Separating government regulatory roles from operational functions by public hospitals for greater supply capacity?

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Abstract

This paper evaluates the separation reform between operation and regulation of public hospitals in China. Using city-level data and the difference-in-difference (DD) model method, this paper estimates the changes in health care supply in response to the policy reform. Based on the DD model estimates, the pure reform effect led to a significant increase of 41.1% for number of doctors and 42.2% for number of health workers per 10,000 people in Weifang city from 2006 through 2008, and for Shuzhou city with data from 2005 through 2008, the reform-led increase is 60.7% for hospital beds and 36.3% for health workers per 10,000 people respectively. Moreover, the magnitude of impact increases over time based on the dynamic trend. Furthermore, the study finds a consistent increase in supply capacity in response to the separation policy regardless of it taking place inside or outside the government. This leads us to conclude that it is crucial for government to focus on regulatory roles while leaving market forces to determine the operational functions for better and greater healthcare supply in China.

Key Words: Public Hospital, accountability, Separation, Regulation, Operation, Policy Impact, Supply, Health Care Reform, China

JEL Classification: E60, I18, P36

1. Introduction

The recent complaints among the Chinese people—"kan bing nan, kan bing gui (getting medical care is difficult and expensive)"— best summarizes the major problem of accessibility and affordability in China's health service delivery system. The demand for health care witnessed a rapid rise along with the increasing incomes, while the supply capacity of health delivery increased at a relatively low speed. This was manifested by the exponential growth of total health expenditure by about 115 times after discounting CPI, while the hospital beds and registered doctors increased by only 168.57% and 160.98% times respectively, from 1980 to 2009. It seems the shortage of supply is one of the main reasons causing the health system problem.

How to improve the supply capacity becomes the primary goal for policy-makers. The facts that 85% hospital beds in China are government-run, and most of them are directly operated by central or local health departments make the government aware that the pooling roles of regulation and operation might constrain health care supply. Thus, "guan ban fen kai (separating government regulatory roles from operational functions)" was introduced as one of the core guidelines for the new round of Chinese health system reform which was launched in 2009 (CPC Central Committee and State Council, 2009) and further deepened during the 12th Five Year Plan period (2012-2015) (The State Council, 2009).

However, the guideline did not clearly define the reform protocols. Separation reforms have been proposed in various forms by different schools of thoughts. There are mainly three strategies: some conservatists advocate a moderate separation to improve overall effectiveness of health care system. Others propose a thorough separation reform instead, in which case roles of health departments are clarified and changed from "coach and referee" to independent "health market regulator" aiming at creating better market access and fairer competition environment. For thorough separation, there are gradualists arguing for separation within the government but still independent from the health departments, and there are also radicalists insisting that the government can only choose one of the two functions of operation or regulation and must entrust the other to an organization independent from the government.

In the context where theoretical debates did not reach a consistent conclusion, empirical evaluations are proposed accordingly. Fortunately, the local separation reforms take on various strategies so far in practice. Shanghai, Wuxi, and Suzhou set up new organizations as non-profit entity, public service unit or corporatized structure that independent from the government agencies to run public hospitals, the management roles being thoroughly separated; Beijing and Chengdu announced new government agencies that are independent from the health departments, which can be categorized as thorough separation within the government; Weifang adopted a moderate approach by conducting the separation reforms within the health departments. These "natural experiments" provide us with an opportunity to evaluate the impacts of different strategies of separation reforms.

This study contributes to the literature in four aspects. First, it offers empirical evidence on the impacts of different separation reform strategies based on three cities' natural experiments. Second, it explores the dynamic trend of the reforms by comparing the short-term impact versus long term impact. Third, the significant and positive impacts of separation reform on health delivery system shed a good deal of light on the right directions for separation reforms in other sectors of social affairs, such as education, sports, culture and so forth in China. Fourth, China's reform experience might inspire other developing countries facing similar problems in determining the respective role of government and market force in health care.

The remaining part of this paper is organized as follows: Section 2 is a brief overview of the background of Chinese health service delivery system in general and the evaluated local separation practices in particular. Section 3 illustrates the research design. Section 4 presents the empirical results. Section 5 is discussion. Section 6 concludes with policy recommendations.

2. Background

2.1. Health service delivery system

What makes getting medical care so difficult and expensive is twofold, the first being the increasing prices based on a supply of high quality health services that fall short of demand. The second is that the government has established a distorted pricing policy that sets service prices below actual costs, but at the same time allows profit margins for 15% mark-up on drug prices for public hospitals, which results in the problem of "generating revenue from excessive drug sales" (Wagstaff, 2007). To sum, the root of the problem lies mainly in the shortage of high quality care to meet the increasing demand.

Solving the contradiction between the demand and supply needs an increase in supply, which can be done by two ways: to improve economic efficiency of health facilities and workforce, and/or to increase the supply capacity of the health facilities and workforce. There are three sources to increase supply capacity: first, incentivizing existing public sector to provide more volumes of care; second, increasing government investment; third, further mobilizing social capital to invest in health care.

In the situation where remuneration and financing mechanisms lagged behind, the government should seek to incentivize existing public providers and mobilize additional social capital to produce better and more health care services, in order to meet the diversified demand for health care from the general public, and to fundamentally solve the problem of *"kan bing nan, kanbing gui"*.

In China, the management and governance of public hospitals are archaic and have been in accordance with public service units (PSUs) for a long time. Similar to most other PSUs, most public hospitals are not only regulated but also operated with interventions from government at different levels, which has been labeled as "pooling/unification of government agencies and PSUs". Such a system creates confusions and blurs boundaries between administration and ownership. The regulatory roles administered by government and the operational functions derived from ownership are pooled/unified, hence the "pooling/unification of regulation and operation". Such organizational arrangements constrain health care supply in three ways:

First, the accountability of public hospital is fragmented. In China, public hospitals are accountable for different liabilities to different agencies with different duties and at different levels, which make the management of public hospitals uncoordinated and shape the "principally local leadership, vertical and local leadership combined" and "many dragons governing the same water" hierarchical structure in healthcare governance (Organisation for Economic Co-Operation Development, 2005b). The management of public hospitals involves multiple government agencies, including the department of finance as the sponsor or contributor; department of social security and department of health as the payer(s); the department of organizing and department of personnel responsible for the way hospital managers ("leaders group") appointed and health workers (including doctors, nurses, and other health personnel) managed respectively; the department of health also performing dual roles of operation and regulation (coach and referee); while the departments of drug, pricing, planning, commerce and civil affairs performing each respective functions. as shown in figure 1.
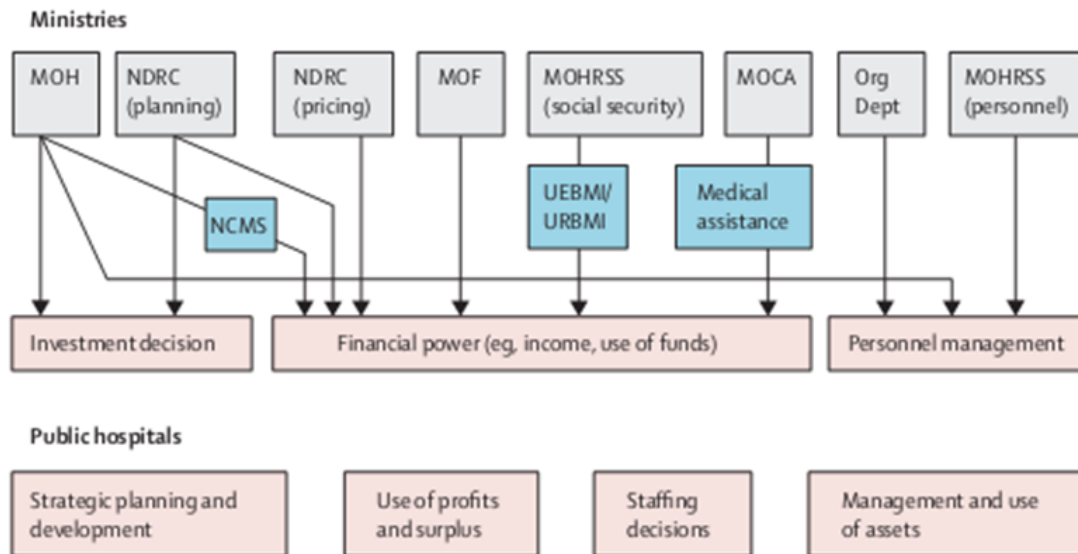
Figure 1: Dispersion of power between ministries and public hospitals, adapted from (Yip et al., 2012)

The powers are distributed across different departments, who often have competing priorities as a lack of coordination and communication mechanisms to align their bureaucratic interests. The corresponding internal governance of public hospital is also dispersed especially in terms of assets management, strategic planning, and decision rights. Public hospital finds it difficult to act independently as they usually lack boards and other essential governance structures (Organisation for Economic Co-Operation Development, 2005a). Furthermore, it also lacks of autonomy in allocation of human, financial, and material resources and is therefore reluctant to respond to incentives, improve management and increase efficiency.

Second, the accountability of public hospital is concentrated. The health departments are empowered with the dual managerial role as both "hospital manager general" and "health market regulator" in the current health care system. Such system of "coach and referee" is highly vulnerable to "Regulatory Capture": public hospitals are subordinated to health departments and become their stake-holders; while health departments give public hospital acquiescence to dominate in the healthcare market by way of administrative interventions, such as setting up invisible entry barriers. This tight alliance was created from the historical practices, and was later termed as a "medical axis-of-power" by Hsiao (2007). As a result, the health department cannot concentrate on fulfilling their obligations such as strategic plans, market access, policy making, service oversight and industry regulation etc.

Compounding the accountability problems further, the unified system with high level of administrative interventions derails the development of the health care market from its basic principle of being "just, fair and transparent". The market competition plays a limited role in health care as the capabilities to mobilize societal resources are constrained to a great extend.

The above factors undermine the independence and autonomy of public hospitals, and limit the role of market competition and social capital in health care. In sum, the current organizational arrangements constrain the internal and external incentives, and furthermore constrain the health care provision capacities. Therefore, it is necessary to clarify the relationship between operation and regulation, in order to improve the accountability and public hospital governance in China.

2.2. The evaluated local separation practices

Since July 2005, Shanghai, Beijing, and some other local governments have initiated alternative management and governance models of separation between regulatory roles from operational functions. We summarize the local practices into five typical models, including Shanghai model, Beijing model, Wuxi model, Suzhou model, and Weifang model.

In 2005, Shanghai Shenkang Hospital Development Center was created as a nonprofit structure responsible for state-owned investment, management, and operations of municipal public hospitals. It manages their state-owned assets under the leadership and guidance of the municipal health bureau (The World Bank, 2010).

In 2011, Beijing Municipal Hospital Management Bureau was established, responsible for the management of human resources, business operations, and state-owned assets of the 22 municipal public hospitals, leaving the Beijing Municipal Health Bureau responsible for the planning, access, license, standard, and regulations. The head of Beijing Municipal Health Bureau hold a concurrent post of head of the Beijing Municipal Hospital Management Bureau (The People's Daily, 2011).

Neither the Shanghai nor Beijing reform was included in the final analysis because it is difficult to find a comparable city for the control group. Instead, Suzhou city and Wuxi city in Jiangsu province and Weifang city in Shangdong province are finally chosen as study objects in this paper. The brief summaries of separation policy interventions of the three evaluated cities are as follows.

2.2.1 Hospital management center in Wuxi

On September 29th of 2005, the Hospital Management Center in Wuxi was formally established to separate the regulation from operation in Wuxi. This was followed by creation of three other centers of public affairs covering sports, education and culture. Wuxi City Hospital Management Center (WCHMC) was created as a Public Service Unit (PSU) in an administrative capacity of equal rank to the Wuxi Municipal Health Bureau. It acts as a representative for the government to manage and operate the state-owned asset and business. Figure 3 represents the reform model of public hospital organization in Wuxi.

The health bureau serves as a functional department to manage various health activities including policy adjustment, service supervision, public administration, market access, and licensing in a broad and administrative capacity. Clearly, this method requires a shift in the framework of governmental organization and a change in the ideological role of government. This type of shift will cause public hospitals to leave the jurisdiction of the health department and pave new ways for separation between government agencies and PSUs.
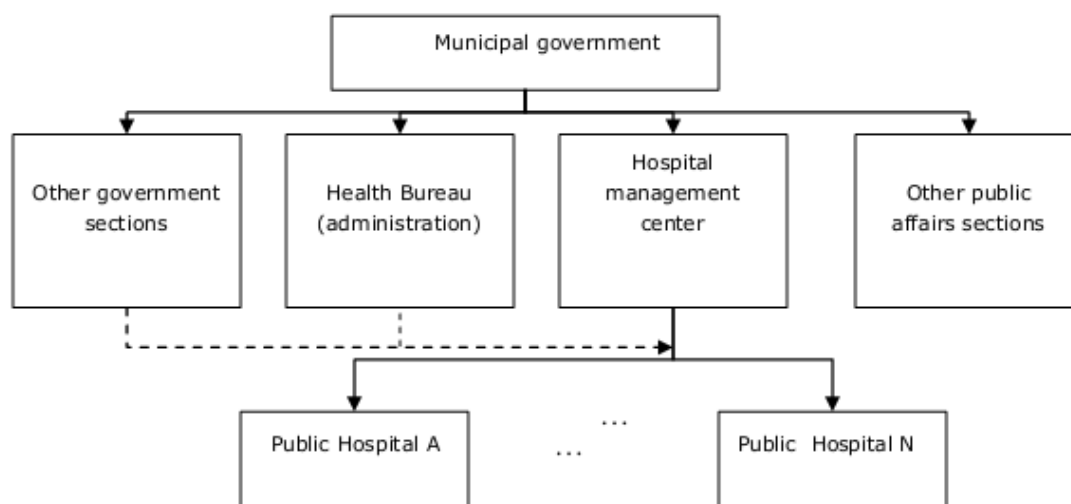

Figure 2 Reform model of public hospital organization in Wuxi , adapted from (The World Bank, 2010)

2.2.2 Hospital management council in Suzhou

In April 2004, Suzhou municipal government issued the "Detailed Implementing Rules for the Reform of Separation between Regulation and Operation of Municipal Hospitals". Since then,

Suzhou city established councils of the hospital management centers (HMCs) to implement a comprehensive separation reform of six hospitals in the first round in September 2004, and four hospitals in the second round in 2008. According to the document, every experimented hospital will establish its respective executive group through their existing leadership groups to form the management council and the size of each group will be determined by the size of the hospital.

Figure 2 shows the Management System Reform in Suzhou. The hospital management council is the decision-making body of HMCs and the operational management authorities are transferred from hospitals to the councils. The nature of the councils of HMCs is that they are non-government, non-enterprise, and non-profit corporatized structures, which are responsible for the hospital decision rights including employing personnel, payroll mechanism, disposing of assets, and so forth. For instance, hospital leaders are appointed by the councils instead of the relevant local personnel departments.

The Suzhou Municipal Health Bureau is entrusted by the municipal government to serve as the state sponsor for the public hospitals. A third party from the municipal government is responsible to supervise the state-owned assets of public hospitals and financial budgets of HMCs.

The responsible health department and the hospital management councils of HMCs are bound by a contract rather than administrative hierarchy. In this way, the government will supervise the market and the hospitals will supervise their internal management.
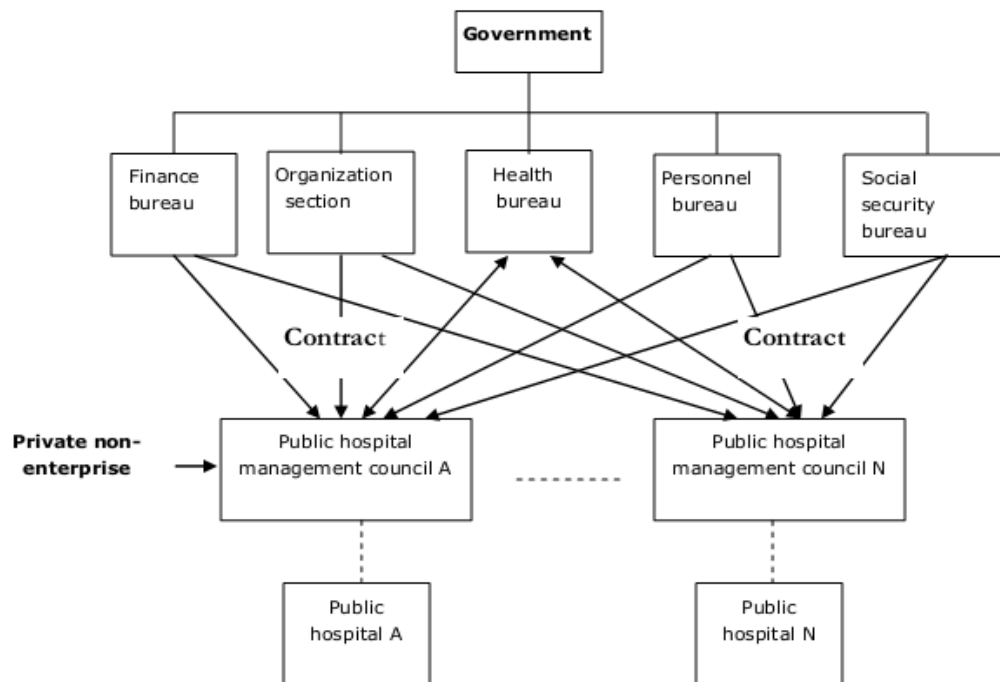
Figure 3: Management System Reform in Suzhou, adapted from (The World Bank, 2010)

2.2.3 Separation within the health department in Weifang

In December 2005, the separation reform in Weifang started within the health department. Under the premise of the Weifang's efforts in preserving the original health administration system, the prefecture has established parallel agencies within the bureau. For instance, the center for health supervision and law enforcement is responsible to administer an integrated supervision of the entire local health industry, see Figure 4.

Apart from regulatory roles, the Weifang Health Bureau has also acted as a sponsor on behalf of the government with well-defined powers and responsibilities, and is concurrently responsible for the way hospital managers are appointed and promoted. The previously dispersed governmental roles have been integrated into one executive branch—the Weifang Health Bureau—to be in charge of this coordination. The reform has strengthened regulatory functions

of health department and meanwhile improved the once fragmented organizational structure (Fu, 2008).

Before Reform: Polycentric Management

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                        │ Government trust │
                        └──────────────────┘
     ┌──────────┬──────────────┬──────────────┬──────────────┐
     ▼          ▼              ▼              ▼              ▼
┌─────────┐ ┌─────────────┐ ┌─────────┐ ┌───────────┐ ┌───────────────┐
│ Finance │ │ Organizatio │ │ Health  │ │ Personnel │ │ Social security│
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┌──────────────┐ ┌───────────┐ ┌───────────┐ ┌───────────┐ ┌──────────────────┐
│ Compensation │ │ Leader    │ │ Industry  │ │ Stuffing  │ │ Medical insurance│
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                        │ Hospital's objectives │
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After Reform

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                        ┌──────────────┐
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Health
administration    ┌─────────┐ ┌─────────────┐ ┌─────────┐ ┌───────────┐ ┌───────────────┐
affairs           │ Finance │ │ Organization│ │ Health  │ │ Personnel │ │ Social security│
                  │ bureau  │ │ bureau      │ │ bureau  │ │ bureau    │ │ bureau         │
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                  │ Health       │ │ Hospital       │ │ Center of disease  │
                  │ supervision  │ │ management     │ │ control and        │
                  │              │ │ center         │ │ prevention         │
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Health affairs
                    Supervision     Sponsorship      Support

                        ┌──────────┐
                        │ Public   │
                        │ hospital │
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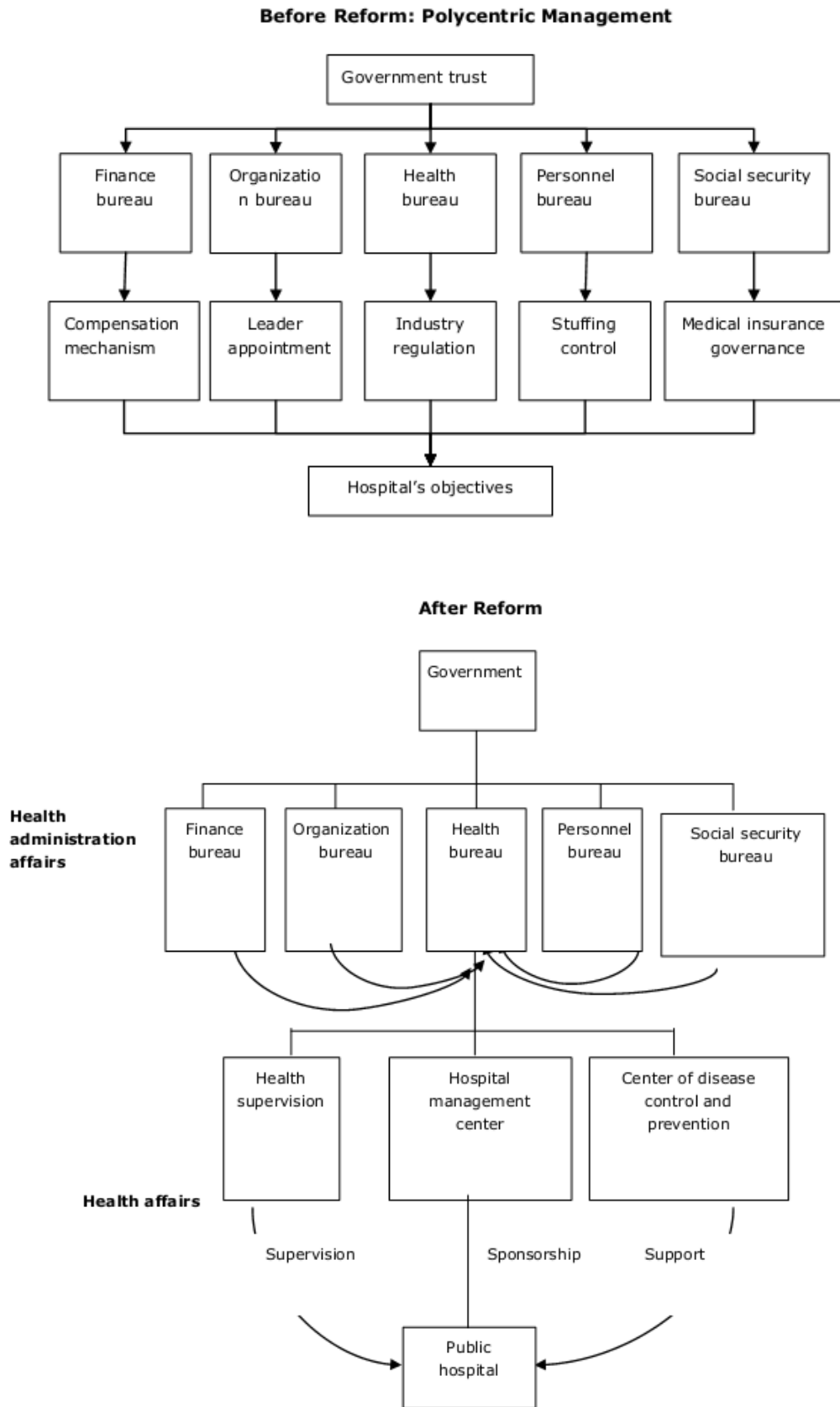
Figure 4: Designated management model in Weifang, adapted from (The World Bank, 2010)

In sum, distances were created after the reforms between the regulatory bodies and the entities they regulate in all three cities, furthermore, between health departments and public hospitals in Suzhou and Wuxi. The separation reform in Suzhou and Wuxi can be classified as the aforementioned "thorough separation"; while that in Weifang belongs to "moderate separation".

It is worth noting that there is a potential progressive relationship between moderate and thorough separation reforms. However, different separation strategies share a common objective of improving the internal and external incentives and combined they increase health care supply. Whether or not the different separation reforms achieve the objectives in health service delivery is a research hypothesis that calls for an empirical method that allows investigating in a controlled manner.

3. Research design

3.1. Data

We used a sample of panel data covering 17 cities in Shandong Province and 13 cities in Jiangsu Province, respectively, during 2003-2008. These data were compiled from annual publications of Yearbook of Shandong Province and Jiangsu Province from 2004-2009. Both GDP and government health expenditures (GHE) were converted into real per capita form by dividing through city population and deflating using the CPI with 2005=100 as the base year, which was extracted from China Statistical Yearbook 2009.

3.2. Model

The research hypothesis is that separation reform increases health care supply in the entire health care system by way of incentivizing the public providers while mobilizing social capitals. It is worth noting that each city varies greatly in terms of the socioeconomic development, population structure, medical situation and disease pattern etc. These factors exert great impact on the health care reform and health care supply in each city. Some of these data are difficult to collect, thus we assume these unobservables remain constant over the study time period, therefore we use fixed effect models to eliminate the unobserved effects among cities.

The number of beds, number of doctors, and number of health workers per 10,000 people are chosen as dependent variables. The key independent variables are the dummy variables indicating the policy implementation in the reform cities. To control the specific economic development of each city, the GDP per capita and government health expenditure (GHE) per capita are also added into the models. To fix the time effects, n-1 specific year dummy variables are added.

A natural experiment always has a control group, which is not affected by the policy change and a treatment groups, which is thought to be affect by the policy change. Unlike with a true experiment, where treatment and control groups are randomly and explicitly chosen, the control and treatment groups in natural experiments always systematically differ with each other. In order to control for systematic differences between groups, we need to exclude this "selection bias". If C is control group, T is treatment group, dT equals to 1 for objects in group T and 0 otherwise, d2 is the dummy variable for the post-intervention period, then the standard Difference-in-Differences (DID) model is (Wooldridge, 2009):

$$Y = \alpha_0 + \alpha d2 + \delta dT + \theta dT \cdot d2 + other\ factors \tag{1}$$

where Y is the outcome variable of interest, δ measures the systematic difference between the two groups, θ captures the effect of policy.

The magnitude of policy impact may change over time. For this consideration, the policy effects specified to years is captured using the following model which was developed from the standard DID model:

$$Y_{it} = \alpha_0 + \alpha \sum_t dTime_t + \lambda\, dTreat_i + \theta \sum_t (d_{it} \cdot dTime_t) + X\beta + a_i + u_{it}$$

(2)

where i denotes the city, t denotes the year. Y indicates the supply variables, dTime is the year dummy variables, dTreat is the dummy variable for treatment group, and d is policy implementation dummy variable with 1 for implementation and 0 otherwise. The year specific effects of separation reform is θ. X is a vector of controls with coefficient β, while the term a_i is the unobserved city fixed effects, and u_{it} is an error term that reflect random fluctuation in supply.

Thus, the regression model to evaluate the outcome of separation reform in Weifang (since 2006), Wuxi (since 2006) and Suzhou (since 2005) are as follows, respectively:

$$Y_{it} = \alpha_0 + \alpha_1 d04_t + \cdots + \alpha_5 d08_t + \lambda\, dWeifang_i + \theta_1 l_{it} \cdot d06_t + \theta_2 l_{it} \cdot d07_t + \theta_3 l_{it} \\ \cdot d08_t + X\beta + a_i + u_{it}$$

(3)

$$Y_{it} = \alpha_0 + \alpha_1 d04_t + \cdots + \alpha_5 d08_t + \lambda\, dWuxi_i + \lambda\, dSuzhou_i + \gamma_1 w_{it} \cdot d06_t + \gamma_2 w_{it} \cdot \\ d07_t + \gamma_3 w_{it} \cdot d08_t + \delta_1 s_{it} \cdot d05_t + \delta_2 s_{it} \cdot d06_t + \delta_3 s_{it} \cdot d07_t + \delta_4 s_{it} \cdot d08_t + X\beta + \\ a_i + u_{it}$$

(4)

where dWeifang, dWuxi, and dSuzhou are dummy variables indicating Weifang, Wuxi and Suzhou city respectively; l, w and s are policy implementation dummy variables for each city. θ, γ, δ are concerned policy effects specified to different years.

Considering the unobserved effect a_i might be related to policy variables and dependent variables, OLS regressions might not produce consistent estimations. Assuming the unobserved fixed effects do not change over time, there are two methods for estimating unobserved effects models. One involves differencing the data, that is first differencing (FD) which we call the resulting estimator the first-differenced estimator, and the other involves time–demeaning, that is fixed effects transformation (FE) which we call it fixed effect estimator (Wooldridge, 2009).

Both FD and FE estimations are unbiased under the assumption E(u_{it}|d_{it}, X, a_i)=0. The choice between of FE and FD hinges on the assumptions about serial correlation in the idiosyncratic errors u_{it}, which determines the relative efficiency of the estimators. FE is more efficient than FD when the u_{it} are serially uncorrelated while FD should be employed if u_{it} follows a random walk, meaning the difference is serially correlated. In the present study, there might be a positive serial correlation in view of the policy continuity, and FD is consequently thought to perform better estimations. If we first-difference Equation (3) and (4), then we end up with:

$$\Delta Y_{it} = \alpha_1 \Delta d04_t + \cdots + \alpha_5 \Delta d08_t + \theta_1 \Delta (l_{it} \cdot d06_t) + \theta_2 \Delta (l_{it} \cdot d07_t) + \theta_3 \Delta (l_{it} \cdot \\ d08_t) + \Delta X\beta + \Delta u_{it}$$

(5)

$$\Delta Y_{it} = \alpha_1 \Delta d04_t + \cdots + \alpha_5 \Delta d08_t + \gamma_1 \Delta (w_{it} \cdot d06_t) + \gamma_2 \Delta (w_{it} \cdot d07_t) + \gamma_3 \Delta (w_{it} \cdot \\ d08_t) + \delta_1 \Delta (s_{it} \cdot d05_t) + \delta_2 \Delta (s_{it} \cdot d06_t) + \delta_3 \Delta (s_{it} \cdot d07_t) + \delta_4 \Delta (s_{it} \cdot d08_t) + \Delta X\beta \\ + \Delta u_{it}$$

(6)

The time constant and unobserved effects a_i, and the city dummy variables for Weifang, Wuxi, and Suzhou are removed. The Equations (5) and (6) have no intercept, which provides little value to the present research anyway. It is more meaningful to estimate by an equation with intercept and (n-2) instead. The equations are transformed into:

$$\Delta Y_{it} = \alpha_0 + \alpha_2 d05_t + \cdots + \alpha_5 \Delta d08_t + \theta_1 \Delta (l_{it} \cdot d06_t) + \theta_2 \Delta (l_{it} \cdot d07_t) + \theta_3 \Delta (l_{it} \cdot \\ d08_t) + \Delta X\beta + \Delta u_{it}$$

(7)

$$\Delta Y_{it} = \alpha_0 + \alpha_2 d05_t + \cdots + \alpha_5 \Delta d08_t + \gamma_1 \Delta (w_{it} \cdot d06_t) + \gamma_2 \Delta (w_{it} \cdot d07_t) + \gamma_3 \Delta \quad (8)$$
$$(w_{it} \cdot d08_t) + \delta_1 \Delta (s_{it} \cdot d05_t) + \delta_2 \Delta (s_{it} \cdot d06_t) + \delta_3 \Delta (s_{it} \cdot d07_t) + \delta_4 \Delta (s_{it} \cdot d08_t) +$$
$$\Delta X \beta + \Delta u_{it}$$

The OLS regression based on equations (7) and (8) produce the unbiased estimators θ_i, γ_i, δ_i as the yearly policy impacts for Weifang, Wuxi and Suzhou respectively. The overall policy impact $\sum_i^3 \theta_i$, $\sum_i^3 \gamma_i$, and $\sum_i^4 \delta_i$ are also the concerned outcomes for this research. But if we aggregate the yearly impact, the variance information and the statistical significant information of the overall impact are missing. Equations (7) and (8) are further transformed as follows to obtain accurate t statistics for the overall impact.

$$\Delta Y_{it} = \alpha_0 + \alpha_2 d05_t + \cdots + \alpha_5 d08_t + \theta_1 \Delta (l_{it} \cdot d06_t - l_{it} \cdot d08_t) + \theta_2 \Delta (l_{it} \cdot d07_t - l_{it} \quad (9)$$
$$\cdot d08_t) + (\theta_1 + \theta_2 + \theta_3) \Delta (l_{it} \cdot d08_t) + \Delta X \beta + \Delta u_{it}$$

$$\Delta Y_{it} = \alpha_0 + \alpha_2 d05_t + \cdots + \alpha_5 d08_t + \gamma_1 \Delta (w_{it} \cdot d06_t - w_{it} \cdot d08_t) + \gamma_2 \Delta (w_{it} \cdot d07_t - \quad (10)$$
$$w_{it} \cdot d08_t) + (\gamma_1 + \gamma_2 + \gamma_3) \Delta (w_{it} \cdot d08_t) + \delta_1 \Delta (s_{it} \cdot d05_t - s_{it} \cdot d08_t) + \delta_2 \Delta (s_{it} \cdot$$
$$d06_t - s_{it} \cdot d08_t) + \delta_3 \Delta (s_{it} \cdot d07_t - s_{it} \cdot d08_t) + (\delta_1 + \delta_2 + \delta_3 + \delta_4) \Delta (s_{it} \cdot d08_t) + \Delta$$
$$X \beta + \Delta u_{it}$$

The coefficients of $(l_{it} \cdot d08_t)$, $(w_{it} \cdot d08_t)$, $(s_{it} \cdot d08_t)$ estimated from OLS regressions based on Equation (9) and (10) are the overall impact of the separation reforms measures in Weifang, Wuxi, and Suzhou respectively on health service supply.

Moreover, the FE model is also employed as the robust test to the results of FD:

$$Y_{it} - \overline{Y_{\iota t}} = \alpha_1 (d04_t - \overline{d04_t}) + \cdots + \alpha_5 (d08_t - \overline{d08_t}) + \theta_1 \left(l_{it} \cdot d06_t - \overline{l_{\iota t} \cdot d06_t} \right) \quad (11)$$
$$+ \theta_2 \left(l_{it} \cdot d07_t - \overline{l_{\iota t} \cdot d07_t} \right) + \theta_3 \left(l_{it} \cdot d08_t - \overline{l_{\iota t} \cdot d08_t} \right)$$
$$+ (X - \bar{X})\beta + u_{it} - \bar{u}_\iota$$

$$Y_{it} - \overline{Y_{\iota t}} = \alpha_1 (d04_t - \overline{d04_t}) + \cdots + \alpha_5 (d08_t - \overline{d08_t}) + \gamma_1 \left(w_{it} \cdot d06_t - \overline{w_{\iota t} \cdot d06_t} \right) \quad (12)$$
$$+ \gamma_2 \left(w_{it} \cdot d07_t - \overline{w_{\iota t} \cdot d07_t} \right) + \gamma_3 \left(w_{it} \cdot d08_t - \overline{w_{\iota t} \cdot d08_t} \right)$$
$$+ \delta_1 \left(s_{it} \cdot d05_t - \overline{s_{\iota t} \cdot d05_t} \right) + \gamma_2 \left(s_{it} \cdot d06_t - \overline{s_{\iota t} \cdot d06_t} \right)$$
$$+ \gamma_3 \left(s_{it} \cdot d07_t - \overline{s_{\iota t} \cdot d07_t} \right) + \gamma_4 \left(s_{it} \cdot d08_t - \overline{s_{\iota t} \cdot d08_t} \right)$$
$$+ (X - \bar{X})\beta + u_{it} - \bar{u}_\iota$$

Then the OLS regressions based on Equation (11) and (12) yield the yearly policy impact for three cities, respectively. The overall impact based on FE is similar to FD.

4. Results

4.1. Descriptive statistics

As the major research question is the overall impact of separation reform on health care supply, the supply indicators used in the present study is the total supply, which is composed of health care supply from both public and private providers. Table 1 presents the health care supply variables and other controls in Shandong province and Jiangsu province from 2003 to 2008, respectively. During this period, both the number of beds and number of doctors were on the rise, and the increase in Shandong outraced that in Jiangsu. Specifically, the number of beds per 10,000 in Shandong was one less than that of Jiangsu in 2003, but it raised to two more per 10,000 than that of Jiangsu in 2008; GDP per capita was also on the rise in both provinces; GHE per capita in Shandong increased at high speed whereas in contrast that of Jiangsu fell by almost

half albeit still higher than Shandong by 33 Yuan per person.

Table 1 Descriptive statistics for the impact of separation reform in Weifang, Suzhou, and Wuxi

Variables	2003	2004	Shandong Province 2005	2006	2007	2008	Coefficient of variation
Number of beds per 10,000	24.92	27.00	28.12	29.83	32.00	35.79	0.32
	(6.793)	(8.634)	(7.739)	(9.748)	(9.740)	(11.35)	
Number of doctors per 10,000	15.54	16.21	16.09	17.09	17.18	18.23	0.29
	(4.099)	(4.619)	(4.206)	(5.410)	(5.129)	(5.979)	
Number of health workers per 10,000	35.86	37.56	37.00	39.01	39.38	42.12	0.28
	(9.571)	(10.79)	(9.454)	(11.92)	(10.94)	(12.26)	
Number of deaths per 1,000	6.123	5.599	6.281	5.705	6.509	6.901	0.15
	(0.824)	(0.928)	(0.521)	(0.864)	(0.895)	(0.946)	
GDP per capita (Yuan)	17,146	20,450	23,899	27,554	30,723	34,137	0.63
	(10,340)	(12,313)	(14,793)	(16,563)	(17,602)	(19,129)	
GHE per capita (Yuan)	43.97	48.22	54.45	74.83	100.7	131.9	0.56
	(21.96)	(23.87)	(23.41)	(29.04)	(33.42)	(35.79)	
Observations	17	17	17	17	17	17	

Variables	2003	2004	Jiangsu Province 2005	2006	2007	2008	Coefficient of variation
Number of beds per 10,000	26.05	26.98	28.39	29.95	30.93	32.58	0.36
	(9.862)	(10.07)	(10.30)	(10.60)	(10.94)	(11.61)	
Number of doctors per 10,000	15.03	14.92	15.57	16.32	16.76	16.65	0.34
	(5.099)	(5.384)	(5.344)	(5.798)	(5.830)	(5.848)	
Number of health workers per 10,000	35.24	35.50	36.79	39.30	40.94	40.45	0.35
	(11.96)	(12.89)	(12.90)	(14.68)	(14.50)	(15.14)	
Number of deaths per 1,000	5.868	6.690	5.537	5.557	8.731	7.076	0.29
	(1.094)	(1.156)	(1.383)	(1.192)	(2.726)	(1.491)	
GDP per capita (Yuan)	20,128	23,479	26,828	30,974	34,676	38,090	0.75
	(14,568)	(17,166)	(19,867)	(22,859)	(25,336)	(27,328)	
GHE per capita (Yuan)	329.7	374.9	433.8	502.8	134.5	164.6	0.67
	(165.3)	(184.9)	(208.6)	(251.8)	(84.92)	(79.98)	
Observations	13	13	13	13	13	13	

a. Source: Shandong Statistical Yearbook 2004-2009; Jiangsu Statistical Yearbook 2004-2009
b. GDP per capita and GHE per capita were converted to real terms by deflating using the CPI with 2005 as the base year
c. Coefficient of variation is calculated by standard deviation divided by the mean.

4.2. Correlations

Table 2 presents the rank of performance for the three cities within each locating province with respect to health care supply and other indicators, in descending order.

Table 2 Rank of performance in health supply, mortality, GDP and GHE per capita within the province

Weifang	Beds	Doctors	Health care supply Health workers	Mortality	GDP per capita	GHE per capita
2003	10	10	10	8	8	15
2004	10	10	11	8	8	15
2005	9	10	10	10	10	16
2006	9	10	11	10	10	16
2007	8	9	9	10	10	16
2008	7	7	5	11	11	17
Wuxi						

	Health care supply					
	Beds	Doctors	Health workers	Mortality	GDP per capita	GHE per capita
2001	2	4	3	1	1	2
2002	2	1	1	1	1	2
2003	1	2	4	2	2	3
2004	2	2	2	2	2	2
2005	1	2	3	2	2	2
2006	2	3	3	2	2	2
2007	2	3	3	2	2	3
2008	2	3	3	2	2	4

Suzhou

	Health care supply					
	Beds	Doctors	Health workers	Mortality	GDP per capita	GHE per capita
2001	4	3	5	2	2	5
2002	4	4	4	2	2	5
2003	4	3	3	1	1	1
2004	3	3	4	1	1	1
2005	3	3	2	1	1	1
2006	1	2	2	1	1	1
2007	1	2	2	1	1	1
2008	1	2	2	1	1	1

Source: Shandong Statistical Yearbook 2004-2009; Jiangsu Statistical Yearbook 2004-2009

The supply rankings of Weifang remained stable in the lower-middle position among the 17 administrative regions in Shandong province from 2003 to 2006; while in 2007 and 2008, the supply rankings were ascended despite the relative decrease of GDP per capita and GHE per capita; in particular the health workers rose from 11th to 5th position. It is worth noting that the separation reform was initiated in December 2005 in Weifang. With regard to health service outcome, the mortality ranking descended. Therefore separation reform was associated with increase of health care supply in Weifang, albeit the government investment was limited.

Wuxi and Suzhou presented different rankings patterns. The two cities are two best cities in economic development within Jiangsu province. The separation reforms both started in 2005 when Suzhou municipal hospital council began its operation on January 1st and Wuxi hospital management center was formally established on September 29th. According to table 2, no significant change of health care supply was found after the reform in Wuxi whereas the supply indicators all increased in Suzhou; the GHE per capita of Suzhou was the highest in Jiangsu province. It can be seen from the simple rankings that the reform in Wuxi did not increase the supply of care but that in Suzhou did.

For a more straightforward comparison, two cities from each province with similar economic levels as the three evaluated cities were chosen as the control group[1]. Figure 5 illustrates the trend of the three supply indicators respectively in the cities from both treatment and control groups over the period between 2003 and 2008.

In Weifang city, the three supply indicators increased year by year from lower than that of Zaozhuang city and close to Shandong provincial average in 2003 to surpass Zaozhuang and Shandong average in 2008. A further look at the trend of increase found that the dramatic increases happened in 2006, the year when reform began.

In Suzhou city, the three supply indicators increased faster than the Jiangsu average. The number of beds, doctors and health workers were lower than Nanjing in 2003; but they surpass, reach to, and close the gap with that of Nanjing respectively in 2008. The trend of Wuxi presented a similar picture with Suzhou, albeit at low speed. A further look at the trend found there was a bouncing growth for Suzhou in 2005, the year of reform; but no dramatic increase

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[1] We calculated and ranked the GDP per capita during the 6 years before selecting two cities before and after Weifang city (19,206 yuan) from the ranking table, i.e. Zaozhuang city (19,746 yuan) and Rizhao city (18,523 yuan) in Shandong province; Nanjing city (43,633 yuan) and Changzhou city (42,301 yuan) followed by Suzhou city (75,004 yuan) and Wuxi city (68,362 yuan) in Jiangsu province since Suzhou and Wuxi ranked the first two.

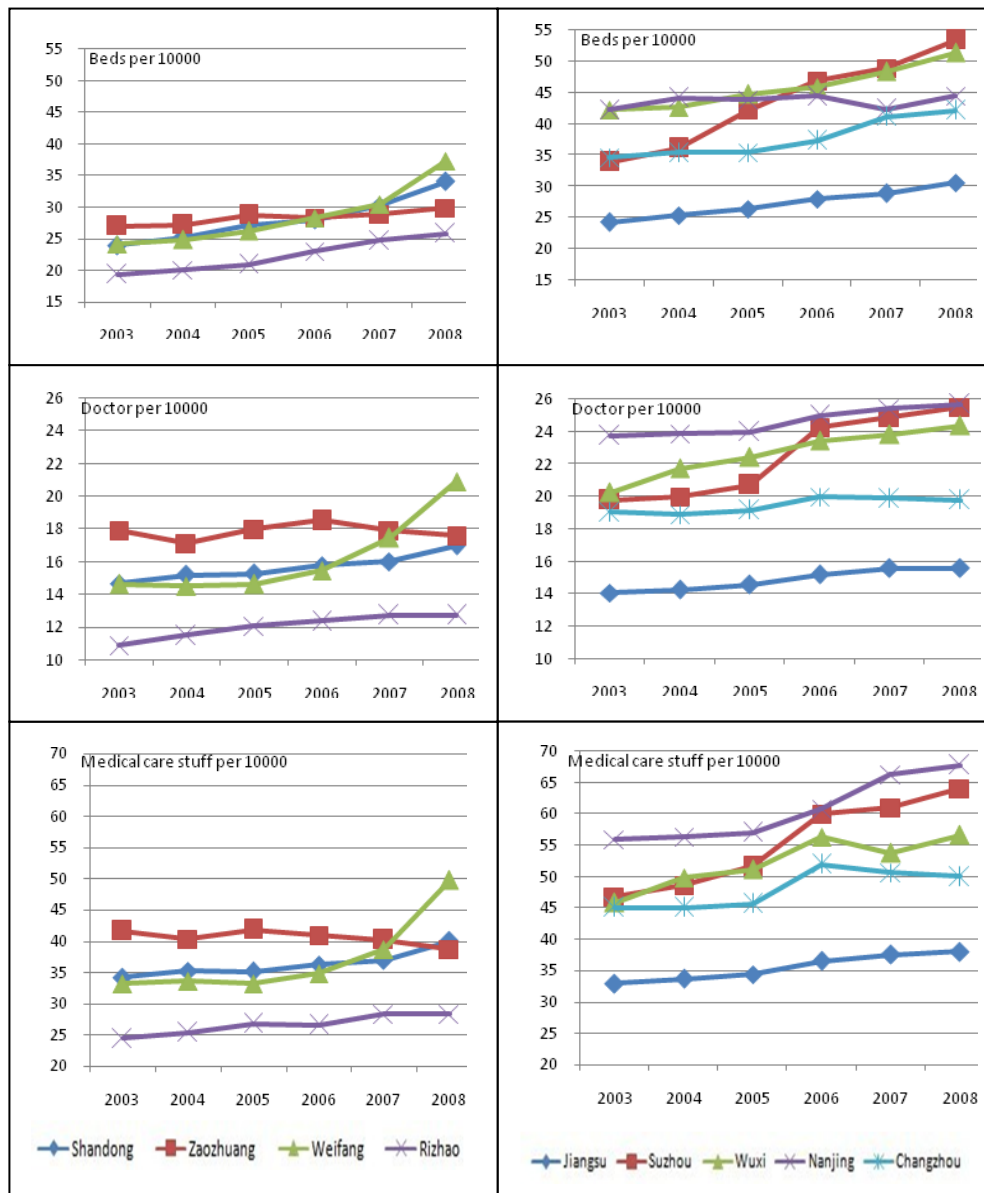was found in the year of reform for Wuxi in 2006.

Figure 5 the supply indicator comparison with treatment group
Source: Shandong Statistical Yearbook 2004-2009; Jiangsu Statistical Yearbook 2004-2009

4.3. Regression

The above descriptive analysis provides preliminary results. Furthermore, regression analysis with multi-year panel data yields robust results of the policy impacts on supply by controlling the heterogeneities in Weifang, Wuxi, and Suzhou.

Table 3 and Table 4 report the regression results. The columns (1) (5) (9) are the regression result from equation (7) and equation (8) for the yearly impact of the policy; the columns (3) (7) (11) are the regression result from equation (9) (10) for the overall impact; the even number of columns report the FE results as the robust tests. The logarithm transformation on Y_i intends to eliminate the impact of extreme values, and satisfy the homoscedasticity assumption of linear regression, followed by computation of a geometric mean ratio, rather than a mean difference (Allison, 1999).

In general, based on the overall impact analysis, the coefficients of Wuxi are not significant even at 10% level; the coefficients of Weifang and Suzhou are all significant at 1% level except the

hospital bed in Weifang and the number of doctors in Suzhou. The separation reform increased the health care supply in Weifang and Suzhou. According to the yearly impact analysis, most coefficients of Wuxi are not significant; most coefficients of Weifang and Suzhou are statistically significant at 1% level mostly except the first year. With respect to the absolute magnitude over time, the size of policy impact increased year by year for all three cities even including Wuxi, which denotes that the policy measures produce increasing magnitude of effects over time.

Specifically, The pure reform effect led to a significant increase of 41.1% for doctors and 42.2% for health workers per 10,000 people in Weifang city from 2006 through 2008, and for Suzhou city with data from 2005 through 2008, the reform-led increase is 60.7% for hospital beds and 36.3% for health workers per 10,000 people respectively. The overall impact is especially significant on the number of beds in Suzhou. With respect to the absolute magnitude over time, the number of beds per 10,000 increased by 9.7% after 4 years in Suzhou, which is faster than Weifang; while the increase of number of doctors and number of health workers are both faster in Weifang.

The parameter estimates based on FD and FE models are similar in terms of both significance and magnitude, which proves the robustness of the regression result in the present study. Furthermore, mortality regressions found no impact of separation reform on mortality rates in all three evaluated cities[2].

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[2] The mortality results are not reported in the paper due to page limits; but they are available upon request.

Table 3 Parameter estimates for the policy impact in Weifang

Dependent variables	Ln(number of beds per 10,000)				Ln(number of doctors per 10,000)				Ln(number of health workers per 10,000)			
	FD (1)	FE (2)	FD (3)	FE (4)	FD (5)	FE (6)	FD (7)	FE (8)	FD (9)	FE (10)	FD (11)	FE (12)
Weifang 2006 [a]	0.010 (0.026)	0.001 (0.025)			0.005 (0.022)	-0.010 (0.021)			0.009 (0.022)	-0.008 (0.021)		
Weifang 2007 [a]	-0.013 (0.041)	-0.009 (0.043)			0.132*** (0.029)	0.132*** (0.025)			0.106*** (0.028)	0.104*** (0.027)		
Weifang 2008 [a]	0.089** (0.042)	0.094* (0.045)			0.273*** (0.031)	0.272*** (0.028)			0.308*** (0.032)	0.305*** (0.034)		
Weifang Overall [a]			0.086 (0.104)	0.085 (0.105)			0.411*** (0.078)	0.394*** (0.065)			0.422*** (0.078)	0.401*** (0.071)
Observations	85	102	85	102	85	102	85	102	85	102	85	102
R square	0.121	0.752	0.121	0.752	0.214	0.590	0.214	0.590	0.200	0.505	0.200	0.505

Note: Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; a is short for "the policy impact of separation reform"

Table 4 Parameter estimates for the policy impact in Wuxi and Suzhou

Dependent variables	Ln(number of beds per 10,000)				Ln(number of doctors per 10,000)				Ln(number of health workers per 10,000)			
	FD (1)	FE (2)	FD (3)	FE (4)	FD (5)	FE (6)	FD (7)	FE (8)	FD (9)	FE (10)	FD (11)	FE (12)
Wuxi 2006 [a]	-0.035** (0.016)	-0.047* (0.023)			0.008 (0.015)	0.007 (0.027)			0.047*** (0.016)	0.050* (0.023)		
Wuxi 2007 [a]	-0.014 (0.023)	-0.025 (0.035)			-0.003 (0.021)	0.001 (0.034)			-0.055** (0.027)	-0.049 (0.038)		
Wuxi 2008 [a]	0.026 (0.022)	0.044 (0.031)			0.064* (0.034)	0.141*** (0.029)			0.044 (0.043)	0.136*** (0.043)		
Suzhou 2005 [a]	0.106*** (0.010)	0.120*** (0.012)			-0.016 (0.023)	-0.008 (0.018)			0.019 (0.017)	0.035** (0.015)		
Suzhou 2006 [a]	0.150*** (0.020)	0.157*** (0.030)			0.101*** (0.029)	0.095** (0.037)			0.116*** (0.025)	0.117*** (0.030)		
Suzhou 2007 [a]	0.148*** (0.036)	0.142** (0.062)			0.085** (0.040)	0.052 (0.067)			0.071* (0.041)	0.036 (0.063)		
Suzhou 2008 [a]	0.203*** (0.029)	0.214*** (0.035)			0.138*** (0.034)	0.146*** (0.041)			0.157*** (0.037)	0.171*** (0.036)		
Wuxi Overall [a]			-0.023 (0.052)	-0.029 (0.061)			0.069 (0.056)	0.148** (0.054)			0.036 (0.068)	0.137* (0.070)
Suzhou Overall [a]			0.607*** (0.084)	0.634*** (0.133)			0.308** (0.116)	0.285* (0.157)			0.363*** (0.103)	0.358** (0.134)
Observations	65	78	65	78	65	78	65	78	65	78	65	78
R square	0.251	0.824	0.251	0.824	0.288	0.617	0.288	0.617	0.359	0.684	0.359	0.684

Note: Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; a is short for "the policy impact of separation reform"

5. Discussion

5.1. Separation and other reforms

Different supporting policies were formulated and various complementary interventions were implemented in the separation reforms in Weifang, Wuxi and Suzhou. The model in the present study estimates the overall and yearly impact of the local health care system reform with separation reform as the core on health care supply. Partly because it is impossible to distinguish or discompose the impact of each policy based on macro data and partly because the separation reform is the core component of the health care system reform which consists of or related to a series of policy interventions including public hospitals reforms, the impact estimated in the present study is meaningful from overall perspective. In other words, what we estimated is the overall impact of the health care system reform with separation reform as the core policy component on the health care supply.

5.2. The quality and efficiency

Quantity, quality and efficiency are three dimensions to evaluate health care supply. The model adopted in the present study is to evaluate the quantity of supply, with an assumption that the quality and efficiency of care delivered by certain health facilities or personnel are consistent over time. This assumption would be too strong at micro level, however, the homogenous assumption of the operational efficiency is reasonable at macro level after controlling the regional differences. There are also some exceptions, for example, like the "no holiday outpatient service" policy intervention initiated by Chengdu municipal government in 2010 when it started its separation reform. This intervention means that after the separation reform in Chengdu, there will be less leisure time for doctors in Chengdu's public hospital – working extra hours in weekends became mandated. This policy could obviously increase the health care delivery. The cases like this are not considered in this paper.

6. Conclusions and Policy Recommendations

By putting separation reform into the context of the health care system reform from supply perspective, this paper explores how unification system of regulation and operation constrains supply in health service delivery system, discusses the different separation strategies in practices, and finally estimates the impact of different separation reforms in Weifang, Wuxi and Suzhou on health care provision using econometric modeling. We found that the impact differs in the three cities: it significantly increased health care provision in Weifang and Suzhou, but not in Wuxi. We also found it has a more sizable effect over time with relatively insignificant degree of impact in the first year.

It is worth noting that the theoretical debate over moderate separation and through separation, which corresponded to separation within health department and separation outside (or independent from) government respectively, was not completely solved by the empirical analysis in the present study. The reform increased health care provision in Weifang where moderate separation is being experimented, and Suzhou which is typical of thorough separation, but not in another city with thorough separation—Wuxi.

Under the backdrop of various degrees of economic development and health provisions, furthering the discussion of a separation model is necessary. Whether or not this happens within the health department or inside the government are not as important as the separation itself. Therefore we recommend local governments should actively explore different ways of implementing the separation between operation and regulation in a manner where government effectively supervises for the common good. This contingent separation approach was exactly encouraged by the "The Principles of the Health Care Reform" (CPC Central Committee and State Council, 2009).

Particularly, China announced to spend an additional 850 billion RMB (USD 125 billion) over

the period between 2009 and 2011 to provide universal basic health care for everyone (Yip et al., 2009), and two thirds go to the demand side (Wang, 2009). Universal coverage improves financial access to care and accelerates the demand for care. The health care system in China faces new challenge to further increase the supply capacities. To respond the challenge, China needs to speed up the public hospital reform so as to bring the internal and external initiatives into play. Our empirical findings prove that the effective implementation of separation expands the healthcare supply capacities, and therefore improves the physical access to care for patients. The Chinese central government has clearly stated the goal of building a harmonious society as a national priority; the separation reforms are beneficial to this objective and therefore coordinate the relationship between top Chinese political leaders as the principal and the health departments as the agent (Cheng, 2008; Hsiao, 2007).

It is also worth noting that there have been only 6 years since the earliest attempt of separation reform. We estimate both the overall and yearly effect, but the overall impact includes at most 4 years. It waits to be explored for the effect over a longer period of time. Besides, the paper does not include service quality, efficiency, or hospital ownership in the final analysis, which leaves room for further analysis if data allows in the future.

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