as detrimental for its development, and demand power sharing and flexible institutions that can accommodate diverse and changing needs in citizens' data practices. By contrast, some members in municipality may consider data as a resource with economic value that a municipality controls with expectations of future profit through data-driven innovation. Following this thought, they may be inclined to structure and execute

decision-making rights in a certain way to ensure data generates economic values expectedly. Moreover, individuals may also subscribe to different institutional logics or engage in institutional work that changes collective identities and practice over time.

In this sense, when a new sociotechnical phenomenon such as open data emerges, while there may be a governance void initially, as actors interact with data and amongst each other, different data imaginaries and practices may arise and be mobilised to consider data a governance subject. As a result, actors may be up against varying demands of 'appropriate' governance arrangements, following particular views and practices of data.

In this context, adaptive governance therefore can be understood as how actors adapt to these fragmented demands by creatively blending, layering, and piecing together ways of coordinating resources in response to daily challenges in an open data ecosystem. The concept institutional bricolage (Cleaver & Koning, 2015) particularly sheds light on adaptative governance as a process where people, consciously and non-consciously, assemble and reshape institutional arrangements around resource coordination and decision-making. It brings our attention to the daily practices where experimentation of governance arrangements takes place. Looking into how people relate to the sociotechnical world, power dynamics and technology of control in particular help us to understand how governance experimentations are shaped through people's daily practices.

More specifically, people have cultivated different ways to order their social and technological worlds in daily practices. These ways of ordering the worlds shape how people assemble governance arrangements by influencing what they consider as the appropriate sources of authority and identity. For instance, people can choose certain governance arrangements out of pragmatic or strategic needs. But people's emotions, symbolic world views and moral considerations can also be sources for legitimising their choice of governance arrangements.

As assembling governance arrangement is a collective action that often involves multiple actors in an ecosystem, the exercise of the actor's agency can also be shaped by the power dynamics people perceive among themselves. The power dynamics can take place, for instance, between power attributed through regulations and organisational functions, power adhering to professional expertise and political roles, power accompanied by possession of resources, and power emerged through the informal interactions between actors. This also means that the variability in people's identities can enable people's negotiation over their access and rights to resources, discourses, and meanings, as well as representation and participation, and in this way shape the assemblage of the governance arrangements.

In addition, technology is also an important actor for shaping governance arrangement (Forsberg, 2018), especially given that today communication and coordination are increasingly

mediated through information technologies such as social media (e.g., Slack) or collaborative technologies (Teams). While actors can use these technologies for social learning and expanding networks, they can also use them to exercise varying extent of control (Wang et al., 2020).

In our case, the governance form of the open data ecosystem in Shanghai shifted from community to corporate. Rather than viewing such transition as an abrupt change, in this paper, I look at it as an accumulation of contextualised daily experimentation. Next, I zoom in on the transition in the governance form by unfolding the bricolage work that went into these transitions. I illustrate how adaptive governance is effective in addressing the initial void of data governance as well as the competing logics of data and governance demands over time.

<b> ADAPTIVE GOVERNANCE OF OPEN DATA ECOSYSTEM IN SHANGHAI
<c> Open Data in Shanghai

Before I unfold the emergence of adaptive governance arrangements in the open data ecosystem in Shanghai, I start by briefly introducing the development of open data in Shanghai, and why I consider the empirical context relevant for exploring the concept of adaptive governance empirically.

In 2015, Shanghai was among the first municipalities in China to experiment with different ways to promote and utilise open government data, among which one major effort was to establish a municipal level contest – Shanghai Open Data Applications (SODA) to award the best applications developed using open government data. At the time, the local open data landscape was almost empty, with very few distributed grassroot online groups on open data and open knowledge. The goals of the contest were to foster a unifying community of open data advocates, tap the potential benefits of open data in service and product development, and experiment with new ways of governance (Gao, 2018).

The contest was organised in 2015 by an interest group, made up by 7 actors from municipal government, IT industry, Non-governmental Organisations (NGOs) and research institutes, who got to know each other through an open data seminar that took place the year before. Although the contest had substantial involvement of government officials from the local municipality, it was not officially funded or owned by Shanghai Municipality. Rather, the contest heavily relied on the interest group members and their networks, especially the ones with existing grassroot open data groups online. The connection and coordination that went into organising the contest were made possible through collaborative platform such as WeChat, where people across organisations or distance can discuss and work together online.

Following the success of the contest in 2015, the Shanghai Municipality decided to continue the project annually, with an increasing number of local municipal bureaus and businesses agreed to share data through the contest. In 2016, four of the actors founded a company S to manage the operation of the contest. Subsequently, the four actors became shareholders of the company. In 2017, the four shareholders founded a new company D to restructure the share distribution among them. They do by having company S and two shareholders of S re-invested in the new company, leaving some room for a fifth shareholder.

I found the governance of open data ecosystem in Shanghai interesting for illustrating adaptive governance for three reasons. First, the open data ecosystem in Shanghai was characterised by a governance void due to its nascency, thus providing a relevant case to understand how actors do bricolage work to establish governance arrangements and adapt over time in response to sociotechnical changes. Second, China provides an interesting institutional context where experimental governance, that is, central policymaking relies on experiences of local governance experiment, is foregrounded as a way to address uncertainty related to emerging technologies (Heilmann, 2008; Wang & Staykova, 2019). In this way, one can argue social actors' bricolage work is invited to address the governance void in a new sociotechnical phenomenon such as open data. Nonetheless, it is also expected that these bricolage governance work may be formalised into state policies over time, presenting another condition for adaptation. Third, open data as a phenomenon is increasingly relevant to the management of natural resources, as big data analytics are increasingly used for monitoring resource usage or environmental impacts. Understanding the dilemma and response in the governance of open data can also shed light on the advancement in understanding the governance of socioecological systems.

<c> 2015 – 2020: Evolving Development and Governance Arrangements

Initial stage. In 2015, the local actors' primary focus was to find out how to identify, build and mobilise resources and capacities for organising open data in Shanghai, as there was no large-scale open government data initiative held in China prior to that. The local actors' ambition at the time was to focus on government data and use contest as an experimental form to test out what are the landscape of actors, their demands, needed resources and capacities, as well as the potential barriers and benefits for involved parties.

To do so, two first movers – Zhang, the Chief Executive Officer (CEO) of a state-owned enterprise and Gao, the director of the first open data NGO in China, who met each other in an open data workshop funded by the World Bank, set out to scout and assemble a group of people to organise the first open data contest in China. They have reached out through their

professional networks, including Zhang's former colleagues in the local government, Gao's online network of open data enthusiasts in the country, and people they met in the open data workshop. Zhang and Gao established contacts with a few practitioners who endorsed the value of open data, and who had data-related expertise, resources, or capacities. An unusual trait about this assemblage is that it not only included actors who are in leadership positions in their organisations, such as, section heads in local government, heads of research centres in university, CEOs of state-owned enterprise. It also involved startups, small and medium enterprises(SMEs) and NGOs. Zhang regarded this choice of involvement as *community building* based on relevant expertise and shared interests rather than organisational affiliations. Zhang and Gao built the open data community by connecting newcomers in a chat group on a popular messaging application – WeChat. The chat group was named as "open data advocates", and soon became a space for knowledge sharing and remote work, where people dropped important files, introduced relevant contacts, and socialised with each other. This group was particularly important for the members to form a collective identity outside their affiliated workplace and to create shared work norms that help to make things happen within a short period of time. For instance, a start-up CEO initially anticipated government actors to follow a nine to five schedule and "prefer meetings over actions". He was surprised to see that everyone in the group worked around o'clock and acted as "an entrepreneur".

In addition, as interactions between members are visible in the chat group, persistent presence in the chat group became as a sign of commitment, and an important consideration for the distribution of decision-making power in the group. The members who constantly contributed to the chat group soon gained more significance in making operational decisions. The online chat also made members' preferences and engagement of involvement in different tasks more visible. Subsequently, people started to identify different actors' roles in the ecosystem: government actors were better at bringing contacts and brokering data sources; start-ups were strong and efficient in coming up with solutions to store data and ensure data security; NGOs had a wide knowledge about international success cases of open data applications; university research centres were good at conceptualising and developing a narrative around open data that is appropriate for the local context.

From the discussion, the members considered contest as a means to discover stakeholder groups, explore possible data-driven outcomes and connect the stakeholders in the open data ecosystem. Because of the collective participation in organizing the contest, the contest is viewed as a shared product where all the involved members can claim ownership. For this reason, the members decided not to engage any public or private sponsorship to avoid a particular party claims ownership of their collective efforts. The resources used for organising

the contest are instead "borrowed" via the members' networks. Some members brought in their own organizational resources, such as an employee or an event venue, to help to organize the contest.

In parallel to the digital arrangements in the chat group on WeChat, the members also engaged in other types of symbolic work, which helped to unite different views around open data and its potential benefits. For instance, the abbreviation of the open data contest, SODA, is drawn on by some of the stakeholders to present a worldview where data-related uncertainty symbolises growth rather than chaos. In the official narratives and news reports of the contest, the abbreviation SODA is viewed as a metaphor for data: Just like soda water is still when it is bottled, data is the same. But once the bottle is open, data can release "smart energy" once it is open, just like the opened soda. The metaphor of SODA particularly helped the municipal actors, who were initially afraid of the "destructive chaos" caused by open data, to establish a positive imaginary of open data, and recognized the legitimacy of the community-driven data application contest as an effective way to map out data-related resources in the early stage of the open data movement. The metaphor also helped to establish the relevance of open data for the non-data professionals in the group by showing data can also be understood as a common artefact.

Overall, the emergent *community building* practices in- and out- side the chat group helped to cope with the initial governance void in the nascent open data ecosystem. These practices helped to establish ways of working and coordination, roles, and decision-making structure among the members. The technical features of the digitalised chat group, including its name and group member setup, acted as a materialised frame of reference to which the members can relate their identity as an open data advocate, and sustain their relations in the emerging open data ecosystem. The community-driven governance practices proved to be effective for organising the ecosystem through contest: within three months, the members have convinced local governments, public institutions, and private companies to share ten transportation-related datasets with the public through the contest. These available datasets drew more than eight hundred teams and more than five hundred proposals across the country to attend the contest. The contest resulted in applicable proposals for new business models, policy guidance, and service or product solutions for data providers.

Expansion stage. Following the success of the contest in 2015, the members refocused the new contests on the expansion of open data ecosystem, including widening the themes of the shared dataset from transportation to city safety and other social issues, attracting more public bureaus, government agencies, and private organisations to the open data ecosystem and making their

datasets available to the public. Meanwhile, government agencies and companies have also become more interested in the membership of the contest with different offers of sponsorship to financially support the contest. After the contest in 2015, the members at the time conducted an evaluation on the organisation of the contest and decided to keep the membership in chat group open in the spirit of "open" data. This also means, with new offers and membership requests, newcomers (such as leaders in different levels of government) are invited into the chat group to share relevant information and participate in day-to-day discussion and decision-making.

With newcomers there also came tensions, which revolved around working norms, membership, and decision-making. These tensions were made visible in the chat group. Soon after the new members from district governments were invited into the chat group, the existing members realised the newcomers did not engage in the same way. For instance, the members from district government were not aware that they were expected to give immediate feedback on the documents that people shared in the group. As one of the members recalled, "I just don't understand what they [new members] are doing sometimes. There is one time we agreed to write a campaign article together. I finished the draft and put it in the group, expecting them to comment on it. But they dragged for days to respond, and when they responded I don't even think we are on the same page."

These miscommunications reportedly slowed down the work and created a lot of frustrations in the group. After some time, some old members got together and decided to solve this issue by dividing the chat group into two: one with the old members from 2015; and the other one with everyone including the newcomers that came later. While daily decisions were made in the new group, critical decisions were discussed in the 2015 group first, and then forwarded to the new group for plenum discussion. In doing so, all the members were involved in decision-making, while the tasks could also be completed within a limited period.

Similarly, some members also found the involvement of high-level government officials in decision-making cycle "tricky" because they were "too busy to be involved in every petite discussion", yet "their opinions are important". To solve this dilemma, the members strategically invited high-level government officials into the chat groups, to ensure the high-level government officials were informed about the process and could grant permission to the tasks by giving a "silent agreement". In this way, the members managed to combine the community-driven, participatory decision-making with the hierarchical, bureaucratic decision-making structure. Through these strategic engagements with WeChat groups, the members managed to accommodate different demands of authority and membership. Following the split of groups, the 2015 chat group was renamed into SODA Organizing Committee, gradually

formalising the roles of the members. This also means that a centre-periphery structure in the open data ecosystem started to emerge.

After the open data movement started to expand to other Chinese cities, the movement soon attracted national attention, with a policy push to make the municipalities as the main drive of growth in open data ecosystems. In January 2018, Shanghai alongside four other municipal governments, i.e., Beijing, Zhejiang, Fujian, and Guizhou, has been appointed as a pilot municipality for open data. Contest and open data portal are especially seen as main instruments to stimulate the growth of local open data ecosystem. The experiences of organising SODA therefore made the members of open data ecosystem in Shanghai "hot commodity", and were, in fact, asked to organise open data application contests for other municipalities.

Meanwhile, there was an increasing tension around the ownership of the SODA contest, including the data sources that were made open, the data infrastructures that supported the contest, and the data applications that generated by the contestants. As the talk around equal ownership was still prevalent, some actors started to use different references to assert their ownership of the open data contest. For instance, a private actor who managed the chat group, used the administrator status in the chat group as a reference for ownership of the network. Another private actor who built the data storage systems for the open data contest, referred to the data storage system as their stake in the contest ownership, in their talk with an investment company. Rumours like these travelled across the ecosystem and started to unsettle actors in the ecosystem in terms of contest ownership. These unsettlements especially came from the public actors, who were concerned about the private interests that drove the claim of ownership. With the increased internal concerns over ownership and the external requests to purchase organising service of open data application contest, four of the original committee members of SODA 2015 (i.e., affiliated with the private sector and NGOs) set up a joint-stake company S. The company was described as an open data service company that design and deliver open data contest for local municipalities and was overseen by a board that consisted of the four original committee members. After the company was established, the company S signed a service contract with the Shanghai Municipality, becoming a private service provider for local open data contest SODA. The introduction of corporate as way to govern the open data ecosystem subsequently changed the relationship between these members and the rest of the ecosystem: the company S privately owned the organising service of open data contest, and the municipal government owned the product of the open data contest. This also means that the open data contest became publicly funded. And the Shanghai municipal government's role has been

reduced to overseeing the progress of the contest and brokering local government data within the Shanghai open data ecosystem .

As the founders of company S explored how to generate profit as a service provider for open data contests to sustain the company, the four board members also wanted to bring back the "openness" of the open data ecosystem into the company structure. Attempting to embrace the evolving range and changing roles of the actors in the open data ecosystem, the four founders of company S decided to change the share distribution between the board members and leave room for future newcomers. To do so, the founding members established a new company D. The company S reinvested in the new company D with another two original founders of S, making a total of three shareholders of D. The three shareholders together held 80% of the shares of D, with the additional 20% share was set-aside for the potential new stakeholders in the future. Before that, the 20% share was entrusted to the CEO of D.

DISCUSSION

What are the governance dilemmas in the open data ecosystem?

The evolving governance arrangement of open data ecosystem in Shanghai reveals different views of data ownership at play, that is, *asset* and *commons*. Over time, the two logics of data ownership enact different imaginaries of appropriate governance arrangements for the local actors in the open data ecosystem, each driven by an archetypical source of legitimacy and authority, such as, community, state, and market. Nonetheless, these imaginaries of governance arrangements were not always consistent with each other and created conflicts in practice when confronted with each other.

If we look at the local actors' discourses around open data, they arguably share a value of data commons, that is, data is a shared resource in the society. Following this value, the actors' governance preferences often underline the commitment to community value, as well as voluntary and cooperative engagement in the governance of the open data ecosystem. The actors were expected to contribute to the development of open data ecosystem on a voluntary basis in pursuit of shared interests and values, despite their varying professional and organisational interests.

As data becomes enacted into practice through various data related processes and systems in relation to brokering, organising, maintaining, storing, processing, and analysing data, local actors also inevitably developed a view of data resources as private assets that are generated through their investment of expertise and resources. Following these development, the actors' governance preferences also involve control-oriented ways of working and distributing roles and decision-making rights.

While the rhetoric of the commons are used by some actors to advocate for data sharing, the governance dilemmas that come with a group of people using a shared resource remain in the dark (Purtova, 2017). In our case, the governance dilemma of open data lays in the tension between appropriation and provision. That is, actors in the ecosystem tend to believe their access to the benefits of open data depends on their perceived ability to provide data. Thus, as their involvement deepens in the ecosystem, they are increasingly interested in claiming ownership to secure their benefits for investing in open data. The issue here is that the resource boundary of data is far less than clear. For instance, the value of data source is dependent on the technologies that generate, store, process and analyse them, as well as the people that use, operate, and maintain these technologies. Depending on how data is created, mediated, and used, all the actors in an ecosystem may perceive themselves as owner of data sources or part of the infrastructure that sustain the value of the data sources.

The divergent views of data ownership therefore create a governance dilemma when actors link their access to the benefits of data to their perceived ownership of data resource: On the one hand, the health of open data ecosystem depends on actors' voluntary participation and their contributions of data related expertise and resources. On the other hand, actors may only be interested in sharing their resources when they can secure their benefits or avoid certain risks. The governance dilemma in open data ecosystem thus concerns how to encourage actors to share data resources while preserve their individual interests in securing benefits of open data. Future studies can verify and enrich the understanding of governance dilemma by looking into other open data ecosystems across the world. The studies can also deepen the understanding of governance dilemma also by investigating what motivates the actors to contribute to an open data ecosystem. From the perspective of critical institutionalism, to answer this question, one may pay attention to the actors' shifting positions in the open data ecosystem such as a citizen, a knowledge expert or an organizational employee, their logics of data as a governance subject and the corresponding motivations. Open data researchers may also identify the boundary conditions that drive the actors to shift their positions and mobilize different logics of data to justify their participation in open data.

<c> How did adaptive governance emerge in an open data ecosystem and address this dilemma?

In our case, when open data was first introduced into Shanghai, it was approached as a new phenomenon with no precedent, and with divergent influences from government, market, and civil society. In response to this governance void, our informants attempted to create a community arrangement by engaging in a series of practices that connect the actors' interests.

These practices include creating a shared view of open data using the metaphor of SODA, forming a common identity of open data advocate, and creating a unique work routine.

The introduction of community as a governance arrangement was initially possible due to the distributed domain expertise and access to open data infrastructure across the ecosystem. The community arrangement was effective enough to support the ideation, implementation, and operation of the first open data contest in Shanghai. Nonetheless, as the expertise and access to open data infrastructures started to centralise on a few key stakeholders and the contest model started to take place, clashes between community-, and state-driven governance practices start to clash. These clashes were not only reflected as disagreements in who should have the authority to decide on what it means to be open and who has access to data sources and infrastructures, but also as differences in working routines and tropes of discourses around data. In response to the varying and fragmented demands about how to govern open data, our informants creatively used the online collaborative platform as a governance *avatar* to test out the possibilities of carrying out the open data movement without the actors' consensus on the extent of control and types of ownership. For instance, our informants engaged with a *divide and dissent* approach to create separate closed groups to accommodate different needs for knowledge sharing and decision making. These separate closed groups also make disagreements and differences in work styles less visible to newcomers in the ecosystem, thus creating a sense of coherent community that is attractive for the newcomers to engage.

As the competition between state-, and community-driven governance practices intensified, the pro-community actors brought the *divide and dissent* approach offline as a long-term structural design. The actors who did not agree with the increasingly established state-driven data governance practices, borrowed the organisational form of corporate to take a circuitous route to guard non-government actors' access to data resources by privatising parts of data infrastructure and using the private data ownership as a leverage for exchange.

To better understand the emergence of adaptive governance, future studies should investigate if there are other organizing logics of data aside from community, state and market, and how actors mobilise these logics to create different combination of governance arrangements that enhance the adaptive capacity of the ecosystem. Along this line of inquiry, it is also important for future studies to investigate whether divide and dissent is an effective approach for coping with the everchanging needs and demands within an expanding open data ecosystem, and how the approach may manifest in other contexts.

<c> How to understand adaptive governance as sociotechnical arrangements?

The use of knowledge sharing technology is an important dimension in the adaptive governance arrangement that emerged in our case. This is because learning is core for the adaptive governance of open data ecosystem, and the use of knowledge sharing technology has the potential to shape the way and the extent actors learn. From an ecosystem perspective, the adaptative capacity of the governance arrangements largely depend on human actors' learning about the latest technical advancement as well as the available resources and needed capacities to deal with the changes. The use of knowledge sharing technology therefore can potentially increase the learning capacities across the ecosystem. Given knowledge sharing technology is also based on the possibilities for actors to make connections and interact with each other, it can also potentially help to create a shared sense of community and identity, which may lead to the institutionalisation of governance practices in the long run.

Nonetheless, from an individual actor's perspective, each actor in the ecosystem has their own expertise, assumptions, interests, and ways of working in their engagement with open data, which are not always congruent with each other. This means that they may not always be willing to share knowledge to the same extent. In fact, they may be interested in controlling and even constraining know sharing, depending on their perceived power dynamics with others in the ecosystem, potentially harming the adaptive capacity of the ecosystem. In addition, through actors' interactions, knowledge sharing technology can also make visible the differences in actors' ways of working therefore revealing divergence or disagreement in actors' interests or intentions. Given the prevalent use of information technologies in collaboration today, it would be interesting for open data researchers to identify the sociotechnical arrangements of learning that are deployed in an ecosystem. These sociotechnical arrangements also provide adaptive governance scholars a new range of experimentation venues to observe how learning and control are balanced through digitally medicated governance practices.

In our case, our informants tactfully engage with the tension between facilitating and constraining knowledge exchange in order to create a shared sense of community while preserve the interests and capacity of each actor. These tactics helped to solve issues rapidly without delving into disagreement in assumptions and interests. For instance, our informants engaged in bricolage work on governance in their daily operations working with open data, marking ownership contingently in different scenarios where data resource could mean database or data storage systems. However, this also means there are fundamental differences in the boundaries of data sources and views of data ownership that are not reconciled. One thing that remains puzzling in our case is how actors in the ecosystem who are prone to data-sharing ended up privatising their organising capabilities for open data initiatives to increase their leverage to convince newcomers. Future research could investigate further how

privatisation of data resources is used creatively as a way to guard the public access to data resources and what the implications are there for the constructed nature of data as a resource.

<c> What can we learn about adaptive governance by looking into the context of sociotechnical ecosystem?

It is important to emphasise that the governance of socioecological systems is increasingly mediated by technologies (Forsberg, 2018; Kooij et al., 2015), especially digital technologies. For instance, information and communication technologies (ICT), such as, social media or collaborative platforms, are used for knowledge sharing and coordination to assist collaborators between human actors in disaster relief. Data analytics and Internet of Things (IoT) are also used for sustainable management of commons, such as, monitoring the use of natural resources. As environmental and climate crises become imminent, policy initiatives, such as green transition put greater emphasis on data auditing of natural resources usage. This increasing focus on data also means the governance of socioecological systems not only concerns governance *via* IT (i.e., ICT), but also governance *of* IT (i.e., data).

This dual focus on IT means that we need to take into consideration of sociotechnical complexity in the discussion of adaptive governance of socioecological systems. As I have shown in the case of open data ecosystem, sociotechnical complexity in adaptive governance manifests along two dimensions: the boundary of data as a social resource and the use of knowledge sharing technology, together they have implications for theorizing adaptive governance in terms of digitized governance object, involved data actors and knowledge needs, digital learning mechanism and experimentation venue.

Digitized governance object. The increasing *datafication* of natural resource management invites questions about the subject of adaptive governance: as natural resources, individual and organizational behaviours become inevitably digitized through different sensing and tracing method. Our understanding of and interaction with natural resources is increasingly mediated through the imaginaries and practices of data as a resource. From a critical institutionalism perspective, in this study, I understood governance as collective arrangements that are subject to human contingency and a mix of rationalities informed by different logics. Adaptive governance, in this sense, refers to an adaptation process where actors respond to fragmented demands by creatively combining ways, or logics, of coordinating resources in daily practice. Following this line of inquiry, I argue that adaptive governance scholar needs to take into consideration of the various data logics at play and investigate the relation between data logics and actors' governance responses in socioecological systems. In the context of open data ecosystem, I have showcased that there are at least two different data logics - data as commons

and assets - are at play, generating divergent governance demands. Adaptive governance scholars should further investigate what are the implications for adaptive governance arrangements in the face of divergent data logics in daily practices.

Involved data actors and knowledge needs. Considering the effects of datafication also means to recognize data-related stakeholders in the governance of socioecological systems, including data industry, experts, bureaucrats, and activists. This is important for the understanding of adaptive governance, as one of its primary foci is to achieve resilience through wide learning across emerging and evolving networks of stakeholders. Given the importance of learning and networking in adaptive governance, taking into consideration of the participation of data-related stakeholders in the socioecological systems also requires adaptive governance scholars to rethink the required networks and knowledge needs to enhance the adaptive capacity of a governance arrangement. It could be interesting to understand what kind of knowledge sources data workers utilise to create, process, and use the data generated in natural resources management, and how does the choice or the lack of knowledge sources for data worker shape the corresponding governance arrangements in a socioecological system.

Digital learning mechanism and experimentation venue. With the expanding network and the increasing penetration of digital technology in our daily (work) life, learning across a network is inevitably mediated through digital platforms, be it social media, collaborative platform, or even conferencing applications. In the open case study, I have demonstrated the use of these networking and sharing technologies also shapes the emergent adaptive governance arrangement. It does so, not because of the technology itself, but the interaction between the actors and the learning technologies: depending on the actor's role, and subsequent expectations and expectations, they may perceive the technologies for different purpose – enabling or constraining learning and use these technologies strategically. This is critical for the understanding of adaptive governance, as existing adaptive governance scholarship argues for an experimental approach the builds upon learning from testing policy as hypotheses in a new context. With the prevalence of knowledge sharing technologies, learning can take place at a much smaller, daily scale. Focusing on the knowledge sharing technology, it is thus important for adaptive governance scholars to identify the effective sociotechnical arrangement around learning, and their implications for the emergent adaptive governance arrangements.

CONCLUSION

In this study, I demonstrated how adaptive governance in an open data ecosystem emerged from the need to fill in the governance void in the beginning to coping with different demands of data logics afterwards. Our finding suggests community-driven governance practices

emerged as an effective way to identify distributed resources for building data infrastructure and experiment with unique governance practices that are suitable for the development in the open data ecosystem. Nonetheless, as the initial governance practices start to stabilise, overlaps and clashes between the emergent and other existing governance practices become more visible to actors. Our informants coped with these competing governance practices, using a "divide and dissent" approach that allows them to accommodate differences while carrying on the work needs to be done. This divide and dissent approach was tested through its virtual avatar on a collaborative platform and later materialised into separate companies that aimed at using private ownership to guard non-government actors' access to data resources. These insights from the case study are relevant for the understanding the adaptive governance of socioecological system by drawing attention to the duality of IT in adaptive governance: governance via knowledge sharing technology and data governance. Based on these insights, I put forward a research agenda for open data scholars, focusing on the data logics that are at play in an open data ecosystem, the associated governance dilemma and coping mechanism, the sociotechnical learning arrangements, and their consequence for the form of adaptive governance. I also argue that the case on open data ecosystem has implications for theorizing adaptive governance, by putting forward the two dimensions of IT involvement in adaptive governance: governance *via* IT (i.e., ICT), but also governance *of* IT. As datafication of natural resources management intensifies, the dual focus on IT requires adaptive governance scholars to address digitized governance object, involved data actors and knowledge needs, digital learning mechanism and experimentation venue.

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