Artificial Intelligence Entering Public Healthcare Ecosystems: Do Policies Matter?

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Introduction

The artificial intelligence (AI) field can be traced back to the 1950th (Tzafestas, 2016). In recent years, with the emerging of web 3.0 and big data, AI is rapidly flourishing and start to be widely used in many fields, such as high tech, the automotive industry, financial services, retail, media, education, healthcare and travel (Chui, 2017). Early business adopters regard AI as increasing revenue, while organizations using AI expect lower costs and efficient service (Chui, 2017). In the healthcare sector, the use of AI is slow, compared with other fields, but its adoption is steadily increasing, due to the nature of healthcare services, which require face-to-face interactions for its service delivery (Jung & Padman, 2015). The use of AI in healthcare is a promising field for many businesses (Chui, 2017; Dirican, 2015; McKinsey Global Institute, 2017) and it will be likely to redesign the healthcare sector in many aspects, such as in mining medical records, designing treatment plans, and assisting repetitive jobs (Meskó, 2016).

In China, many public hospitals have started to use AI for providing better treatment plans and for helping doctors in advanced decision-making for diagnoses and treatments (Christine Douglass, 2016). The Chinese government has started introducing a number of innovation policies in order to accelerate the development of AI, to inspire healthcare innovation, and to provide easier access to improved and more efficient care for patients. According to Lundvall and Borrás (2006), "innovation policy covers a wide range of initiatives and it is necessary to give some structure to the complex reality". These innovation policies introduced by diverse actors target both ICT firms and hospitals, with diverse policy instruments and policy goals.

Healthcare is one of the major areas in which the government plays a central role, especially in China. AI adoption in healthcare has a strong requirement on policy support. Existing research falls short of analyzing the impacts of innovation policies of AI in healthcare. As a result, there is a need for both researchers and practitioners in the public healthcare sector to understand the effects of policies on the adoption of AI in healthcare in China. Therefore, in our study we would like to tackle the following overarching research question: *How do government innovation policies affect the use of AI by actors in the public healthcare ecosystem?* This research question is articulated in two sub-research questions: *What are the characteristics of government innovation policies (RQ1)*; and *How do the characteristics of government innovation policies affect the use of AI in the public healthcare ecosystem by key actors (hospital managers, IT firms, and doctors)?* (RQ2).

This extended abstract reports on the initial phases of a study aimed at answering the overarching research question, which is part of the doctoral research design of one of the authors. Our preliminary findings tackle RQ1 by mapping the innovation policies introduced by the government in China, with the future goal of tackling RQ2 by investigating the effects of these policies on the use of AI by specific actors in the public healthcare ecosystem (hospital managers, IT firms, and doctors).

Previous Research

Existing research on the impacts of government policies on technology use frequently highlights that government policies, drawing on a mix of policy goals, actors and agencies, have the potential to promote technology use. For instance, when policy actors and agencies are matched with policy goals on social and economic development, they can result in promoting technology use in an industry (Wonglimpiyarat, 2014).

Recent research focusing on the development of emerging technologies in government – such as open and big data, gaming and crowdsourcing – highlights that not only innovative policies can impact the use of these technologies, but also the other way around. On the one hand, in fact, government policies can affect the use of technology in practice while, on the other hand, the emerging technology use can influence the policy process (Janssen & Helbig, 2016). Policy makers thus need to consider the policy goals and policy instruments used to facilitate the adoption of technology.

Research has also focused on distinguishing the impacts of government policies of different nature. Demand-pull policies (i.e., policies with the goal of developing the demand side in a market, such as extending the user base of a service, or developing new markets for the application of new technology) and supply-pull policies (i.e., policies with the goal of developing the supply side in a market, such as improving the infrastructure, providing fiscal support to business) are both found to increase domestic innovation rates and hence levels of technology exports in the energy storage industry (Fabrizio, Poczter, & Zelner, 2017). Empirical evidence, however, shows that demand-pull policies attract competition from abroad, while supply-pull policies do not have this effect (Fabrizio et al., 2017)

In sum, we observe that policy goals, policy actors and agencies, and different policy instruments used by the government, can affect the use of a technology. The influences of this policy mix depend on a variety of factors related to society, and to the industry ecosystem. Given the dearth of research on impacts of government policies on AI adoption, in our study we aim at understanding how government policies affect the use of AI in the public healthcare sector, focusing on a case situated in the context of China.

Analytical Framework: Policy Mix

order to start answering the overarching research question *How do government innovation policies affect the use of AI by actors in the public healthcare ecosystem?*, we first focus on mapping the innovation policies introduced by the Chinese government (RQ1). To classify and map these policies, we adopt the analytical framework of the *policy mix.*

The analytical framework of the policy mix draws on the idea that policies can be conceptualized as a combination of different policy components (Flanagan, Uyarra, & Laranja, 2010, 2011; Rogge & Reichardt, 2016). Innovation policy scholars have originally discussed the need for innovation policy-makers to consider a 'mix' of objectives and policy instruments (Branscomb & Florida, 1998; Smith, 1994). Various contributions have discussed and refined the notion of policy mix, by identifying a number of key components (Flanagan et al., 2010, 2011) (Reichardt, Negro, Rogge, & Hekkert, 2016; Reichardt & Rogge, 2016; Rogge & Reichardt, 2016). In its different forms, the analytical framework of the policy mix has been recently use in different empirical settings, such as energy technologies (Costantini, Crespi, & Palma, 2017), and low carbon innovation (Uyarra, Shapira, & Harding, 2016).

Drawing on the lessons learned from extant literature, for the purposes of this study, we consider the following as the key components of the policy mix; *policy actors and agencies, policy goals, policy instruments, policy targets, and policy beneficiaries.*

In the following section, we outline how this analysis framework has been used in our study for data collection and analysis.

Methods

In order to answer the two research sub-questions RQ1 and RQ2, our research design consists of two steps: 1) a mapping and classification of extant government policies, using the analytical framework of the policy mix (RQ1); 2) an analysis of the effects of the policies on the use of AI in the public healthcare

ecosystem (RQ2), carried out on the basis of data collected from key stakeholders (i.e., hospital managers, IT firms, and doctors) (Pan & Tan, 2011).

To investigate the overarching research question, we draw on empirical data from a case of use of the AI platform Watson in a hospital in China. Watson is the name given by IBM to its computer system capable of answering questions posed in natural language (Shader, 2016). We have chosen the Zhejiang Provincial Hospital of Traditional Chinese Medicine, located in Hangzhou, Zhejiang province, China (Zhejiang Provincial Hospital of TCM, 2011), as the source of empirical data, since it is the leading public hospital in China in adopting the AI cognitive assistant IBM Watson for supporting cancer treatment decision-making.

In order to map government policies affecting AI use in the public healthcare ecosystem, we collected reports and policy documents from three sources: a) The website of the Chinese State Council, providing access to all types of government policy documents (e.g., plans, opinions, notices); b) the websites of 20 ministries and commissions (e.g., the National Development and Reform Commission) introduced since 1978; and c) the Report on Deepening Health Reform in China (World Bank Group, World Health Organization, Ministry of Finance, National Health and Family Planning Commission, & Ministry of Human Resources and Social Security, 2016).

Through a keyword search within the resulting policy documents, we then selected all documents at national level related to a) healthcare; b) emerging information and communication technology (i.e., big data, the Internet of Things, and cloud computing); and c) AI. We discarded policy documents that are published yearly (e.g. "Circular of the General Office of the State Council on Printing and Deepening the Key Tasks of the Reform of Medical and Health System"), and only kept the latest 2017 edition; we also discarded policy documents targeting only specific areas, such as traditional Chinese medicine, or specific medical instruments.

As a result, we identified 22 relevant and unique government policy documents. We then coded the content of these 22 policy documents against the key components of the policy mix (policy actors and agencies, policy goals, policy instruments, policy targets, and policy beneficiaries), using version 11 of the NVivo software.

Table 1 illustrates the application of the key components of the policy mix to our case, and Table 2 summarizes the selection process of the policy documents.

Table 1. Applying the analytical framework of policy mix to the public healthcare ecosystem in China	
Policy mix	**Description**
Policy actors & agencies	The State Council; General Office of the State Council; Ministries and Commissions
Policy goals	Economic, social, technological
Policy instruments	Supply-pull, demand-pull, environment-pull
Policy targets	Hospitals; IT firms; doctors
Policy beneficiaries	Patients

Table 2. Steps in the selection of the government policy documents		
Selection step	**Selection criteria**	**Sum of results**
Step 1: Keyword search in the government websites of the People's Republic of China and of the State Council, and in the Catalogue of Government Information Disclosure.	- Presence of keywords: healthcare (health, health care), medical, technology, artificial intelligence, big data, internet of things, cloud computing	- 43 reports. - 62 policies.

Table 2. Steps in the selection of the government policy documents		
Selection step	**Selection criteria**	**Sum of results**
Step 2: Keyword search in the websites of 20 ministries and commissions.	- Presence of keywords: ICT and health/medical, artificial intelligence	- 20 websites - 6 policies
Step 3: Analysing the report "Deepening Health Reform in China"	- Healthcare policies introduced by all policy actors	- 20 policies
Step 4: Eliminating non-relevant policy documents	- Duplicate policy documents; - Policy documents published on a yearly basis; - Policy documents targeting only specific areas (e.g., traditional Chinese medicine)	- 22 policies

Preliminary Findings

Our initial classification of the policy in *themes* captures policies on healthcare, policies on emerging technologies, and policies on AI. The Venn diagram in Figure 1 illustrates the overlap between these three areas.
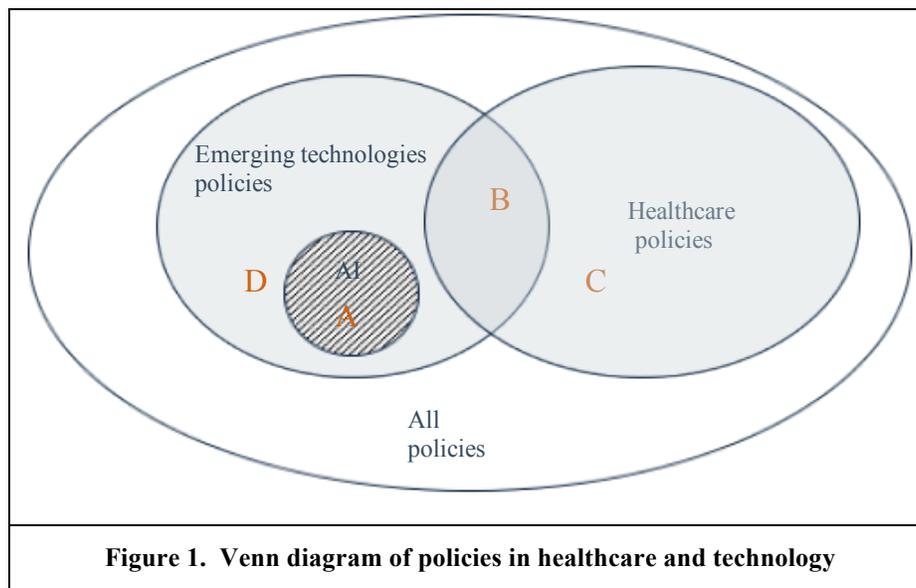

Figure 1. Venn diagram of policies in healthcare and technology

A quantitative analysis of themes in the policy documents shows that most policy documents focus on general healthcare (n=10, group C), or general emerging technologies (n=8, group D), and only 2 documents focus on the overlap between these two, that is on emerging technologies in the healthcare sector (group B). Within emerging technologies, only 2 policy documents concern AI (group A), while there are currently no policies concerning specifically AI in the healthcare sector in China. Appendix A provides the details of each policy document in each of the four groups.

Regarding the *policy goals*, our analysis shows that the dominant focus of the policy documents is on *economic* and *social* development, while there is a smaller focus on the *technology* development. Figure 2 provides a visualization of the focus on policy goals within these three areas.

Figure 2. Policy goals analysis
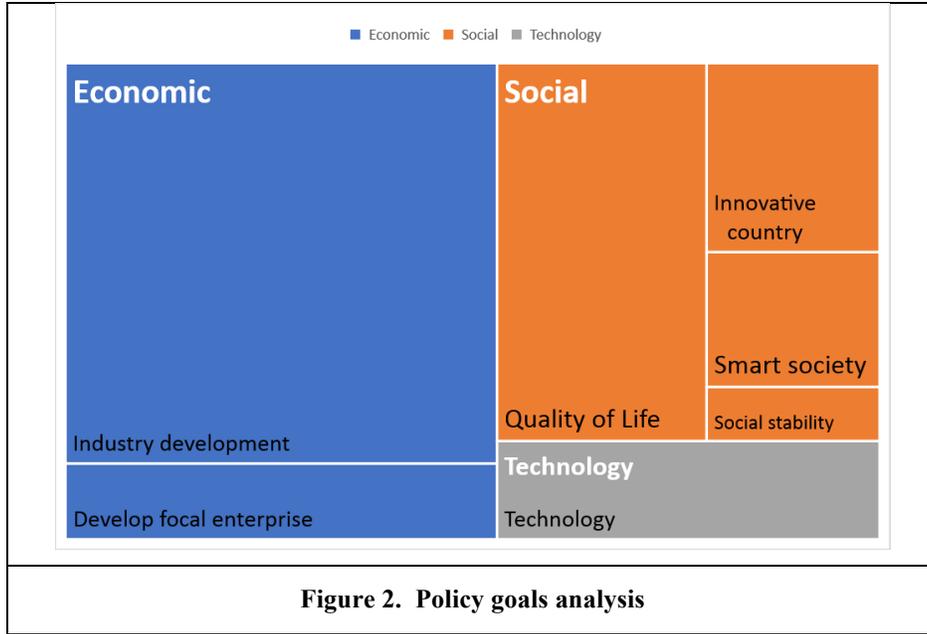
Regarding the *policy instruments* used by the government, the main focus is on *supply-pull* (n=481), while the least attention is given improving the environment (*environment-pull*) (i.e., policies with the goal of developing an effective environment for technology application via tax tools, or other regulation tools) (n=43). Fig. 3 provides a visualization of the focus on policy instruments.

Figure 3. Policy instruments analysis
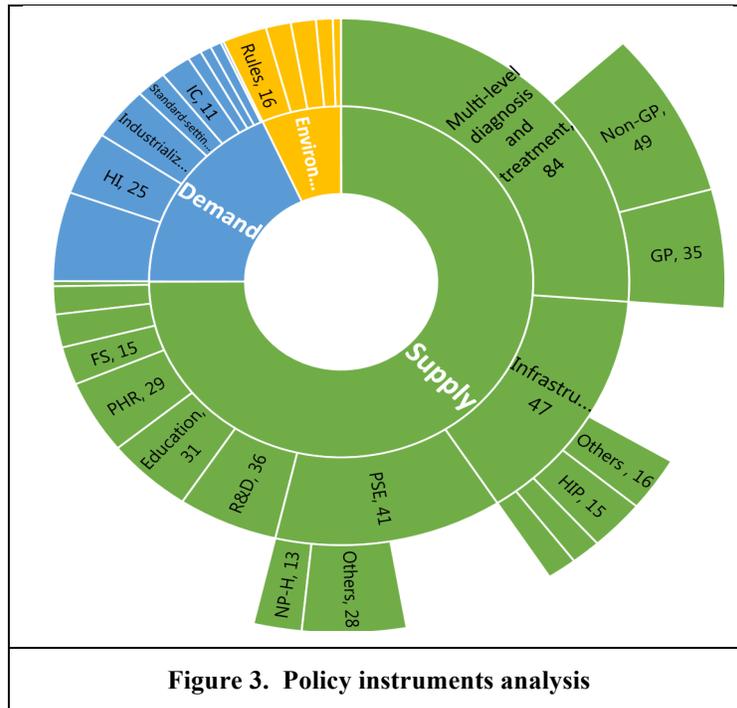
Within the supply-pull focus, policy documents show that the government highly emphasizes building multi-level diagnosis and treatment, aiming at supporting general practitioners. In addition, there is a strong focus on developing healthcare infrastructure, – such as information platforms, internet-based healthcare, and telemedicine – and fostering private sector engagement, in particular by trying to stimulate the development of non-public hospitals. Doctors are also encouraged to work in non-public hospitals in China. Moreover, foreign-owned hospitals are encouraged to establish in China, especially in rural areas or areas with lower healthcare service level. Appendix B provides a detailed listing of the characteristics of the policy documents.

Discussion and Future Research

Summarizing, the analysis of the policies referring to AI in healthcare in China has showed the following findings. First, the most important focus in *policy goals* is on the economic development, especially on the industry development. Surprisingly, there is less focus on social stability, which is a goal traditionally emphasized by government policies in China. Second, the most important focus in policy instruments is on the *supply-pull* instruments, especially on the multi-level diagnosis and treatment. Healthcare infrastructure development and private sector engagement participation are the other two highlights from the supply side. Third, there is less attention on *environment* building. Few policy documents focus, for instance, on IPR, data security, or on using tax measures to facilitate private sector engagement. The limited attention provided by the Chinese government to issues of data security and privacy is in contrast with many extant studies that highlight the key role of data security and privacy in healthcare information system, or other emerging technologies such as cloud computing (Chen & Zhao, 2012; Meingast, Roosta, & Sastry, 2006; Wilkowska & Ziefle, 2012).

These emerging characteristics of the policy goals and instruments related to technology and healthcare in China can be expected to affect the way AI is used by hospital managers, doctors, and IT firms in the public healthcare ecosystem. In order to investigate the effects of these policy characteristics, we have started conducting semi-structured interviews with hospital managers, doctors, the IT firm *CognitiveCare*, managers at *IBM*, and policy makers that work with AI in healthcare. The interviews focus on the perceived impacts of the characteristics of the policies analysed on the use of AI by these key stakeholders. We plan to conduct interviews with at least six informants for each group of stakeholders.

Questions to be answered through the second phase of our study include: is AI welcomed or not welcomed by healthcare ecosystem stakeholders? And why? How are stakeholders making sense of government policies directly or indirectly affecting the introduction of AI in the healthcare ecosystem?

Further findings from the ongoing data collection and analysis will be aimed at both research and practice. In relation to research, we aim at contributing to the body of e-government research focusing on policy impacts, in relation to the emerging AI field. In relation to practice, we aim at providing public managers with a better understanding of the needs and expectations of diverse healthcare ecosystem stakeholders (hospital managers, doctors, IT firms).

We would like to receive feedback from workshop participants in relation to the upcoming challenges of our research design. The challenges include, but are not limited to, the following items:

- How to argue for the uniqueness of AI technology in our research design?

- What existing body of knowledge can we draw on to assess policy impacts on each of the three groups of stakeholders (hospital managers, doctors, IT firms)?

- What other theoretical frameworks could be used as lenses to answer our two research sub-questions

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Appendix A : List of policies coded

Policy Groups	No.	Policy Title	Reference
Group A	1	Notice of the State Council on Printing and Distributing a New Generation of Artificial Intelligence Development Plan	(State Council (Guo Fa) 2017a)
	2	"Internet +" three years of artificial intelligence implementation plan	(National Department and Reform Commission (Fa Gai Gao Ji) 2016)
Group B	3	A Guidance on the promotion and regulation of the development of healthy medical data applications	(General Office of the State Council (Guo Ban Fa) 2016)
	4	"13th Five-Year Plan" National Population Health Information Development Plan)	(Ministry of Science and Technology (Guo Ke Fa Gao) 2017)
Group C	5	Guiding Opinions of the General Office of the State Council on Promoting the Construction and Development of Medical Consortium	(General Office of the State Council (Guo Ban Fa) 2017a)
	6	Circular of the General Office of the State Council on Printing and Deepening the Key Tasks of the Reform of Medical and Health System in 2017	(General Office of the State Council (Guo Ban Fa) 2017b)
	7	Opinions of the General Office of the State Council on the provision of multi - level and diversified medical services in support of social forces	(General Office of the State Council (Guo Ban Fa) 2017c)
	8	Notice of the State Council on Printing and Distributing the "13th Five - Year Plan" to Deepen the Reform Plan of Medical and Health System	(State Council (Guo Fa) 2016)
	9	A Guidance on Promoting the Construction of the Classification and Treatment System	(General Office of the State Council (Guo Ban Fa) 2015a)
	10	Suggestions of the CPC Committee on the 13th Five-Year Plan for National Economic and Social Development	(Central Committee of the Communist Party of China (Zhōnggòng zhōngyāng) 2015)
	11	Notification on launching the pilot of establishing wholly foreign-owned hospitals	(National Health Commission (Guo Wei Yi Han) and Ministry of Commerce 2014)
	12	Several Opinions of the State Council on Promoting the Development of Health Service Industry	(State Council (Guo Fa) 2013a)
	13	Opinions of the State Council on the establishment of a general practitioner system	(State Council (Guo Fa) 2011)
	14	A Forwarding Development and Reform Commission Ministry of Health and other departments on further encouragement and guidance of social capital held medical institutions advice	(General Office of the State Council (Guo Ban Fa) 2010)
Group D	15	Notice of the Ministry of Science and Technology on Printing and Distributing the Special Plan for Scientific and Technological Innovation in the "13th Five-Year Plan" Advanced Manufacturing Technology	(Ministry of Science and Technology (Guo Ke Fa Gao) 2017)
	16	Opinions of the State Council on Implementing the Division of Key Work Departments of the Government Work Report	(State Council (Guo Fa) 2017b)

Policy Groups	No.	Policy Title	Reference
	17	Integration of information and industrialization development plan (2016-2020)	(Ministry of Industry and Information Technology (Gong Xin Bu Gui) 2016)
	18	A number of views on the use of big data to enhance service and regulation of market players	(General Office of the State Council (Guo Ban Fa) 2015b)
	19	Circular of the State Council on Printing and Distributing the Platform for Action for the Development of Large Data	(State Council (Guo Fa) 2015a)
	20	Opinions of the State Council on Promoting the Development of Cloud Computing and Cultivating New Pattern of Information Industry	(State Council (Guo Fa) 2015b)
	21	Opinions of the State Council on Promoting the Orderly and Healthy Development of Internet of Things	(State Council (Guo Fa) 2013b)
	22	Several Opinions of the State Council on Promoting Information Consumption to Expand Domestic Demand	(State Council (Guo Fa) 2013c)

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Appendix B : Summary of policy characteristics (N=22)

Policy Mix		Characteristics	Number of coding references
Policy goals	Economic	Industry development	37
		Develop focal enterprise	7
	Social	Quality of Life	17
		Innovative country	7
		Smart society	5
		Social stability	2
	Technology	Technology	8
Policy instruments	Supply	Multi-level diagnosis and treatment	84
		• General practitioner (GP)	35
		• Non-GP	49
		Private sector engagement	41
		• Non-public hospitals	13
		• Others	28
		R&D	36
		Education	31
		Public hospital reform	29
		Infrastructure	47
		• Healthcare information platform	15
		• Internet + healthcare	8
		• Telemedicine	8
		• Others	16
		Fiscal support	15
		Public service platform	13
		Foreign Owned Hospitals (FOH)	11
		Personalized Medicine	2
	Demand	New application	35
		Health insurance	25
		Industrialization	21
		International collaboration	11
		Standard-setting	11
		Help-the-poor	5
		Diagnosis Related Group (DRG)	4
		Drug price reform	4
		Public Procurement	1
	Environment	Regulations & Rules	16
		VC	9
		Tax measures	9
		Data security	6
		IPR	3
Policy targets		Hospitals	16
		IT Firms	11
		Doctors	3
Policy beneficiaries		Patients	17
Policy actors & agencies		The State Council	7
		General Office of the State Council	9
		Ministries and Commissions	6