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Factors affecting Internet diffusion in China: A multivariate time series analysis

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ABSTRACT

China's Internet industry has boomed over the last two decades. Given that China is home to the world's largest Internet population, we may wonder what factors have caused this medium, which is strictly controlled in China, to grow and flourish. Based on previous studies and theories, a framework called EPIC (Economy-Policy-Infrastructure-Content) is proposed, and a multivariate time series analysis is performed to examine the relationships between Internet diffusion and these factors. The growth of Internet penetration was found to be mainly driven by Internet content and access cost; however, GDP per capita and telecommunications infrastructure were inconsequential. The implications of these findings are discussed.

1. Introduction

China first embraced the Internet in 1993, when a Chinese academic institute leased a satellite link to the U.S. Subsequently, China Telecom, China's telecommunications industry monopoly,[1] connected to the U.S. in 1994 and provided Internet access to the general public in limited areas. In the meantime, China Telecom initiated the construction of a nationwide Internet network called "ChinaNet", preparing for large-scale commercial service throughout the country. In January 1996, subsequent to the completion of the ChinaNet backbone, China Telecom began to offer nationwide Internet service (Loo, 2004). This represents the official beginning of China's Internet era.

The Chinese government has long hoped to take full advantage of the economic benefits of Internet development while remaining wary of the threat it poses to the regime (Kalathil and Boas, 2003). Due to these double motives, the Chinese government encourages the industrial use of the Internet on the one hand, while strictly monitoring private Internet use on the other (Foster and Goodman, 2000). Despite Internet controls, China's Internet population has been booming. Since June 2008, China has possessed the world's largest number of Internet users, a total of 649 million who account for 47.9% of China's total population as of January 2015. Nevertheless, the contributing factors to China's rapid Internet development have been understudied, although the factors affecting Internet diffusion in other regions have been extensively examined in the literature. Nonetheless, most studies use variables at the individual or organizational level [for a review, see Dewan and Riggins, 2005; Fichman, 1992; Kumar et al., 2007], relying on Rogers' (1983) theory of the diffusion of innovations, Rubin's (1994)

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[1] China Telecom became a commercial firm and was renamed the Directorate General of Telecommunications of China subordinate to the Ministry of Posts and Telecommunications (MPT) in 1995. It was taken under MPT's wing until 1998, when the Ministry of Information Industry (MII) was established by merging MPT with Ministry of Electronic Industry. In addition, although China Unicom was founded in 1994, it did not have independent International Internet bandwidth until 1999. See Xu and Pitt (2002, pp. 65–110) for the telecom reform during this period.

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theory of use and gratification [e.g., Ebersole, 2000], the model of the adoption of technology in households (MATH) [see Venkatesh and Brown, 2001; Brown and Venkatesh, 2005], the decomposed theory of planned behavior (Taylor and Todd, 1995a,b), Dutton et al.'s (1987) chain process model [e.g., Zhu and He, 2002], and Davis' (1989) technology acceptance model to investigate factors affecting people's intentions or behavior in adopting certain technologies, either at the workplace or in households (for a review, see Vishwanath and Chen, 2011, in addition to chapters 2 through 4 in the same work). Despite the importance of individual-level factors, they missed the variance driven by those effects due to the country-level factors and passage of time.

Relying on country-level data, the present study aims to discover the dynamics of China's Internet population, explicate what and how it has driven the Internet to diffuse, and determine why it has such a diffusion pattern by proposing a new integrative theoretical framework. Before formally introducing this framework, relevant studies (see Table 1 for a summary) are reviewed in the following section.

2. Literature review

2.1. Rogers' diffusion model

In the diffusion literature [for a review, see Meade and Islam, 2006], the diffusion of innovation has been defined as the process by which that innovation "is communicated through certain channels over time among the members of a social system" (Rogers, 1983, p. 5). Understandably, each innovation has unique characteristics, while mass media and interpersonal communication may facilitate the process. Rogers (1983) further classifies innovation adopters according to the timing of their adoption, i.e., innovators, early adopters, early majority, late majority, and laggards. Furthermore, adopters are influenced in the timing of adoption by the pressures of the social system; the pressure increases for later adopters with the rise of the number of previous adopters. Rogers (1983) underscores the importance of a system's structure over individual characteristics. As many later scholars [e.g., Glanz et al., 2002; Siegel, 1999] have noted, however, the characteristics and behaviors of adopters are also critical to the adoption. In spite of the elegance of Roger's theory, few empirical studies have examined the diffusion process. Bass (1969) hence argued that Rogers' theory[2] is largely literary and that it can therefore be difficult to separate the premises of the theory from the conclusions.

2.2. The Bass model

Sultan et al. (1990) summarized a general model of diffusion of innovation, which can be mathematically defined as follows:

$$\frac{\partial N(t)}{\partial t} = g(t)[N^* - N(t))],$$

where $\frac{\partial N(t)}{\partial t}$ is the rate of diffusion at time t, $N(t)$ is the cumulative number of adopters at time t, N^* is the total number of potential adopters in a population, and $g(t)$ is the adoption rate. Various functional forms of $g(t)$ result in models implying different diffusion processes (Sultan et al., 1990). For example, $g(t) = P$ implies an "external influence" model, with diffusion driven by mass media. The coefficient P is commonly called the "coefficient of innovation", and this model leads to a modified exponential diffusion curve. If $g(t)$ equals $Q \times F(t)$, the model is called an "internal influence" model, where later adopters learn from earlier adopters through word of mouth (Mahajan et al., 1990). Q is often called the "coefficient of imitation," and market growth follows a logistic curve related to the Gompertz function (Mahajan and Peterson, 1985). When $g(t) = P + Q[F(t)]$, it is a "mixed influence," or the so-called Bass model (Bass, 1969), in which both innovation (P) and imitation effects (Q) drive the innovation and market growth follows a generalized logistic curve (Sultan et al., 1990). The Bass paradigm is empirically based and this line of research has been prolific, whereas problems associated with the Bass paradigm (the Bass model and its extensions), e.g., restrictive model assumptions, abstract parameters, deterministic model specification and lack of validity and reliability, have been well noted [see Barnett, 2011; Mahajan and Muller, 1979; Mahajan et al., 1990]. Barnett (2011) proposed several models to correct the bias from which the Bass paradigm suffers. More importantly, however, this paradigm has also failed to consider the contemporaneous as well as the long run dynamic relationships among the factors concerned, which can be examined using time series modeling.

2.3. Country level factors

Aside from the literature based on the Bass paradigm, previous studies focusing on the diffusion of new technologies have examined factors at the aggregate level from economic (e.g., GDP per capita, Internet access cost), technological (e.g., network infrastructure), social (e.g., the literacy rate, openness), and political (e.g., government regulations) perspectives. Among them, Roycroft and Anantho (2003) hypothesized that factors influencing Internet access include economic development, international Internet bandwidth, domestic Internet hosts, ISP market structure, the cost of a local telephone call, and

[2] The first edition was published in 1962.