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From concept to implementation: The development of the emerging cloud computing industry in China

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ABSTRACT

Cloud computing has emerged as an important ICT (information and communication technology) innovation that could potentially revolutionize the way computing resources are consumed and provided. In emerging economies, such innovation is regarded as the new way to provide information infrastructure that has the potential for further economic upgrading. In this paper, we investigate the initiation and growth process of the cloud computing industry in China, based on an in-depth case study. We discover that the development of China's cloud computing industry that emerged from an initial concept involves the co-evolution of technological and institutional infrastructure leading to a preliminary cloud ecosystem. We also find that such a process involves a wide range of different actors, from the government side to the business side, the interaction among which, in pursuing their own interests, drive the development of the cloud computing industry into being. Finally, situated in the institutional context of China, the government–business relationship is witnessed to have changed and evolved along development of such an emerging industry, demonstrating the important and unique roles of both sides in industrial (or even national) wide diffusion of the ICT innovation.

1. Introduction

In recent years, fast economic development in emerging countries has intensified further the considerable need for information technologies and services. These emerging countries leverage different strategies to link the domestic information and communication technology (ICT) industry development with the rest of the world. As pointed out by Avgerou (2008), one important means of understanding the future of ICT industry lies in emerging economies, which are playing an increasingly significant role within the global economy. Compared with developed countries, emerging economies have some unique characteristics, such as immature capital markets, lack of resources necessary for innovation development, poor legal framework to protect property rights, and weak pools of vertical intermediaries (Back, Parboteeah, & Nam, 2014; Mahmood & Mitchell, 2004). Furthermore, emerging economies present a more dynamic and uncertain environment where changes are constant and complicated, both in terms of government regulations and market settings (Back, Parboteeah, & Nam, 2014; Fang & Zou, 2010; Mahmood, Chung, & Mitchell, 2012). Finally, the contexts of emerging economies are quite

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different in terms of cultural background and political environment, which have profound implications for understanding certain ICT related phenomenon (Xiao, Califf, Sarker, & Sarker, 2013).

In this paper, we focus our attention on one of the emerging economies – China. The world has witnessed the tremendous economic growth of China in recent decades, which has been given impetus by a series of changes in various aspects of the social and regulative systems, since the "reform and openness" policy implemented in the late 1970s. Parallel with such economic growth, we have also seen the impressive development of the ICT industry in China, which has been one of the major forces to transform China into a "knowledge-based" society. In recent decades, the development of the ICT sector has been given highest priority by the Chinese government in an effort to modernize the country (Amiri, Campbell, & Ruan, 2013; Zhu, 2006). As Martinsons (2005) puts it, "more than any other country, China is being transformed by the application of IT, from a poor and isolated society to major force in the global economy." Such efforts have led to a series of revolutions in the ICT sector, including industry-level deregulation to decrease monopoly and introduce competition, internationalization and standardization (Gao & Lyytinen, 2000; Xia, 2012; Zhang & Cheng, 2011; Zhu, 2006). For instance, the gradual transformation of the telecommunication sector over the years resulted in controlled liberalization and limited competition (Gao & Lyytinen, 2000). This once again emphasizes the importance of contextualization in understanding technological progress in emerging economies (Li, Gao, & Mao, 2014).

In this study, we focus on the emerging cloud computing industry in China, examining the process of its evolution and investigating the role of various actors in driving such evolution. Cloud computing represents a convergence of two major trends in information technology, which are IT efficiency and business agility (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi 2011). Since 2007, the advent and spread of cloud computing, which represents a fundamental change in the way IT services are developed, deployed, scaled, updated, maintained and paid for, has been gradually changing the traditional ICT landscape in China. The market of China cloud computing services grew quickly and the overall cloud computing value chain is expected to grow to $122 billion by 2015 (Larson, 2013).

The focus on cloud computing follows the call by Xiao et al. (2013) for more studies to consider emerging technologies, as previous ICT-related research in the context of emerging economies mostly focused on the adoption of well-established technologies such as various information systems and the Internet. These types of technological innovations are evolving in parallel with more socio-technical uncertainties than well-established ones both in emerging and advanced economies, and the applicability and use of such technologies are somewhat incomplete and unstable (Morris, 2009; Rosenberg, 1994).

By exploring the process through which the cloud computing industry has developed, we aim to provide insights into the underlying mechanisms of the large-scale diffusion, deployment, and adoption process of emerging ICT innovations – cloud computing in this case – in China. To do so, a longitudinal study is conducted to investigate the evolution process of the cloud computing industry in China. Taking such a "bottom-up" approach to analyze the phenomenon will allow us to generate context-specific insights and understand how the particular social and political environment in China has influenced or shaped such a process (Walsham, 2001).

The rest of the paper is organized as follows: first, we discuss previous literature and present relevant theoretical background for our analysis. This is followed by a brief discussion of the methodology employed in this study, and our interpretation of the data with respect to the development of China's cloud computing industry. We discuss our findings and then offer our conclusions.

2. Cloud computing

Cloud computing is defined by the *National Institution of Standards and Technology* (NIST) as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service-provider interaction" (Owens, 2010). This new paradigm is regarded as an important solution for reducing IT investment costs, minimizing management effort, and improving business process (Armbrust et al., 2010).

According to NIST, cloud computing services are usually provided in three models: SaaS (software as a service),[1] PaaS (platform as a service),[2] and IaaS (infrastructure as a service)[3] (Owens, 2010). The cloud-based IT deployment model differs from traditional IT service models in several aspects. First and foremost, with minimal initial capital investment, it has significantly lowered the entry cost of IT deployment, especially for smaller firms (Marston et al., 2011). This is complemented by the "pay-as-you-go" payment mode, which essentially transformed IT resources as measured service or another type of utility (Yang & Tate, 2012). Secondly, cloud computing utilizes on-demand network access as a means to connect users to a shared pool of IT resources, meaning that the amount of IT resources that can be accessed by almost everyone is unlimited (Marston et al., 2011). Furthermore, the level of elasticity associated with cloud computing is much higher than traditional IT solutions, making it easy for the users to scale up and down the deployment (Yang & Tate, 2012).

[1] Software as a Service (SaaS) is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the Internet (Owens, 2010).

[2] Platform as a Service (PaaS) is a way to rent hardware, operating systems, storage and network capacity over the Internet (Owens, 2010).

[3] Infrastructure as a Service (IaaS) is a provision model in which an organization outsources the equipment used to support operations, including storage, hardware, servers, and networking components (Owens, 2010).