Is China's e-governance sustainable? Testing Solow IT productivity paradox in China's context

Shiyi Chen *, Zhen Xie

School of Economics, Fudan University, Guoquan Road 600, Shanghai, China

ABSTRACT

The role of technology in economic development and productivity change has always been an important issue, and it is also a debated topic that whether the ICT (information and communication technology) succeeded in promoting the productivity or not, thus proposing a famous notion of "Solow paradox". If the ICT could drive the productivity, we could state that the e-governance management of Chinese government is sustainable. By using the SBM and super SBM method, this article measures the regional efficiency and productivity in China, and then conducts an empirical investigation to examine whether the Solow paradox applies in China or not. We found that in recent two decades, the regional disparity of productivity has been widening accompanied with the bigger wealth gap between the east and the central, west regions. ICT may contribute to the widen discrepancy of productivity in part, and the west region has outperformed the central region in both catch up effect and frontier shift, which means that the productivity gap between central and west region has been narrowed. The empirical results also show that the ICT has a negative impact on the regional productivity in China, while for the east region, the negative impact can be basically ignored, while the central and the west region are negatively affected. This result may indicate that with a higher development level, the current period negative impact of ICT on productivity will be lessened and maybe converted to positive impact in the future.

1. Introduction

The interrelationships between the technology, productivity and growth have long been discussed along the history of human civilization. The importance of technological innovation cannot be overemphasized in today's world. It is the major determinant of long-run success or failure of organizations (Munir, 2003). The first industrial revolution symbolized by the steam and railroad in Britain during 1780–1860, and the

second industrial revolution accompanied with the massive utilization of electricity during 1899–1929, and it is said that with the popularization and dissemination of the information and communications technology in the United States between 1974 and 2000, this world has entered the third industrial revolution or the IT era. However, even in the United States, where the so-called third industrial revolution started, whether the ICT (information and communication technology) industry succeeded in stimulating the economy, serving as a new economic engine and promotes the productivity, has long been a compelling issue among researchers. Quoting the famous aphorism made by Robert Solow, "You see the computer age everywhere but in the productivity statistics."(Solow, 1987) In his words, Solow described a paradoxical situation in the context of the post-1973 productivity slowdown in the U.S...

* Corresponding author.
E-mail addresses: shiyichen@fudan.edu.cn (S. Chen),
zhenxie13@fudan.edu.cn (Z. Xie).

From 1948 to 1973, total-factor productivity increased to 1.9% per year in the U.S., and labor productivity grew at the rate of 2.9%; but after 1973, these productivity growth rates were 0.2% and 1.1%.[1] Solow raised an interesting question that why the rising investments and the volume of business in information related industries failed to alleviate the economy's declining growth, thus establishing the notion of a paradox. The following boom in productivity during the late 1990's brought back the question regarding the importance of IT. A lot of researchers gave their own versions of explanation, and Jack Triplett reviewed the most commonly used explanations for the Solow paradox, he divided them into seven categories, various theories have been proposed for a plausible explanation (Triplett, 1999). Among these theories, some argued that the information and computer industries only account for a relatively small fraction both in capital formation and the GDP as a whole. There also exists productivity measurement issue, such as heavy users of computer and information technology, like insurance and financial firms, their ICT-related output is seldom measured. While the time lag effect of the ICT is also a great concern, for the new technology could be visible in statistics only after a certain time period, just as the contributions of electricity diffusion to the actual gains in productivity could be seen only after a long time lag. After the new economy policy implemented in U.S. during the Clinton administration, the U.S. economy had seen a sound and stable growth and an increase of productivity in 1990s, but the following burst in IT bubble had also dragged the U.S. economy behind for a short period, therefore, some economists cautiously analyze the role of the GPT (general purpose technology), such as ICT, and are skeptical about the "magic bullet" attitude towards it. After the boom and burst of the IT bubble, the debate over the Solow paradox is still ongoing.

Based on the importance of this issue, numerous scholars have studied the IT paradox; David suggested the computer-dynamo analogy placing the recent experience of ICT in historical perspective (David, 1990). Krueger found that workers who use computers have higher earnings than workers who do not, suggesting that the adverse shifts in income and earnings distributions in the United States in recent years are connected with the growth of computers (Krueger, 1991). Romer, Brynjolfsson and Lichtenberg all argued that computers yield higher returns than investment in other capital (Romer, 1986; Brynjolfsson and Hitt, 2000; Lichtenberg, 1993). Stiroh shows just that at the industry level: more intensive computer usage raises industry labor productivity through input substitution, but it does not raise industry multifactor productivity (Stiroh, 1998). Oliner and Sichel estimate that the use of information technology and the production of computers accounted for about two-thirds of the 1 percentage point step-up in productivity growth between the first and second halves of 1990s, appears to be quite opposite to the IT paradox (Oliner and Sichel, 2000). Crafts suggests that the growth contribution of ICT in the past 25 years has exceeded that of steam and at least matched that of electricity over comparable periods and that the true paradox is why more should have been expected of ICT (Crafts, 2002). Until most recently, Gracht, Bañuls, Turoff, Skulimowskid and Gordone discussed the future role of ICT for foresight (von der Gracht et al., 2014). Moreover, Acemoglu, Autor, Dorn, Hanson and Price

provide certain evidence for the viewpoint that IT-induced technological changes are rapidly raising productivity while making workers redundant (Acemoglu et al., 2014), this paper also discussed the context of Solow Paradox.

As for China, after the reform and opening up policy were implemented in early 1980s, the following 30 years have seen enormous economic growth and efficiency promotion. However, the high input, over polluted and extensive mode for China's past development has also been criticized as unsound and unsustainable, while the ICT related industry and the derivative e-governance and e-business sectors have attracted our attention. As Choi and Gao stated "Recently, the Chinese economy has re-oriented its traditional export brick industry paradigm towards the evolving IT industry. China has been regarded a good learner and fast follower with respect to economic development of developed countries."(Choi and Gao, 2014). Following the development pattern of developed countries, what is the role of ICT in China's growth in the past decades? Whether the ICT and the emerging e-business and e-governance sectors serve as the engine of economic growth stimulates the total factor productivity growth, or the Solow paradox also applies in China, which is not only an interesting and fascinating topic that needs to be studied, but also an important issue for China's long term sustainable development and e-governance promotion.

In this paper, we first use the slacks-based measure in DEA to model China's technical efficiency over the period of 1980–2010, and then we compute the Malmquist index for the productivity growth and its decompositions. After that, we conduct an empirical analysis between the productivity growth and a series of explanatory variables including the ICT variable, which is our main concern, to testify whether there is Solow paradox in China or not.

The remainder of this paper is organized as follows. Section 2 presents the methodology for the estimation of China's regional productivity. In Section 3, we use the proposed approach to study the regional productivity and efficiency performance of China from 1980 to 2010, and then conduct an empirical analysis, aiming to test the IT Solow paradox in China's context. Finally, Section 4 concludes this study.

2. Methodology

In this section, we present the slacks-based measures for estimating the regional productivity growth in China. For recent studies in the measurement of productivity and efficiency, the DEA (data envelopment analysis) method has been widely used, this approach was first proposed by Farrell, and gained its popularity after Charnes and Cooper's work (Charnes et al., 1978), This method basically uses linear programming to form an efficient convex production frontier, the classic DEA include CCR (Charnes et al., 1978) and BCC (Banker et al., 1984) model. However, traditional DEA techniques have to determine whether the model is 'input-oriented' or 'output-oriented', and sometimes these assumptions may lack objectivity and flexibility in terms of reflecting the real input–output conditions for decision making units (DMUs). Additionally, the DMUs may not be fully efficient, in other words, there are input excesses and output shortfalls in our analysis, and the traditional DEA approach is not suitable enough. To address these methodological problems, we adopt a new DEA technique, slacks-based measures (SBM) and slacks-based measures of super efficiency (super-efficiency-

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[1] According to the statistical data of the U.S. Department of Labor (1998).