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# Has the medical reform improved the cost efficiency of Chinese hospitals?

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### ABSTRACT

After three decades of reform, the medical care system in China has experienced significant changes. However, the present research has not made a tentative evaluation of it to justify further reform. This paper analyses the cost efficiency of Chinese hospitals in 31 provinces during the period from 2002 to 2011 and adopts a Bayesian stochastic frontier model taking account of the identified heterogeneity according to the background of Chinese medical system reform, including the coastal location, 3A class hospital proportion, public subsidies and medical insurance reforms. It finds that the public subsidies and medical insurance reforms have improved the cost efficiency of Chinese hospitals, while the coastal location and 3A class hospital proportion have decreased the cost efficiency of Chinese hospitals. Therefore, these results imply that it will be beneficial for Chinese medical system to optimize the fiscal subsidies of public hospitals, encourage the entrance of private hospitals, improve the medical insurance coverage and set up the pre-triage system.

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## 1. Introduction

As the aging society is approaching for the most populated country in the world, the medical services and public health become a more important issue for China. Due to the miracle of economic development after the reform and open-up policy since 1978, the health status and outcome has already been improved in China. According to the World Development Indicators (WDI), life expectancy in China increased from 66.5 years in 1978 to 73.5 years in 2011, and infant mortality rate decreased from 5.3% to 1.3% during the same period (World Bank, 2013). However, the development of health care has long been lagging in

China (Eggleston, 2012; Li, Dong, & Liu, 2014). With the increasing demand on high-quality medical services, the medical care sector of China has still been blamed for the high fee and low accessibility of medical services after the market-orientated reform started from 1985 in this sector. It even has been regarded as a failure by some researchers in China (Eggleston, Ling, Qingyue, Lindelow, & Wagstaff, 2008; State Council DRC Research Project, 2005; Wagstaff, Yip, Lindelow, & Hsiao, 2009). At present, despite there is broad agreement on that the system needs reform, there is less agreement on the causes of the system's failure and the reforms necessary to improve it (Eggleston et al., 2008). Therefore, it is urgent and necessary to make an overall evaluation for the passing reform and search for solutions to present challenges.

Hospitals are the main medical institutions that deliver medical service to people in China. Therefore, the research on whether have the Chinese hospitals efficiently delivered enough medical service to people is one of the vitally

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important topics, which rarely has been paid attention to in the literature before (Eggleston et al., 2008; Ng, 2011). Meanwhile, monitoring the efficiency performance of Chinese hospitals can provide useful information for assessing the effectiveness of health policies and measures, and also as a way to achieve sustainable development in the most cost-effective way. Moreover, the Chinese hospitals were always the first priority in the medical reform, which have undergone series of reform and deregulation in last three decades. More details are present in the contextual setting part. Therefore, it is worthwhile to investigate the reform's effects on cost efficiency of Chinese hospitals.

For the important role that the hospitals have played in the medical sector, greater attention has been given to hospital efficiency and a growing number of studies have employed SFA to analyze cost-inefficiency in hospitals (Barros, de Menezes, & Vieira, 2013; Hollingsworth, 2008; Hsu, 2013; Hwang & Akdede, 2011; Jacobs, 2001). However, focus on efficiency of Chinese hospitals has not been well discussed until recent years. Eggleston et al. (2008) and Wagstaff, Yip, et al. (2009) have identified dozens of issues in the medical sector of China and concluded that Chinese hospitals were quite inefficient through literature review. Recently, several researches have analyzed the productive efficiency of Chinese hospitals in the post reform period with empirical method (Audibert, Mathonnat, Pelissier, Huang, & Ma, 2013; Hu, Qi, & Yang, 2012; Ng, 2011). According to these researches, the efficiency of Chinese hospitals varies from different provinces and different year. And the overall efficiency had slightly increased before 2008. However, all of them only use the non-parametric method, i.e. Data Envelopment Analysis (DEA) to analyze the efficiency of Chinese hospitals. However, this method cannot handle the noise and outliers in the data, which may strongly influence the shape of the frontier. It also suffers from the inability to test statistically for goodness of fit or significance of variables included in the functions. Meanwhile, the Stochastic Frontier Analysis (SFA) can overcome these limitations, despite being criticized for requiring a pre-defined functional form in the estimation of the frontier. And Coelli, Prasada Rao, and Battese (1998) argue that SFA is more powerful than DEA in panel data applications as it can be used to measure the efficiency and technical change over time. Therefore, we use the SFA to overcome the inherent drawbacks of DEA and make a robust check. To improve the methodological accuracies, recent studies have extended the use of the SFA methodology through introducing Bayesian stochastic frontier (SF) methodology (Assaf, Gillen, & Barros, 2012).<sup>2</sup> The Bayesian SF model incorporates informative priors and use prior knowledge to inform the current model. And small sample inference is carried out in the same way as if one had access to a large sample. The estimation is unbiased with respect to the sample size. However, quite a little literature on the

hospital efficiency uses the Bayesian stochastic frontier (SF) model, except Koop, Osiewalski, and Steel (1997). Following Tsionas (2002) and Assaf (2011), we adopt the Bayesian SF model with random coefficients in this paper. Comparing with traditional SFA and DEA, the Bayesian SF model with random coefficients that capture the unobserved heterogeneity and is more close to the reality, which will assure the efficiency is correctly estimated for separating technical inefficiency from technological differences across hospitals. And Pereira de Souza, Diallo, Castro Souza, and Baidya (2010) analyze the 60 Brazilian electricity distribution utilities with DEA and Bayesian SF and conclude that the DEA results are vulnerable to outlier while the results under Bayesian SF are more credible. Therefore, we are motivated to adopt Bayesian SF model to analyze the efficiency of Chinese hospitals.

Moreover, this paper aims to analyze all the hospitals across all the provinces of China, i.e. 5 autonomous regions, 4 municipalities and 22 normal provinces (it is called 31 provinces below for short). Although these provinces basically are in equal status in administration of government, there are plenty of differences among them, including different economic development, different strategies of local governments to develop the hospital sector and etc. (Jian, Sachs, & Warner, 1996; Xu et al., 2013). It also justifies using the Bayesian SF model with random coefficients in the research to allow for the heterogeneity and acquire more robust results or conclusion (Koop et al., 1997).

With respect to the medical care reform and its influences on the efficiency of Chinese hospitals, Eggleston et al. (2008) and Wagstaff, Yip, et al. (2009) have concluded that the Chinese hospital is quite inefficient after a comprehensive review of Chinese health care system. Hu et al. (2012) use the Tobit model to analyze the effects of some factors on the efficiency of Chinese hospitals, including the coastal location, public subsidies, the social medical insurance reform, the ratio of third-class hospitals to total hospitals and etc. And they conclude that the former two have insignificant effect on improving the technical efficiency, while the latter two significantly promote the technical efficiency. However, they use the traditional DEA to estimate the efficiency score in the first step. Moreover, McDonald (2009) argues that the use of Tobit regression was considered inappropriate in the second stage of DEA. This was because technical efficiency is fraction data and not generated by a censoring process. Therefore, it still needs more rigorous research to act as robust check.

Despite the majority of Chinese hospitals is non-profit, the medical care industry of China had undergone the market-orientated reform. The hospitals had been entitled more autonomy to personnel management and charging of medical service, which had meanwhile triggered the upsurge of medical service price. More details can be learned from the contextual setting part of this paper. Therefore, we focus on the cost efficiency of Chinese hospitals, which had been overlooked in the literature.

The remainder of this paper is organized as follows: section 2 briefly introduces the contextual setting of this paper. Then the methodology, variable selection and data

<sup>2</sup> It is different from the traditional estimation method, i.e. maximum likelihood (ML). Moreover, other Partial frontier approaches, like the order-m (Cazals, Florens, & Simar, 2002) and alpha-frontiers (Aragon, Daouia, & Thomas-Agnan, 2005), and StoNED-stochastic Non-Smooth Envelopment of Data (Kuosmanen, 2012) are also developed to cope with the limitations of DEA.

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