Intra-provincial fiscal decentralisation, relative wealth and healthcare efficiency: empirical evidence from China

Mr Shuo Sun
Cardiff Business School,
Cardiff University,
Cardiff,
CF10 3EU,
Wales, UK,
Tel: +44 (0)29 2087 4674,
Email: SunS7@cardiff.ac.uk

Professor Rhys Andrews
Cardiff Business School,
Cardiff University,
Cardiff,
CF10 3EU,
Wales, UK,
Tel: +44(0)29 2087 4198,
Email: AndrewsR4@cardiff.ac.uk

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Decentralising fiscal power to locally-elected governments is often regarded as beneficial for public service efficiency. However, questions remain about whether decentralising fiscal responsibilities work well in countries lacking political decentralization. In China, fiscal decentralisation has significantly strengthened the role of local governments in the provision of healthcare services, but evidence of its efficiency-effects is scarce. To cast light on this issue, this study investigates the relationship between intra-provincial fiscal decentralization and the productive efficiency of healthcare services in China. Analysis of panel data for 2006 to 2017 suggests that expenditure and revenue decentralisation from provincial to sub-provincial governments significantly improves healthcare efficiency. Further analysis suggests that the positive impact of healthcare expenditure decentralisation on healthcare efficiency may be stronger in wealthier provinces. These findings have important theoretical and practical implications.

Key words: fiscal decentralisation, healthcare efficiency, relative wealth, China, provincial government

1. Introduction

During the past few decades, political and administrative decentralisation has spread around the world, especially policies aimed at decentralising governments' spending and tax responsibilities (Rodríguez-Pose and Gill 2003). Practices of fiscal decentralisation (FD) first initiated in western countries with high levels of political decentralization, such as Italy, Spain, and Australia in the 1970s (Stegarescu 2005), have been promoted by international institutions such as the World Bank and IMF (World Bank 1999; OECD 2016). As a result, FD has spread to Latin America, Eastern Europe, and emerging countries such as China, India, and Indonesia, where political decentralization may be weaker or even absent. In many of those countries, FD in the healthcare sector is considered a central issue in their decentralisation reforms (Mosca, 2006). However, surprisingly little is known about whether such reforms promote healthcare efficiency, even though controlling healthcare costs is a key policy aim for many countries (Plümper and Neumayer 2013). More specifically, few studies investigate the relationship between FD and healthcare efficiency in China, and whether this relationship is influenced by relative wealth.

According to fiscal federalism theories, FD can motivate local governments to utilise the information advantages that they hold over higher levels of government to provide public services more efficiently (Oates 1999; Qian and Weingast 1997). Moreover, because local accountability is stronger in a decentralized system, stricter fiscal discipline and reduced rent-seeking behaviours are assumed (Seabright 1996). Critics of FD, however, claim it leads to diseconomies of scale and reduces productive

efficiency, due to the smaller quantity of localised demands, local governments' weaker economic and political bargaining power, and poorer control of public service externalities (Prud'homme 1995; Treisman 2007). Despite the vigour of these theoretical debates, comparatively little research evaluates the impact of FD on healthcare efficiency (e.g. Sow and Razafimahefa 2015; Arends 2017). Critically, this topic is rarely addressed in China, one of the most fiscally decentralised countries in the world (Boadway and Shah 2009), but one in which political decentralization is largely absent.

Since the 1980s, much of the responsibility for funding and providing public services in China has been transferred from the central government to provincial governments, which have considerable discretion over the intergovernmental fiscal arrangements within their own provinces[1] (Niu 2013). As a result, local governments now take a leading role in providing public services, such as healthcare and compulsory education, with more than 90% of expenditures on these services being undertaken by sub-national governments (National Bureau of Statistics 2019).

There is a growing literature examining the determinants and consequences of FD at the provincial and sub-provincial level in China. The determinants literature indicates that transfer dependency affects levels of expenditure decentralization within provinces (Wu and Wang 2013). Studies of the consequences of FD suggest it can increase inequality (Liu Y. et al. 2017) and impact other social and economic outcomes (e.g. Wu 2019; Wu et al. 2019), including public health (Jin and Sun, 2011; Uchimura and Jutting

[1] In the Chinese administrative system, sub-provincial governments refer to the local governments below the provincial level, including prefecture-level governments, county-level governments, and townships.

2009), and healthcare service quality (Huang et al. 2017). However, although Chinese language studies suggest that decentralisation of fiscal responsibilities from central to provincial governments improves healthcare efficiency (Lu and Tian 2013; Zhang 2013), little is known about the impact of intra-provincial FD on healthcare efficiency within provinces or whether wealth makes a difference. To generate knowledge on the FD-healthcare efficiency relationship in a context in which political decentralization is lacking, this study analyses intra-provincial FD, relative wealth and healthcare efficiency in China for the period 2006 to 2017.

2. Fiscal decentralization and healthcare efficiency

Based on the assumption that bringing government closer to the governed enhances accountability (Faguet 2014), decentralization of political, fiscal and administrative responsibilities from national to subnational governments has become popular across the globe (Schneider 2003) especially among developing countries (Rondinelli et al. 1983). Within the decentralization literature, increasing attention is being paid to FD, defined as "how much central governments cede fiscal impact to non-central government entities" (Schneider 2003, p.33). Importantly, FD often implies the transfer of considerable administrative powers to lower levels of government, but need not entail political decentralization. In China, the sheer extent of this combination of fiscal and administrative decentralization forms the basis for what is termed 'de facto federalism' in the country (Zheng 2007), which provides a distinctive counterpart to fiscal federalism perspectives that emphasize political decentralization.

First-generation theories of fiscal federalism claimed that decentralising fiscal power enhances public service efficiency because governments closer to local residents understand their preferences for public services and how those services can be most efficiently produced (Oates 1999). From the 1980s, second-generation theories of fiscal federalism asserted that FD promotes public service efficiency by strengthening accountability between local bureaucrats and citizens through two key mechanisms: local democracy and fiscal migration (Oates 2005). Healthcare efficiency is therefore expected to be an important consideration for local residents who can vote in local elections (Seabright 1996) or "vote with their feet" to move to another jurisdiction with better levels of efficiency (see Tiebout 1956). To avoid being voted out or confronting dwindling tax revenues from population decline, self-interested bureaucrats will seek to satisfy local demands in a cost-efficient way. As a result, FD can trigger "yardstick competition" through which local bureaucrats improve efficiency in response to citizens' interjurisdictional comparisons (Boadway and Tremblay 2012).

In systems with substantial political decentralization, citizens can pressurize local bureaucrats to meet the standards of rival jurisdictions by voting against incumbents (Boyne et al. 2009). In China, where political decentralization is absent (Cho 2009), residential sorting is likely to be an important source of information through which FD facilitates local bureaucrats' understanding of citizens' needs (De Mello 2011), especially since the relaxation of the household registration (Hukou) system (Li and Li 2015). Importantly, healthcare is a service for which Chinese citizens share similar preferences, and people's residential choices may reflect comparisons of the efficiency

of local healthcare services in “yardstick” jurisdictions, which, in turn, represent a signal to local party-state and healthcare leaders about their relative achievements in healthcare.

In addition to sorting mechanisms potentially informing Chinese LGs about the preferences of local people, local political leaders in China are subject to performance evaluations based on their administrative achievements that make them upwardly accountable to higher levels of government and the Communist Party of China (CPC) (Chien 2010; Ma 2016). As a result, local party-state and healthcare leaders may be motivated to respond to fiscal migration in ways that demonstrate their positive impact to their superiors. Within this setting, management systems that “reward or punish employees based on their performance” may be especially efficacious for the achievement of technical policy objectives that citizens can find difficult to observe, such as improvements in input/output (efficiency) ratios (Hong 2017, pp.123). Because their promotion is dependent on evaluations made by higher-level governments and they understand the criteria underpinning those evaluations, local party-state and healthcare leaders in China are likely to pursue an excellent ‘yardstick’ of public service performance (Caldeira 2012; Yu et al. 2016), especially better healthcare efficiency (Zhu 2017). The effects of this top-down yardstick competition on healthcare efficiency seem likely to be strongest when decentralization of healthcare expenditure is high because the connection between administrative responsibilities and achievements will be especially clear.

Despite longstanding debates about the connection between FD and public service

efficiency, surprisingly little empirical research addresses its relationship with healthcare efficiency specifically. Analyses of OECD countries suggest there is a positive relationship between FD and healthcare efficiency (Sow and Razafimahefa 2015; Arends, 2017), but in emerging economies and developing countries FD may have a negative relationship with healthcare efficiency, potentially due to corruption (Sow and Razafimahefa, 2015). In the Chinese context, Lu and Tian (2013) and Liu (2018) find a positive relationship between FD from the central to the provincial government and healthcare efficiency for 2003-2010 and 2009-2015 (though see Gong and Lu 2013), which may point to the efficacy of administrative decentralization in the absence of political decentralization. However, to date, research has not addressed the impact of decentralisation from provincial to sub-provincial governments on healthcare efficiency, even though responsibility for healthcare is widely decentralized within provinces (Shen et al. 2012). While it can be argued that residential sorting spurs local governments to cut public healthcare inputs to attract wealthy residents (Bardhan and Mookherjee 1999), FD in China seems more likely to promote increased healthcare outputs through top-down performance-based yardstick competition. For the above reasons, we propose:

H1: *Intra-provincial FD will be positively related to healthcare efficiency.*

Although there may be good reasons for anticipating that intra-provincial FD enhances healthcare efficiency, the efficiency-effects of FD may depend on contextual

factors and implementation. In particular, previous studies show that in less-wealthy countries, local governments often lack the capacity required to provide public services efficiently (Bello-Gomez, 2020; Tanzi, 1995). The relative wealth of a given territory, defined in terms of GDP as "the position of the economy of a [territory]… relative to that of other [territories] (van den Bergh 2009) shapes the resources that can be invested in state-building. This, in turn, determines the capacity of governments to co-ordinate public services efficiently and effectively (Bartley and Larbi 2006). Moreover, capacity plays a vital role in ensuring that national and provincial governments can successfully implement far-reaching administrative reforms, such as FD (Smoke 2001). As a result, variations in wealth seem likely to have capacity-based effects that influence the FD-healthcare efficiency relationship for Chinese provinces.

There are extensive debates about capacity in the public administration literature (Christensen and Gazley 2008). According to Ingraham and Donahue (2000, p. 294), government capacity constitutes its 'intrinsic ability to marshal, develop, direct, and control its human, physical and information capital to support the discharge of its policy directions'. High-capacity governments combine strong administrative capability, with well-developed co-production capacity within the communities that they serve (Gargan 1981). Nevertheless, a positive relationship between government capacity and public service performance cannot be taken for granted (Andrews et al., 2013). Instead, the most important contribution of capacity to the realisation of policy objectives may be to enable sub-national governments to better implement major reforms (Smoke 2001). In particular, high-capacity governments can potentially elicit efficiency gains by

generating more output from increased administrative and community inputs (Schwartz, 2003).

In China, like many other less-developed countries, sub-national government capacity is correlated with levels of relative wealth (Jaros, 2016). Due to higher expectations, more financial resources and more citizen engagement, governments serving wealthier areas with a higher GDP per capita are likely to have stronger managerial, organizational and community capacity, especially within the healthcare sector (Ding et al., 2018). Although local officials might pay less attention to efficiency where there is an abundance of public and private funds, the enhancement of government capacity associated with relative wealth could strengthen the connection between intra-provincial FD and healthcare efficiency. In other words, the government capacity in wealthier provinces enables them to realise even more of the benefits of FD for healthcare efficiency. For example, in prosperous areas, wealthy residents may be better at articulating local demands and in assisting public services in meeting them (Frenkiel 2021) – both features of high co-production capacity that are especially beneficial in fiscally decentralized settings. Similarly, bureaucrats serving in wealthier provinces may be able to draw on greater administrative resources and buy-in from citizens to amplify the complementary effects of fiscal migration and top-down performance-based yardstick competition present within the Chinese system. Hence, the second hypothesis is:

H2: *Relative wealth will strengthen the positive relationship between intra-provincial*

FD and healthcare efficiency.

3. Data and Method

3.1 Study context

China's governmental system is vertically divided into five tiers (Donaldson 2017). The central government is at the top of this hierarchy, and retains the authority to unilaterally define the functions and duties of subnational authorities, impose nationwide laws and abolish local regulations (Zheng 2007). 23 provinces, 5 provincial Autonomous Regions with a greater proportion of ethnic minorities, and 4 metropolitan cities (Beijing, Shanghai, Tianjin, and Chongqing) are located in the second tier. Beneath provincial governments, prefectural jurisdictions are at the third tier, most of which are prefecture-level cities (293 of 333). Finally, county-level jurisdictions and townships are located below prefecture-level governments at the 4^{th} and 5^{th} tiers.

In line with the pyramidic governmental system, the intergovernmental fiscal relationship in China follows a layer-cake model (Wang et al. 2012). Central government allocates responsibilities (e.g. public service provision), sets tax rates, and determines revenue-sharing policies with the provincial governments. Then, in each province, the provincial government determines the division of responsibilities and revenues with prefectural jurisdictions. Finally, the fiscal relationship between prefectural governments and counties and townships is determined by the prefectural government (Wang and Herd 2013). In terms of service responsibilities, China's central government carries out nationwide duties, such as national defence and macro-

economic planning, with local governments responsible for local economic development and public services with regional effects and preferences, including healthcare (Donaldson 2017). The dominant role sub-provincial governments play in healthcare spending is illustrated in Figure 1.

[Figure 1]

The units of analysis for this study are all 23 provinces and 4 of the 5 provincial Autonomous Regions across mainland China. Tibet is excluded from the study due to data unavailability. Data for estimating FD were collected for 2006 to 2017, which is firstly due to the issue of data accessibility: before 2006, fiscal transparency was low in China. Second, whereas FD prior to 2006 may have motivated local governments to increase productive expenditures (e.g. infrastructure) at the expense of people's welfare, the launch of the 2006 initiative of "building a harmonious socialist society" (Central Committee of the Chinese Communist Party, 2006) increased the attention paid to public service performance. In particular, the New Healthcare Reform (State Council of China 2009) led to the implementation of numerous local policies to improve healthcare efficiency (Liu G. et al., 2017). Thus, it is of timely importance to explore whether FD benefited healthcare efficiency over the period 2006 to 2017.

Expenditure and revenue statistics for measuring FD and other financial variables were collected from the Finance Yearbooks of China, China Statistical Yearbooks for Regional Economy and the provincial governments' yearly budgetary reports.

Healthcare indicators are from the Chinese Health Statistical Yearbooks, while data for the socio-economic control variables (e.g. GDP, population, and urbanisation) are from the China Population and Employment Statistics Yearbooks. All materials were compiled and published by official statistical institutions and are publicly accessible, ensuring consistency of data quality and reliability.

3.2 Dependent variables

Following previous studies (e.g. Arends 2017; Alonso and Andrews 2019), Data Envelopment Analysis (DEA) and super-efficiency DEA – a modified DEA model – are employed to measure the *productive efficiency* of healthcare services in Chinese provinces. Developed by Charnes, Cooper, and Rhodes (1978), DEA builds a frontier of relative efficiency which "envelops" multiple input/output vectors of selected comparable decision-making units (DMUs). For a DMU (in this case, a province), an efficiency score is then given by comparing its distance to the efficiency frontier for the set of DMUs (Bowlin 1998). The highest possible score is 1, signifying that a DMU has the most efficient combination of given inputs and outputs. For less efficient DMUs, scores from 0 to 1 (excluding 1) are given in terms of their distance to the efficient frontier (Afonso and Fernandes 2008).

Because local governments have greater control over inputs than outputs, we use an input-oriented BCC-DEA model with variable returns to scale (VRS) assumed (see Afonso and Fernandes 2008). To account for problems discriminating between DMUs at the efficiency frontier (i.e. with DEA efficiency scores equal to 1), the input-

orientated BCC-DEA model is then supplemented with the slack-based non-radial super-efficiency DEA model developed by Tone (2002). To ensure the efficiency scores from different years are comparable, BCC-DEA scores and super-efficiency DEA scores were calculated for all provinces between 2006 and 2017 (as per Alonso and Andrews 2019).

The DEA literature emphasizes the importance of combining multiple input and output indicators to obtain robust efficiency scores (Ding et al. 2018; Arends 2017). Following the input-output-outcomes model identified by Boyne (2002), three indicators of resource inputs and four indicators measuring healthcare outputs are selected. The input indicators for each province are: i) the number of public medical institutions[2]; ii) the number of professional staff in medical institutions; and, iii) the number of patient beds in medical institutions. The five output indicators are: i) the number of operations performed a year; ii) the number of inpatients treated per year; iii) the number of outpatients treated per year; and, iv) the number of health checks performed a year. It is important to note here that improved productive efficiency can potentially be achieved by increasing outputs while holding inputs constant or by reducing the healthcare inputs required to keep outputs at the same level.

Our approach meets the requirement that the sum of input and output indicators should not be larger than the number of DMUs divided by two (Golany and Roll 1989). The trends in the BCC-DEA efficiency scores and super-efficiency DEA scores for the twenty-seven provinces analysed in the study are presented in Figure 2 (scores for

[2] Government-funded medical institutions, including general hospitals, public health institutions (e.g. specialised hospitals), community healthcare centres and township hospitals/clinics.

individual provinces are available on request), where an upward trajectory is observed.

[Figure 2]

3.3 Independent variables

Three measures of *fiscal decentralisation* are selected. First, following previous studies (e.g. Cantarero and Pascual 2008; Arends 2017), we measure healthcare expenditure decentralisation (*EDH*) as the ratio of the healthcare expenditure of sub-provincial governments in a province to the total healthcare expenditure of that province. This indicator reflects the partial decentralisation of public service responsibilities from the provincial government. Second, following Uchimura and Jutting (2009), to capture the comprehensive decentralisation of public service responsibilities in a province, we analyze total expenditure decentralisation (*EDT*), which measures the total fiscal expenditure of sub-provincial governments in a province as a ratio of the province's total fiscal expenditure. Finally, we measure revenue decentralisation (*RD*) using the ratio of sub-provincial governments' own revenue to the total revenue of the province (i.e. sub-provincial governments' own revenue plus provincial governments' own revenue). *RD* represents the extent to which local revenues are an important source of resources to sub-provincial governments (Wang and Herd 2013). In line with Jiménez-Rubio (2011), we only consider revenues from local taxes, sharing taxes, and local non-tax revenues; transfer payment revenues are excluded. Trends in FD are shown in Figure 3.

[Figure 3]

Following previous studies (e.g. Adam et al. 2014; Arends 2017), we measure *relative wealth* as each province's per capita GDP (in a natural logarithm form). As mentioned above, it is expected that this variable strengthens the positive relationship between FD and efficiency.

3.4 Control variables

Following the public service efficiency literature, we include a series of control variables in our regression models, starting with five demographic variables: first, population size (in a natural logarithm form), because it proxies for demand and a larger public sector with stronger purchasing power, which may enhance efficiency (Adam et al. 2014). Then, to account for scale economies and urban advantages in accessing healthcare services (Rayp and De Sijpe, 2007), population density (population per square km) and the ratio of urban population to a province's total population.

The fourth demographic variable is the education level of the population, measured as the percentage of inhabitants holding higher education certificates (i.e. bachelor, master, or PhD degrees, see Afonso and Fernandes 2008). In China, well-educated citizens have a healthier lifestyle, which reduces medical demands and improves utilisation of healthcare resources (Ding et al. 2018).

The proportion of older people in the population is the fifth demographic variable, measured as the percentage of inhabitants over 65 years old. A large elderly population

may burden healthcare providers or prompt governments to achieve productive efficiency gains (Liu et al. 2020).

After the above demographic variables, we control the unemployment rate, which captures socio-economic disadvantage and is a proxy for citizens' health status (Mosca 2006). High unemployment may increase healthcare demand, reducing healthcare organisations' capacity to provide cost-efficient services (Geys and Moesen 2009), or may push local authorities to improve efficiency (Arends 2017).

Two fiscal variables are controlled: healthcare expenditure per capita (in a natural logarithm form) within a province; and, fiscal solvency. *Healthcare expenditure* per capita proxies for government healthcare inputs as well as the size of the healthcare sector (Hauner and Kyobe 2010). A larger healthcare sector and greater fiscal inputs might generate scale economies by reducing fixed costs, leading to better healthcare efficiency (Evans et al. 2001). The *fiscal solvency* of the sub-provincial governments in a province is measured as the ratio of all sub-provincial governments' own revenues to their expenditures. The remaining revenue-expenditure gap is covered by funding from the provincial government and elsewhere (e.g. central government). Fiscal solvency could be positively related to efficiency because local taxpayers have more motivation to monitor the financial management of governments that raise more money locally (Balaguer-Coll et al. 2010).

Finally, sub-provincial government fragmentation is controlled by measuring the number of prefectural governments in a province per 100,000 population (see Hendrick et al. 2011). Tiebout's residential sorting theory suggests that local residents within

fragmented regions have more opportunities to vote with their feet, which increases inter-jurisdictional competition, potentially improving healthcare efficiency (Tiebout 1956).

Descriptive statistics for all the variables used in the statistical modelling are shown in Table 1. The mean and median values of the BCC-DEA scores are higher than those for super-efficiency DEA. Additionally, the standard deviation values show that there is less variation in the BCC-DEA efficiency scores than the super-efficiency DEA scores. The mean and median EDH, EDT, and RD values all point to a high level of FD, with the small standard deviation values suggesting levels of intra-provincial FD are similar across China. By contrast, there is huge variation in relative wealth, with GDP per capita in the wealthiest province being almost twenty times that in the poorest province.

[Table 1]

Correlations between all the variables are shown in Table 2. The correlation between the two efficiency measures is high (coefficient = 0.85), highlighting that they capture a common construct. Consistent with the arguments developed here, most of the correlations between FD and the efficiency indicators are positive and statistically significant.

[Table 2]

3.5 Estimation strategy

Fixed effects estimation is employed for the analysis, as it controls for omitted time-invariant variables that vary across individual units (Wooldridge 2010). Thus, the following baseline model is formulated:

$$DEA_{it} = \gamma_1 FD_{it} + \gamma_2 lngdppc_{it} + \gamma_3 lnPop_{it} + \gamma_4 Popden_{it} + \gamma_5 Urban_{it} + \gamma_6 Edu_{it} + \gamma_7 Elder_{it} + \gamma_8 Unemp_{it} + \gamma_9 lnHexppc_{it} + \gamma_{10} Solvency_{it} + \gamma_{11} Fragmentation_{it} + \gamma_{12} Time_{it} + \mu_i + \varepsilon_{it}$$

where DEA_{it} refers to efficiency for province *i* in year *t*, FD_{it} is the level of intra-provincial fiscal decentralisation, $lngdppc_{it}$ per capita GDP (logged), $lnpop_{it}$ the number of residents in a province (logged), $Popden_{it}$ population density, $Urban_{it}$ the percentage of urban residents in a province, Edu_{it} the percentage of residents holding bachelor degrees or above, $Elder_{it}$ the percentage of residents older than 65, $Unemp_{it}$ the unemployment rate, $lnHexppc_{it}$ per capita healthcare expenditure (logged), $Solvency_{it}$ sub-provincial governments' fiscal revenue divided by their expenditure, $Fragmentation_{it}$ the number of prefectural jurisdictions in a province, $Time$ a year trend dummy accounting for the upward trend in our dependent variable i.e. healthcare service efficiency, which may be attributable to technological progress (see Baltagi and Moscone 2010). Finally, μ_i refers to time-invariant province-specific effects, and ε_{it} is the disturbance term. To analyse the combined effects of FD and relative wealth on healthcare efficiency, the interaction term $\gamma_1 FD_{it} * \gamma_2 lngdppc_{it}$ is added to the

baseline model. Robust standard errors are clustered at the provincial level to avoid heteroskedasticity. Similar results to those for the BCC-DEA approach are observed when using a random-effects Tobit estimator, and for the super-efficiency approach when using a random effects Generalized Least Squares estimator (available on request).

4. Results

The statistical results are presented in Tables 3 and 4 below. The average VIF values for all the models are smaller than 10, suggesting that multicollinearity is not a serious issue.

4.1 FD and healthcare efficiency

Estimation of the individual effects of the three FD indicators (*EDH, EDT, RD*) and other variables on healthcare efficiency are shown in Table 3, in which columns (1) to (3) report findings from the BCC-DEA models and columns (4) to (6) those for the super-efficiency DEA models. For all six models, results of the Hausman test (p-values of the Chi-square statistics) indicate that fixed-effects estimates are superior to random-effects estimates.

[Table 3]

As shown in columns (1) to (3), all three FD indicators have a statistically significant positive relationship with the BCC-DEA efficiency scores, which is in line with our first hypothesis, as well as previous studies of FD and public service efficiency more generally (e.g. Barankay and Lockwood 2007; Sow and Razafimahefa 2015;

Alonso and Andrews 2019). Interpretation of the substantive effects of the coefficients indicates that a 0.1 unit increase of *EDH*, *EDT*, and *RD*, (which are scaled between 0 and 1) will respectively lead to efficiency gains of 0.0504, 0.0368, and 0.0564 units. In practice, this can be achieved by improving healthcare outputs for a given level of inputs or by producing the same outputs with fewer inputs (Bowlin 1998). To illustrate these substantive effects, Figure 4 depicts the distribution of the BCC-DEA values grouped in intervals of 0.05. The figure highlights, that for a province with a high-middle BCC-DEA score (e.g. 0.721), the efficiency improvement from a 0.1-unit increase of FD will potentially result in performance better than several of its counterparts.

[Figure 4 here]

For the three models with super-efficiency DEA scores, the coefficients for *EDH*, *EDT*, and *RD* are all positive, and are statistically significant for *EDH* and *RD* at the 1% significance level. Here, a 0.1 unit increase in *EDH* and *RD* is associated with a growth in efficiency of 0.0516 and 0.0601 units, respectively – effects that are consistent with, but slightly larger than those for the BCC-DEA approach. Again, to illustrate these substantive effects, Figure 5 depicts the distribution of the super-efficiency DEA scores .

[Figure 5 here]

The above findings provide empirical evidence that allocating greater financial

responsibilities to sub-provincial healthcare institutions can potentially improve healthcare efficiency. This supports theoretical arguments about the ways in which greater accountability to people's demands and central government's policy agenda under a decentralised setting is expected to encourage local bureaucrats to win yardstick competitions through healthcare efficiency improvements (Hipgrave et al. 2012).

Interestingly, a statistically significant positive relationship between EDT (decentralisation of total expenditures) and healthcare efficiency is only confirmed for the conventional DEA model at the 10% significance level. Moreover, the values of the two EDT coefficients are much smaller than those for EDH and RD. The aggregated level of FD for all sub-provincial governments (EDT) may be less likely to have a positive impact on healthcare efficiency than the level of FD for the healthcare sector because comprehensive FD does not necessarily translate into correspondingly high levels of EDH. Provinces may prefer to prioritize decentralizing expenditure in the areas of education or infrastructure than health, which would lead to a higher value of EDT, but not result in such great advances in healthcare efficiency.

At the same time, high levels of RD may be especially important for healthcare efficiency because sub-provincial governments that raise more of their own revenue may feel less constrained to compete in the GDP tournament encouraged by the Chinese central government. In line with the arguments of key federalism studies (Brennan and Buchanan 1980; Oates 1972) and Chinese-based research (e.g. Guo and Jia 2010), self-financing sub-provincial governments may also have more freedom to compete for citizens by providing more efficient healthcare services. Importantly, this finding

indicates the potential benefits for healthcare of decentralizing revenue generation along with healthcare expenditure responsibilities (Sow and Razafimahefa 2015).

Despite the strength of the support for our first hypothesis, it is nonetheless possible that higher levels of healthcare efficiency may lead to increased FD. To detect whether reverse causality might be influencing our results, we carried out a series of Granger tests. These tests revealed that our measures of healthcare efficiency were not responsible for "Granger-causing" levels of EDH, EDT or RD (available on request).

Turning to the other variables in the model, we can see that the coefficient for *lngdppc* is negative, but is not statistically significant in either the BCC-DEA or the super-efficiency DEA models. Regarding other control variables, first, the coefficient for population (log) is negative, but is only statistically significant in the *EDH* model with efficiencies measured by BCC-DEA, indicating that a larger population may make little difference to provincial healthcare efficiency in China. Second, the coefficient for the percentage of citizens older than 65 (*Elderly*) is negative and statistically significant in the super-efficiency models (albeit at $p.<0.1$). This suggests that a higher percentage of senior residents increases the demand for healthcare services (Guo et al. 2017) in ways that make it more difficult to provide cost-efficient services. Third, as shown in column (1), (2) and column (4), (5), *fiscal solvency* has a statistically significant positive relationship with healthcare efficiency in the four baseline models with expenditure decentralisation indicators (*EDH* and *EDT*). This result implies that in provinces where local governments use more of their own revenue to support services, those revenues are used more efficiently. The coefficients for the other control variables

are not statistically significant in any of the models, although most of them have the expected signs (i.e. *Population density, Urbanisation, Education, Unemployment,* and *lnHexppc*). Finally, fragmentation has negative coefficients, but is insignificant in all six baseline models. The absence of competitive effects here is possibly because the scale of intra-provincial immigration is smaller than that between provincial jurisdictions (Zhao et al. 2018).

4.2 Combined effects of FD and relative wealth on healthcare efficiency

To explore the impact of relative wealth on the FD-efficiency relationship, six multiplicative models are applied, in which three interaction terms (*EDH*lngdppc*, *EDT*lngdppc*, and *RD*lngdppc*, all represented by FD*GDP) are separately included. As interaction terms may cause serious multicollinearity problems (Smith and Sasaki 1979), when estimating our multiplicative models we follow the advice of Balli and Sørensen (2013, p. 589) to centre the data of the key variables (i.e. the FD indicators and *lngdppc*) for each province by their means.

[Table 4]

As shown in Table 4, the coefficients for *EDH*lngdppc* and *RD* lngdppc* are positive, while those for *EDT* lngdppc* are negative. However, only the coefficients for *EDH*lngdppc* are statistically significant, suggesting that an increase of per capita GDP can potentially strengthen the favourable impact of *EDH* on healthcare efficiency. To

properly investigate this finding, figures 6 and 7 show the marginal effects of EDH contingent on per capita GDP.

[Figure 6 here]

[Figure 7 here]

GDP's positive marginal effects are illustrated by the solid upward line, with the histograms representing the distribution of *lngdppc*. The dotted curves above and below the solid line represent the 90% confidence intervals, which when located above or below the zero line, signify that the marginal effect of GDP on the EDH-efficiency relationship is statistically significant (Brambor et al. 2006). Figures 6 and 7 show that the marginal effect of *EDH* on efficiency is statistically significant for all values of *lngdppc*, highlighting that the benefits of healthcare expenditure decentralisation for healthcare efficiency may be somewhat greater in wealthier than less affluent provinces. This finding corroborates our hypothesis that the greater wealth of the government and residents in more affluent areas enhances the impact of a decentralised healthcare sector.

By contrast, the efficiency benefits of total expenditure decentralisation (*EDT*) and revenue decentralisation (*RD*) when combined with relative wealth cannot be confirmed. *EDT* reflects the aggregated level of decentralisation for all sub-provincial government units, which may mean that those units focus on duties other than healthcare (Uchimura and Jütting 2009). Accordingly, although an increase in relative wealth might support better performance in other areas in the presence of

comprehensive decentralisation, there is no evidence to suggest such progress has an indirect impact on the efficiency of the healthcare sector. Regarding RD, as relative wealth grows, financial constraints might be alleviated and greater resources potentially generated by both the provincial and sub-provincial governments. In this situation, however, RD may also be accompanied by the soft budget constraint, leading to corruption and the waste of public funding (Tanzi 1995; Qian and Roland 1996; Fisman and Gatti 2000). Hence, increased wealth appears to have no influence on the *RD*-healthcare efficiency relationship.

Consistent with the initial models focusing on FD's individual effects, *EDH*, *EDT*, and *RD* are still statistically significant in the BCC-DEA models, while the coefficient for *EDT* becomes insignificant in the super-efficiency models, which, along with the findings for *EDH***lngdppc*, point towards the limited impact of total expenditure decentralisation on healthcare efficiency.

5. Conclusion

This paper finds that intra-provincial FD is positively related to healthcare efficiency in China, especially when decentralization of healthcare expenditures and decentralization of revenues is more extensive. Moreover, there is some evidence to suggest that the benefits of healthcare expenditure decentralization for healthcare efficiency may be greater for more wealthy Chinese provinces. These findings have important implications.

Theories and empirical studies of fiscal federalism should pay greater attention to

distinguishing between the potential benefits of comprehensive versus partial decentralization initiatives, especially in settings where political decentralization and local elections are absent. In such circumstances, decentralization of expenditure responsibilities for specific public services may be more conducive to efficiency gains in those services because a central (or provincial) government can more effectively monitor the implementation of technical policy goals when the institutional arrangements for their achievement are clearly delineated (Hong 2017). The efficiency-enhancing effects of targeted FD may be stronger for wealthier regions because they have the capacity needed to develop management systems that can motivate local bureaucrats to improve services. Indeed, centrally-driven processes of 'top-down' yardstick competition may be more important in driving the FD-efficiency relationship in China than the locally-driven fiscal migration associated with Tiebout's vote-with-your feet arguments; something that is also implied by the absence of a relationship between sub-provincial fragmentation and healthcare efficiency.

Although few of our control variables appear to influence healthcare efficiency, it is possible that the results are attributable to some other variable not included in the models. In particular, levels of inequality are sometimes thought to be linked to FD and public service efficiency (Kyriacou et al. 2017). To test whether inequality issues might influence our results we included a provincial-level Gini index produced by social researchers in our models, finding that this seems not to matter (available on request). However, because official provincial-level data to construct a Gini index are not publicly available, we cannot be confident that the index we use is accurate.

Scholars investigating the relative merits of FD versus fiscal centralization as approaches to administrative reform in China should therefore address the issues of efficiency gaps, inequality and equalisation schemes.

Undoubtedly, there are limitations of this study that should be addressed in subsequent studies. First, although the measures of FD used here (EDH, EDT, and RD) reflect, in theory, the overall distribution of expenditure and revenue authority within a province, in practice, they may not perfectly match the allocation of expenditure and revenue-raising power. Future research could therefore seek to develop better indicators to measure the vertical decentralisation of fiscal authority in China in a more precise way. Second, the efficiency of other local public services in China, such as education, infrastructure development and environmental protection, should be investigated in future studies. Moreover, the impact of FD between the central government and provinces, and between city-level governments and counties on public service efficiency should be investigated, so as to clarify to which tier and to what degree FD can generate the greatest contributions to the efficiency of different public services. Finally, FD may be particularly efficient in the Chinese context because of the sheer size of the population and the area of the provinces in China, which makes administrative decentralization a necessity for any central authority seeking to co-ordinate public service provision within its borders. Further research on FD, relative wealth and healthcare efficiency based on international comparisons between countries with large and small sub-provincial units and more or less potential for political decentralization, is therefore required.

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Table 1. Descriptive statistics

	Min	Max	Mean	Median	SD
Dependent variables					
DEA score	0.321	1.000	0.833	0.873	0.147
SDEA score	0.263	1.068	0.762	0.785	0.172
Independent variables					
EDH	0.603	0.982	0.887	0.907	0.066
EDT	0.518	0.935	0.798	0.812	0.080
RD	0.552	0.974	0.802	0.790	0.094
GDP per capita	5750	107150	35559.865	33554	18141.480
Control variables					
Population	5480000	111690000	48245224	43895000	26907798
Population density	7.866	753.189	273.988	236.953	195.269
Urbanisation (%)	27.453	69.854	49.838	49.700	9.283
Education (%)	2.718	19.825	9.445	9.041	3.458
% Over 65	5.473	14.076	9.278	9.111	1.726
Unemployment rate	1.700	5.100	3.536	3.600	0.558
Health spending per capita	47.669	2093.813	547.807	506.014	349.495
Fiscal solvency	15.765	115.934	48.162	43.931	18.009
Fragmentation	0.015	0.146	0.035	0.026	0.026

N = 324

Table 2. Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. DEA	1															
2. SDEA	0.9622*	1														
3. EDH	0.2194*	0.2303*	1													
4. EDT	0.2172*	0.1986*	0.7470*	1												
5. RD	0.2520*	0.2656*	0.5049*	0.6324*	1											
6. GDP per capita (log)	0.5037*	0.5197*	0.4896*	0.5514*	0.4350*	1										
7. Population (log)	-0.1046*	-0.0919	0.6712*	0.7164*	0.5078*	0.1605*	1									
8. Population density	0.1118*	0.1278*	0.3636*	0.6235*	0.5718*	0.3479*	0.6675*	1								
9. Urbanisation	0.3299*	0.3663*	0.2931*	0.4717*	0.3365*	0.8585*	0.1132*	0.3666*	1							
10. Education	0.4108*	0.4308*	0.3240*	0.2743*	0.2755*	0.7905*	-0.0845	0.0311	0.7113*	1						
11. Elderly	0.00970	-0.0517	0.4859*	0.5448*	0.3692*	0.3330*	0.5397*	0.3990*	0.2792*	0.2817*	1					
12. Unemployment	-0.3454*	-0.3394*	-0.2290*	-0.2326*	-0.1330*	-0.4014*	-0.0551	-0.3304*	-0.2995*	-0.2781*	0.0743	1				
13. Healthcare spending per capita (log)	0.6133*	0.5984*	0.3661*	0.2130*	0.1108*	0.7267*	-0.1920*	-0.1192*	0.4396*	0.6885*	0.1240*	-0.3974*	1			
14. Fiscal solvency	0.0625	0.0773	0.2515*	0.5135*	0.6150*	0.4303*	0.5173*	0.7675*	0.5376*	0.1780*	0.2841*	-0.2511*	-0.1731*	1		
15. Fragmentation	0.1458*	0.1360*	-0.5720*	-0.6302*	-0.3779*	-0.1364*	-0.7947*	-0.5972*	-0.1627*	0.0746	-0.4939*	0.0827	-0.5198*	0.2056*	1	

* p>.10.

Table 3. Fiscal Decentralisation and Healthcare Efficiency

	BCC-DEA			Super-efficiency DEA		
EDH	0.504***			0.516***		
	(0.160)			(0.147)		
EDT		0.368*			0.317	
		(0.192)			(0.215)	
RD			0.564***			0.601***
			(0.160)			(0.144)
GDP per capita (ln)	-0.117	-0.085	-0.029	-0.111	-0.074	-0.021
	(0.092)	(0.088)	(0.086)	(0.106)	(0.102)	(0.099)
Population (ln)	-1.398	-1.540*	-0.957	-1.833	-1.965	-1.362
	(0.879)	(0.889)	(0.819)	(1.190)	(1.199)	(1.134)
Population density	-0.001	-0.000	-0.001	-0.000	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
Urbanisation	-0.000	-0.001	-0.001	0.001	0.001	0.000
	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)
Education	0.005	0.006	0.006	0.005	0.005	0.006
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
Elderly	-0.013	-0.012	-0.010	-0.027*	-0.026*	-0.024*
	(0.009)	(0.009)	(0.009)	(0.014)	(0.015)	(0.014)
Unemployment	0.011	0.002	0.012	0.015	0.005	0.015
	(0.021)	(0.021)	(0.020)	(0.026)	(0.026)	(0.024)
Hexppc (ln)	0.061	0.061	0.035	0.040	0.040	0.013
	(0.043)	(0.041)	(0.037)	(0.044)	(0.043)	(0.037)
Fiscal solvency	0.003***	0.003***	0.001	0.003***	0.003***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fragmentation	-3.208	-3.557	-2.887	-2.447	-2.787	-2.096
	(5.025)	(5.369)	(4.982)	(7.323)	(7.679)	(7.280)
Time	0.029**	0.027**	0.024**	0.040**	0.038**	0.035**
	(0.011)	(0.012)	(0.011)	(0.015)	(0.015)	(0.015)
Constant	25.652	27.900*	17.457	33.041	35.138	24.283
	(15.153)	(15.296)	(13.987)	(20.507)	(20.615)	(19.405)
F-test	29.19	28.94	41.68	33.64	31.97	42.31
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

N=312. Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4. Fiscal Decentralisation, Relative Wealth and Healthcare Efficiency

	BCC-DEA efficiencies			Super-efficiency DEA		
FD*GDP	0.530*	-0.214	0.087	0.594*	-0.113	0.334
	(0.267)	(0.270)	(0.255)	(0.299)	(0.390)	(0.330)
EDH	0.558***			0.577***		
	(0.154)			(0.152)		
EDT		0.336*			0.300	
		(0.181)			(0.202)	
RD			0.570***			0.623***
			(0.159)			(0.147)
GDP per capita (ln)	-0.108	-0.091	-0.030	-0.102	-0.077	-0.023
	(0.092)	(0.088)	(0.087)	(0.105)	(0.101)	(0.099)
Population (ln)	-1.394	-1.540*	-0.959	-1.829	-1.966	-1.368
	(0.863)	(0.896)	(0.818)	(1.172)	(1.204)	(1.131)
Population density	-0.001	-0.000	-0.001	-0.000	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Urbanisation	-0.001	-0.000	-0.001	0.000	0.001	-0.000
	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)
Education	0.005	0.006	0.006	0.005	0.005	0.006
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
Elderly	-0.013	-0.012	-0.010	-0.028*	-0.026*	-0.025*
	(0.009)	(0.009)	(0.009)	(0.014)	(0.015)	(0.014)
Unemployment	0.014	0.002	0.012	0.018	0.005	0.016
	(0.021)	(0.021)	(0.020)	(0.027)	(0.027)	(0.025)
Hexppc (ln)	0.085*	0.052	0.038	0.067	0.036	0.022
	(0.046)	(0.043)	(0.039)	(0.049)	(0.047)	(0.039)
Fiscal solvency	0.003***	0.003***	0.001	0.003***	0.003***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fragmentation	-3.466	-3.431	-2.901	-2.737	-2.721	-2.151
	(4.815)	(5.351)	(4.971)	(7.098)	(7.604)	(7.242)
Time	0.025**	0.030**	0.024**	0.036**	0.039**	0.034**
	(0.012)	(0.013)	(0.011)	(0.015)	(0.016)	(0.015)
Constant	25.416	28.002*	17.484	32.775	35.192	24.387
	(14.907)	(15.401)	(13.969)	(20.207)	(20.661)	(19.349)
F-test	29.23	33.92	41.38	31.89	32.43	42.32
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

N=312. Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 1. Sub-provincial share (%) of provincial healthcare expenditure, total expenditure, and revenues (2006 to 2017)

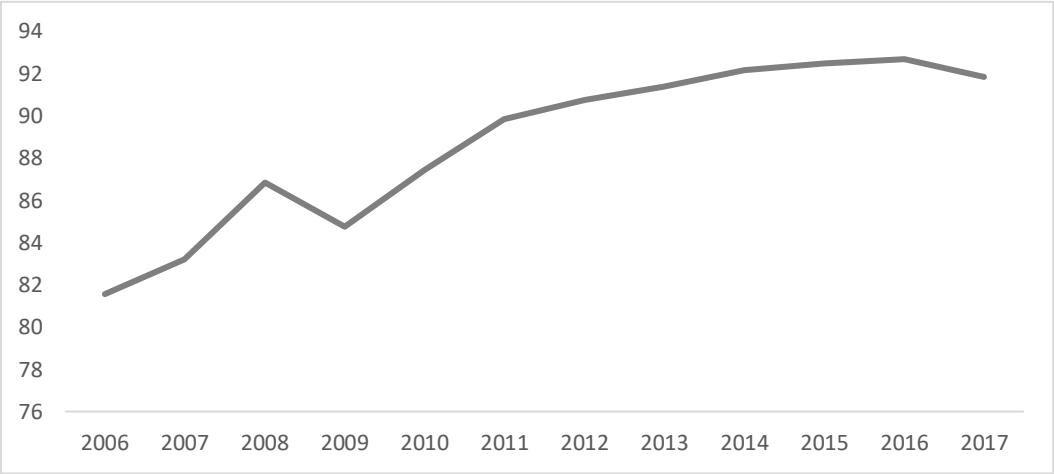

Figure 2. Average efficiency scores (2006 to 2017)

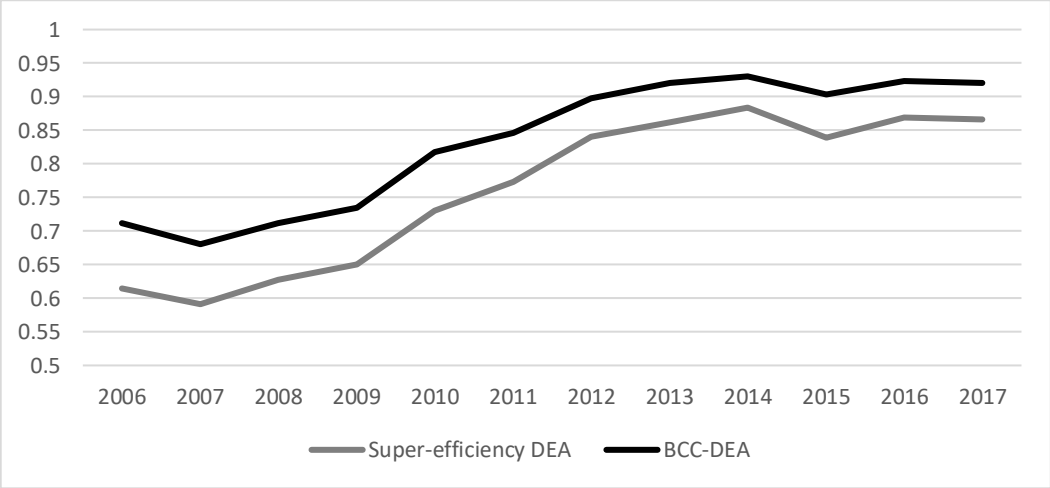

Figure 3. Average FD trend (2006-2017)

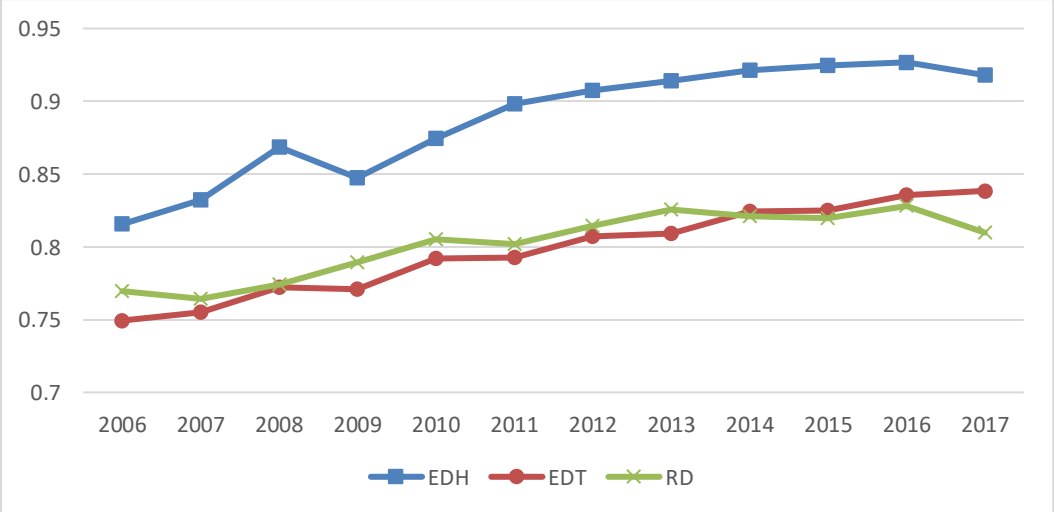

Figure 4. Distribution of BCC-DEA scores

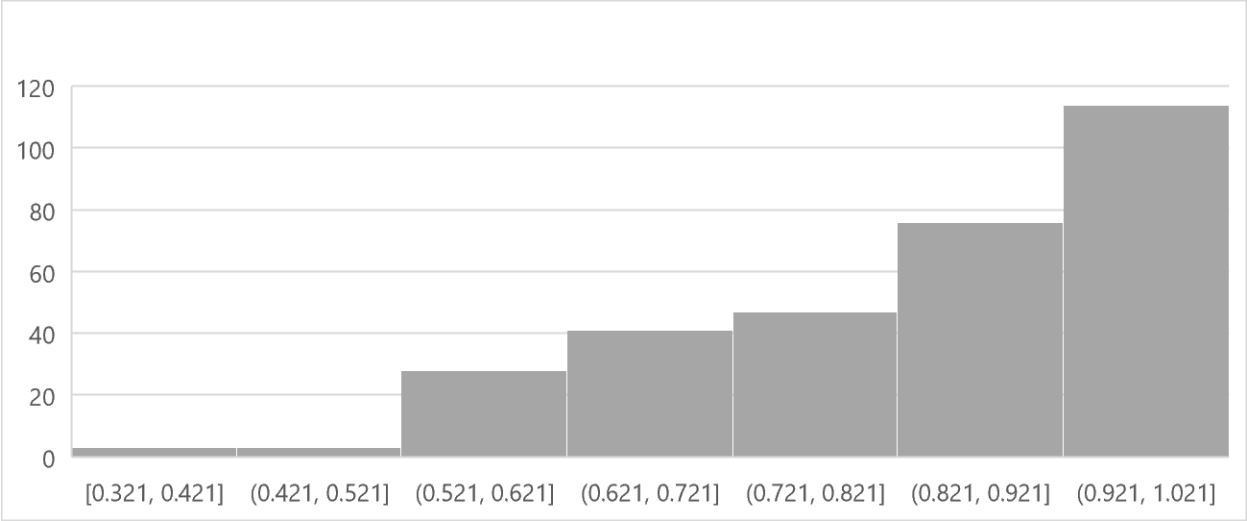

Figure 5. Distribution of super-efficiency DEA scores

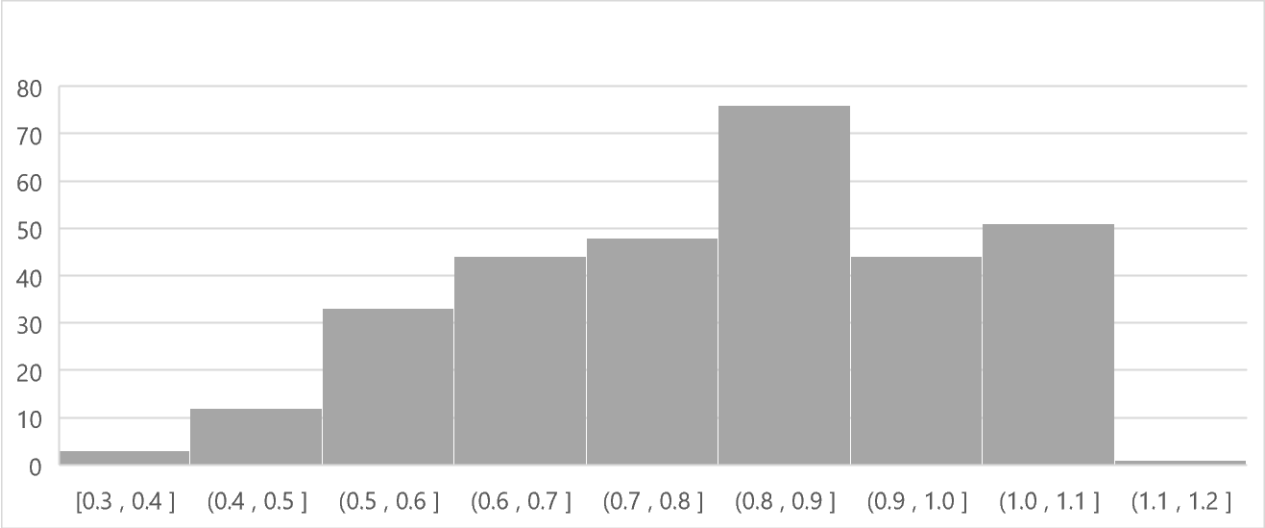

Figure 6. Marginal effect of EDH on healthcare efficiency contingent on relative wealth (BCC-DEA)

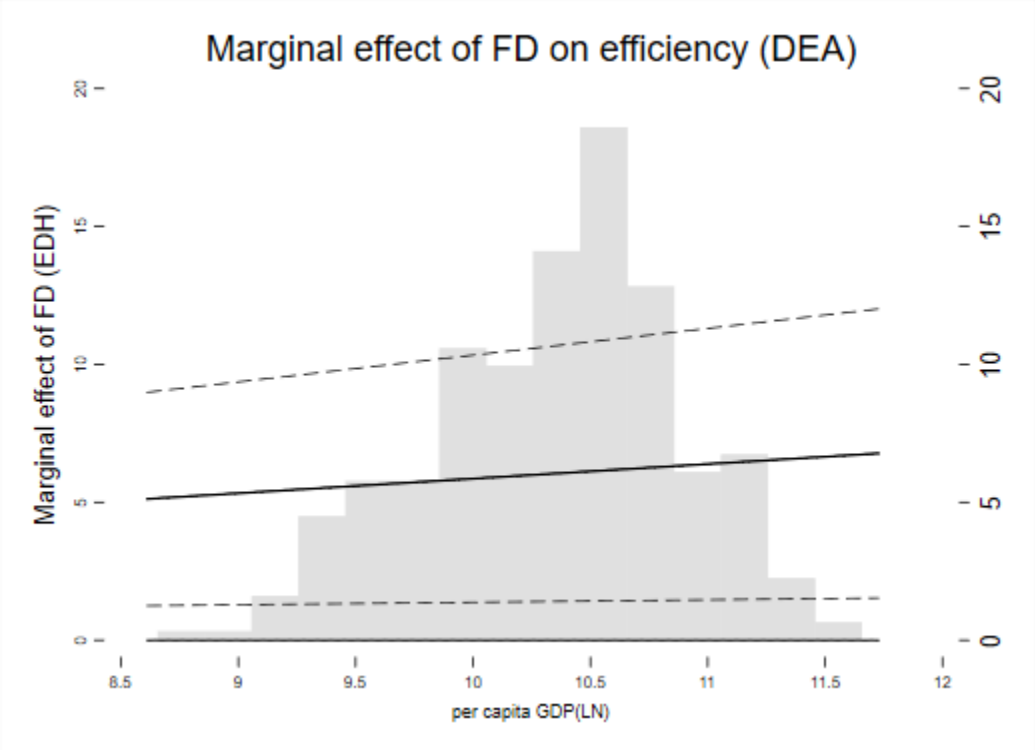

Figure 7. Marginal effect of EDH on healthcare efficiency contingent on relative wealth (Super-efficiency DEA)