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Impact of slack resources on healthcare costs in tertiary and secondary hospitals: a panel data study of public hospitals in Beijing from 2015 to 2019

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ABSTRACT

Objective This study aims to explore the relationship between slack resources and cost consumption index in tertiary and secondary hospitals and to provide targeted healthcare resource utilisation recommendations for tertiary and secondary hospital managers.

Design This is a panel data study of 51 public hospitals in Beijing from 2015 to 2019.

Setting Tertiary and secondary public hospitals in Beijing. Data envelope analysis was used to calculate the slack resources. Regression models were used to explore the relationship between slack resources and healthcare costs.

Participants A total of 255 observations were collected from 33 tertiary hospitals and 18 secondary hospitals.

Outcome measures Slack resources and healthcare costs in tertiary and secondary public hospitals in Beijing from 2015 to 2019. Linear or curve relationship between slack resources and healthcare costs in tertiary and secondary hospitals.

Results The cost of healthcare in tertiary hospitals has always been higher than in secondary hospitals, and the slack resources in secondary hospitals have always been worse than in tertiary hospitals. For tertiary hospitals, the cubic coefficient of slack resources is significant ($\beta=-12.914$, $p<0.01$) and the R^2 of cubic regression is increased compared with linear and quadratic regression models, so there is a transposed S-shaped relationship between slack resources and cost consumption index. For secondary hospitals, only the first-order coefficient of slack resources in the linear regression was significant ($\beta=0.179$, $p<0.05$), so slack resources in secondary hospitals were positively related to the cost consumption index.

Conclusions This study shows that slack resources' impact on healthcare costs differs in tertiary and secondary public hospitals. For tertiary hospitals, slack should be kept within a reasonable range to control excessive growth in healthcare costs. In secondary hospitals, keeping too many slack resources is not ideal, so managers should adopt strategies to improve competitiveness and service transformation.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ To our knowledge, this is the first China-related study to analyse the relationship between slack resources and healthcare costs in public hospitals using panel data.
⇒ We construct linear regression, quadratic regression and cubic regression models to analyse the complex relationship that may exist between hospital slack resources and healthcare costs.
⇒ We use 33 tertiary and 18 secondary hospitals as our sample, which largely represents the distribution of medical resources in Beijing.
⇒ The relationship between slack resources and healthcare costs may be dynamic, which is not reflected in our study.
⇒ Only 5 years of panel data are available.

INTRODUCTION

Health spending rapidly rising is a problem that many countries are facing. According to the WHO, global health spending has more than doubled in the past two decades, amounting to 9.8% of global Gross Domestic Product (GDP) in 2019.[1] Global health spending per capita even increased faster than GDP between 2014 and 2017.[2] There is a particularly alarming increase in health spending in China. As a developing country, China's total health expenditure has soared at an annual rate of 14.72% from the 2009 health reform to 2019, which exceeds not only China's GDP growth rate, but also the growth rates of output in the secondary industries and tertiary industries, as well as the growth rate of health expenditures in 29 large high-income countries.[1] Chinese health expenditures as a share of GDP are also higher than the average for upper middle-income countries.[2] Due to the excessive growth in total health expenditures, social wealth is skewed towards the health sector, which is largely consumed by hospitals. As of 2019, hospital spending in China accounted for 52% of total health expenditures, excluding financial compensation.[3] During the period from 2010 to 2019, Chinese hospitals' total assets grew

by 194%, with a significant increase in beds, equipment and human resources.[3 4] Clearly, hospitals play a crucial role in controlling the excessive growth of medical costs.

Since the new healthcare reform, China has continued to increase its investment in the healthcare sector, and a large amount of money and resources have been poured into hospitals. Despite cost control, the effect is not significant, and inefficient hospital resource use is an important reason.[5 6] There is still a problem with 'inverted triangle' aggregation and uneven distribution of healthcare resources.[7 8] Healthcare resources are concentrated in large public hospitals and large cities. In all 31 provinces of China, Beijing has a large number of public hospitals, most of which are tertiary or secondary in nature.[9] Tertiary public hospitals take the national leader in the treatment of difficult and complex diseases, medical technology innovation and epidemic prevention and control, which undertake the healthcare needs of not only the people of Beijing but also the whole country. Secondary public hospitals are mainly tasked with the diagnosis and treatment of common diseases, receiving patients referred from tertiary hospitals and carrying out rehabilitation treatment. Over the past few years, tertiary hospitals have been overcrowded and congested with resources,[9] while secondary hospitals run inefficiently and have idle resources.[10] There is still a complaint about the high cost of medical care among patients. Massive investments of resources have not significantly reduced medical costs,[11] and one important reason is the low efficiency of resource utilisation.[6 12]

Organisational slack theory suggests that organisational efficiency depends on an organisation's ability to deploy and utilise slack resources.[13] In light of this viewpoint, we explored how slack theory can be used rationally to reduce healthcare costs. Nohria and Gulati defined slack as the pool of resources in an organisation that is in excess of the minimum necessary to produce a given level of organisational output. Slack resources include excess inputs such as redundant employees, unused capacity and unnecessary capital expenditures.[14] Some scholars have applied the slack theory to the health field, such as Miller and Adam, Valdmains *et al* using US hospitals as samples, and Mogha using Indian public hospitals as samples to develop slack resource measurement by data envelopment analysis (DEA).[15–17] There are also empirical analysis models to explore the relationship between organisational slack and service quality in hospitals.[18] Currently, scholars have different opinions on the role of slack resources. Positive views of slack include that it can protect the work environment against environmental threats as well as attract and retain employees.[19 20] Slack has also been suggested to contribute to innovation.[21] Negative views slack as a sign of waste and inefficiency, which reflects irrational and inefficient resource allocation.[22 23] Slack resources, such as equipment or personnel, may also divert patient benefits.[24] The third view is that the effects of slack on hospitals are non-linear. Peng *et al* found a U-shaped relationship between nurse slack and both quality of care and operating costs, with the turning point at a low level of nurse slack.[25]

The above views suggest that the role of slack resources in hospitals has become diverse and complex over time. Yet few scholars in China have applied the slack theory to healthcare. Xiong *et al* investigated the need for reasonable slack in healthcare resource allocation in the face of fluctuating health demand,[26] while Huang and Liu investigated organisational slack in healthcare organisations using DEA.[27] Healthcare costs and slack resources remain unexplored topics. An in-depth investigation of how slack resources can reduce healthcare costs is warranted.

As tertiary hospitals and secondary hospitals differ functionally and in their management styles, the relationship between slack resources and healthcare costs may differ as well. If slack resources can be used to help hospitals control the growth of medical costs, it will largely reduce the burden of medical care for people. Accordingly, this research aims to explore the relationship between slack resources and medical cost consumption in tertiary and secondary hospitals. First, we measured tertiary and secondary hospitals' slack resource situation and cost consumption index. Then, we examined the relationship between slack resources and the cost consumption index in tertiary and secondary hospitals. We hope that our research provides hospital managers at varying levels with a unique reference for the utilisation of healthcare resources and the control of excessive costs.

METHODS

Data

Since 2015, the Beijing Municipal Health Care Commission has been using Diagnosis Related Groups (DRGs) as a tool to evaluate healthcare services and key specialties in Beijing's general hospitals.[28] In this research, 51 public hospitals that used DRGs as a tool to evaluate healthcare services between 2015 and 2019 were selected as the subjects. A total of 255 observations were collected from 33 tertiary hospitals and 18 secondary hospitals. The data were obtained from the Beijing Public Health Information Center's database of the first-page information of discharged patients' cases.

Variable

Dependent variable

This research considered the cost consumption index as the dependent variable. The cost consumption index is a core indicator to evaluate the efficiency of healthcare services by DRGs.[29 30] Cost consumption index increases as treatment costs increase. In fact, treatment costs can be measured in a variety of ways. Thorpe and Phelps, Langland-Orban *et al* and Greenwald *et al* used the total amount of hospital annual medical fee waivers to evaluate hospital performance.[31–33] Clement *et al* measured the community benefits provided by hospitals in terms of price discounts.[34] The Beijing Municipal Health Commission began using DRGs as a tool to evaluate the healthcare

services and key specialties of Beijing's general hospitals in 2015. The cost consumption index is used to estimate the cost of treating similar diseases. By taking DRG grouping into account, this indicator can avoid excessive differences in average cost per case between hospitals owing to differences in patient types.

Independent variables

The independent variable in this study is slack resources, which are obtained by DEA. DEA is widely used in healthcare, including research on Wisconsin hospitals, Massachusetts teaching hospitals and urban hospitals.[35–37] In this research, the BCC model was chosen and the output-oriented DEA model was used to measure the relative efficiency of public hospitals. The overall efficient Decision-Making Units had the highest relative efficiency with an overall efficiency score of 1. The slack was set as (1-DEA overall efficiency score). Miller and Adam, Mogha *et al* and Pritpal and Prikshat also use such measures to assess slack.[15 16 38]

Inputs and outputs for the DEA analysis were derived in part from previous DEA healthcare studies.[39–42] For input indicators, Neill suggested that cost-based indicators are not recommended for technical efficiency input indicators and advocated using the number of beds instead of capital inputs. Therefore, we choose the actual number of beds as one of the input indicators. In addition, the number of practicing physicians and registered nurses were selected as input indicators to reflect the human resources of the hospital.

Among the output indicators, the medical service category is the most widely used (73 studies in China and 72 internationally).[39] Charnes *et al* suggested that the output indicators of the DEA model should not mix quantitative and monetary indicators to avoid confusing technical efficiency and allocative efficiency.[43] Therefore, our output indicators are focused on the medical services category. Dong further divided medical services into three categories: outpatient and emergency business volume, inpatient business volume and surgery.[44] From these three categories, we selected the number of outpatient and emergency visits, the number of hospital discharges, the number of surgeries and the average length of stay as output indicators to ensure that the output of healthcare services is fully reflected.

Several control variables were included in this research in order to control for possible effects unrelated to slack resources: hospital size (including the number of beds and the total number of staff),[45] per capita disposable income, the proportion of the elderly population, resident population density, the level of urbanisation and health expenditure as a percentage of general public budget expenditure.

Research models

To explore the relationship between slack resources and healthcare costs, linear regression, quadratic regression and cubic regression models were constructed in this research and are shown below.

$$\mathrm{LnCOST}_{it} = \beta_0 + \beta_1 \times \mathrm{SLACK}_{it} + \beta_2 \times \mathrm{C}_{it} + \varepsilon_{it} \quad (1)$$

$$\mathrm{LnCOST}_{it} = \beta_0 + \beta_1 \times \mathrm{SLACK}_{it} + \beta_2 \times \mathrm{SLACK}_{it}^2 + \beta_3 \times C_{it} + \varepsilon_{it} \quad (2)$$

$$\mathrm{LnCOST}_{it} = \beta_0 + \beta_1 \times \mathrm{SLACK}_{it} + \beta_2 \times \mathrm{SLACK}_{it}^2 + \beta_3 \times \mathrm{SLACK}_{it}^3 + \beta_4 \times C_{it} + \varepsilon_{it} \quad (3)$$

, where COST represents the cost consumption index; SLACK represents the slack resource in the hospital, *C* represents the control variable and *it* represents the data of the hospital i in year t. If the change in R^2 and β_2 are significant for the quadratic model compared with the linear model, there is a U-shaped or inverted U-shaped relationship. Similarly, If the change in R^2 and β_3 are significant for the cubic model compared with the linear and quadratic models, then an S-shaped relationship (three-stage relationship model) exists.

Analysis

The DEA model was applied to measure the main variable using DEAP 2.1. Descriptive statistical analysis was done using STATA 15. Pearson correlation coefficient analysis and variance inflation factor tests were used to avoid multicollinearity. The HAUSMAN test was used to determine the appropriate panel regression model, and then to analyse the relationship between slack and the cost consumption index.

Patient and public involvement

There was no patient or public involvement.

RESULTS

Slack resource status

The slack resource and cost consumption index for tertiary and secondary hospitals from 2015 to 2019 is shown in figure 1. Mehrtak et al.(2014) divided DEA efficiency scores into low, moderate, and high levels, which we also used to determine slack levels.[46] It can be seen that before 2017, the proportion of secondary hospitals in moderate and high slack was higher than that of tertiary hospitals. After 2017, the proportion of tertiary and secondary hospitals in low slack is not significantly different, but 5.56% of secondary hospitals have high slack. As a whole, secondary hospitals have more slack resources than tertiary hospitals. In secondary hospitals, cost consumption is consistently lower than in tertiary hospitals.

Correlation analysis and covariance test

The hospital size, disposable income per capita, proportion of the elderly population, resident population density, the level of urbanisation, and health expenditure as a percentage of general public budget expenditure were taken as logarithms to avoid heteroskedasticity. Slack took values in the range of (0,1) and the cost consumption index took values in the range of (0,2). Both variables were ratios, so they were not logarithms. Online supplemental table 1 presents the correlation analysis

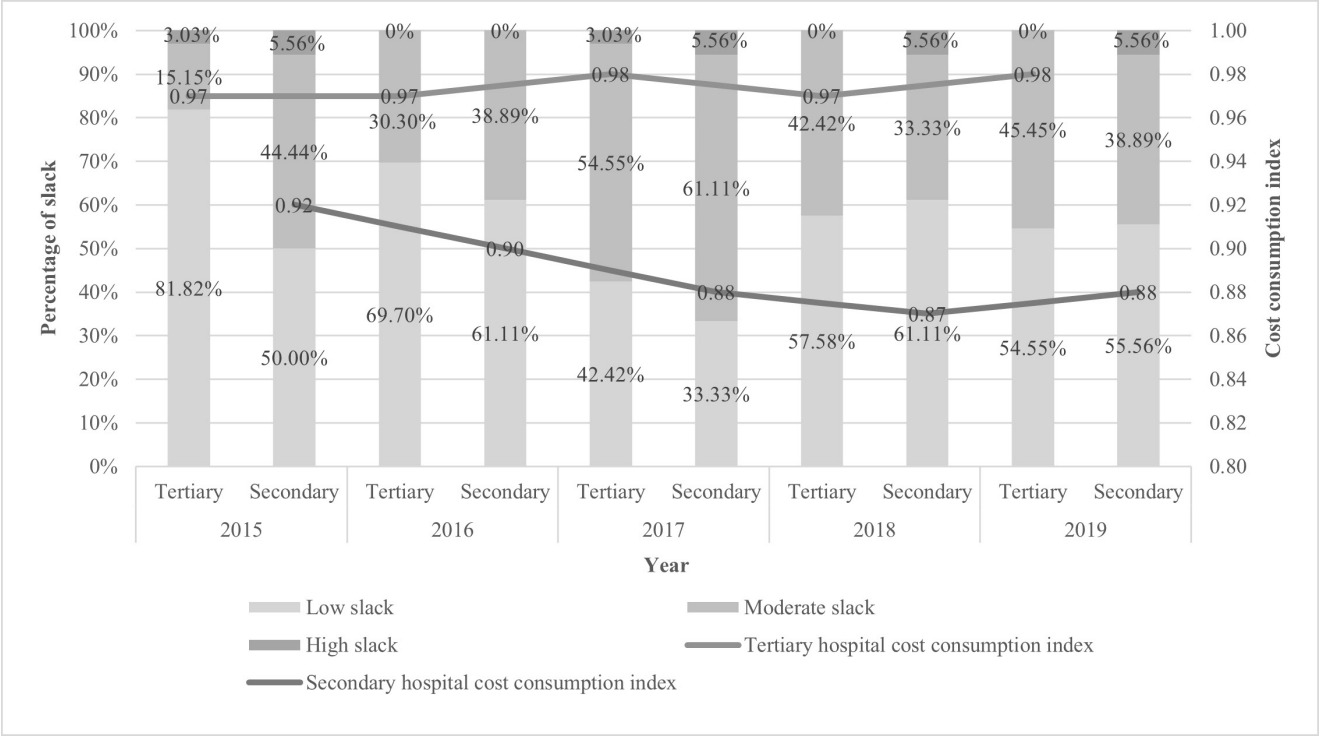

Figure 1 Slack resource and cost consumption index for tertiary and secondary hospitals, 2015–2019.

results between the cost consumption index, slack, and the control variables for tertiary and secondary hospitals. Pearson's correlation coefficient test indicated that some variables showed high correlation in both correlation analyses. Therefore, the variance inflation factor (VIF) was used to test the multicollinearity problem. For tertiary and secondary hospitals, the VIF values of each variable were all less than 10, and the average VIF value was less than 5. Subsequent regression analyses could be performed.

Panel regression analysis

Panel models (1) to (6) were constructed to analyse the linear, (inverted) U-shaped, and transposed S-shaped relationships between slack resources and cost consumption index in tertiary and secondary hospitals. According to the results of the HAUSMAN test, the fixed-effects model was selected for models (1) to (3), and the random-effects model was selected for the others. The results are shown in table 1. All regression models were significant at least at the 10% level. For tertiary hospitals, the cubic coefficient of the slack resources in the model (3) was significant at the 1% level, and its R^2 was increased compared with models (1) and (2). Therefore, the relationship between slack resources and the cost consumption index for tertiary hospitals was transposed S-shaped relationship. For secondary hospitals, the first-order coefficient of slack resources in the model (4) was significant at the 5% level, suggesting the possibility of a linear relationship. The quadratic coefficient in model (5) and the cubic coefficient in model (6) were not significant, indicating that there was no (inverted) U-shaped or transposed S-shaped relationship. Therefore, the slack resources were positively related to the cost consumption index. The regression fit plots are shown in figure 2.

DISCUSSION

In China's healthcare system, public hospitals account for 84.02% of treatments and diagnoses,[47] providing quality and affordable healthcare services is their responsibility. In this study, we evaluate the effect of slack resources on healthcare cost in tertiary and secondary hospitals by applying organisational slack theory.

Between 2015 and 2019, slack resources were consistently more severe in secondary hospitals than in tertiary hospitals. Similarly, Jiang *et al* and Zhu *et al*. found that the efficiency of Beijing's tertiary hospitals has gradually improved after the new medical reform, while secondary hospitals did not perform as well as expected.[48 49] Secondary hospitals in China treat common and multiple diseases and receive referrals from primary care institutions, which are the intermediate links of graded care.[50] The declining bed utilisation rate year after year, however, indicates that this responsibility is not being met.[51] One of the reasons for this phenomenon is that the healthcare reform policy does not pay enough attention to secondary hospitals.[52] Another reason is that patients are diverted.[53] Influenced by previous disorderly medical habits, patients with common diseases tend to go to tertiary hospitals with high levels of medical services or to primary medical services with lower prices.[54] Tertiary hospitals gathered in secondary hospitals' service areas,

Table 1 Results from regression analyses

	Tertiary hospital			Secondary hospital		
Variables	**COST(1)**	**COST(2)**	**COST(3)**	**COST(4)**	**COST(5)**	**COST(6)**
Slack[1]	−0.218*	0.229	−0.717***	0.179**	0.417	0.096
	(−1.99)	(1.35)	(−3.04)	(2.51)	(1.19)	(0.18)
Slack[2]		−1.563***	6.333***		−0.782	1.787
		(−2.75)	(3.45)		(−0.75)	(0.56)
Slack[3]			−12.914***			−5.079
			(−4.61)			(−0.88)
lnsta	0.176*	0.167*	0.204**	−0.056	−0.061	−0.066
	(1.98)	(1.82)	(2.29)	(−0.77)	(−0.80)	(−0.85)
lnbed	0.046	0.020	−0.008	0.125***	0.128***	0.137***
	(0.69)	(0.39)	(−0.18)	(2.67)	(2.75)	(2.76)
lnincome	0.090	0.060	0.014	−0.218**	−0.216**	−0.220**
	(0.70)	(0.59)	(0.17)	(−2.42)	(−2.39)	(−2.43)
lnaging	−0.017	−0.021	−0.043	−0.093	−0.098	−0.100
	(−0.20)	(−0.26)	(−0.56)	(−0.97)	(−0.99)	(−1.01)
lndensi	0.357	0.260	0.091	0.077***	0.077***	0.079***
	(0.99)	(0.95)	(0.40)	(3.02)	(3.09)	(3.08)
lnurban	−0.886	−0.586	−0.080	0.264	0.252	0.251
	(−0.69)	(−0.62)	(−0.08)	(1.20)	(1.16)	(1.13)
lnexpen	−0.038	−0.053	−0.058*	0.079	0.074	0.078
	(−1.18)	(−1.60)	(−2.00)	(1.18)	(1.07)	(1.09)
Constant	−0.626	−0.536	−0.880	1.176	1.240	1.248
	(−0.26)	(−0.31)	(−0.44)	(1.03)	(1.08)	(1.08)
R^2	0.231	0.324	0.442	0.231	0.234	0.237
Wald χ^2	2.11*	3.62***	891.74***	81.08***	91.88***	98.00***

*p<0.1, **p<0.05, ***p<0.01.
COST, cost consumption index; lnaging, logarithm of the proportion of the elderly population; lnbed, logarithm of the number of beds; lndensi, logarithm of resident population density; lnexpen, logarithm of health expenditure as a percentage of general public budget expenditure; lnincome, logarithm of disposable income per capita; lnsta, logarithm of the total number of staff; lnurban, logarithm of the level of urbanization.

further causing a patient diversion.[55] In tertiary hospitals, cost consumption is consistently higher than in secondary hospitals. This might be explained by the fact that tertiary hospitals usually treat patients with worse conditions when they have the same disease.[56 57] The same situation was also obtained in the study conducted by Sangwan *et al* in Indian hospitals.[58]

When the correlation between slack resources and the cost consumption index was analysed separately for tertiary and secondary hospitals, the results were interesting and informative. In tertiary hospitals, the slack resources and cost consumption index show a transposed S-shaped relationship. But for secondary hospitals, slack resources were positively correlated with cost consumption index. This is because tertiary hospitals largely represent the overall level of healthcare in Beijing, and the relationship between slack resources and healthcare costs is more complex. In fact, tertiary hospitals dominate the healthcare market in Beijing. As a whole and in terms of their individual size, tertiary hospitals in Beijing are larger than secondary hospitals, and they naturally occupy more resources.[9] It follows that if we can use slack resources to reduce the cost of treatment in tertiary hospitals, this will result in cost savings for city-wide healthcare services. Jiang *et al* found that organisational slack and performance of listed companies also have a transposed S-shaped relationship, and proposed that enterprise strategy should also be phased.[59] This view is also applicable in hospital management. The following discussion will also examine the relationship between slack and healthcare costs at different stages. It is worth mentioning that hospital managers need to have sufficient sensitivity to slack to keep it within reasonable limits in order to control the rapid growth of healthcare expenses.

The transposed S-shaped relationship between slack resources and the cost consumption index can be

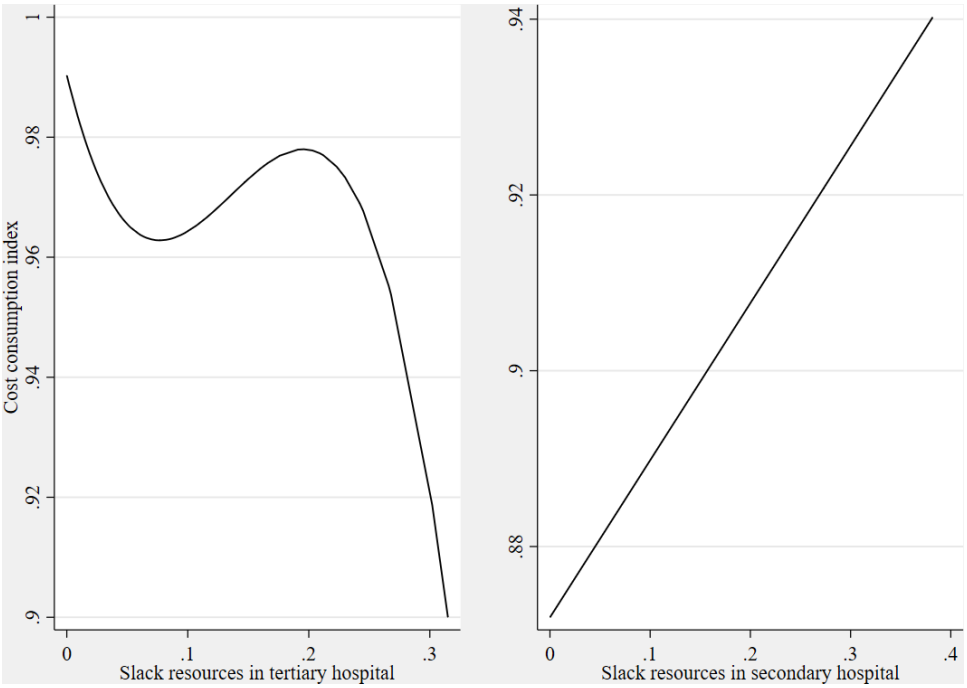

Figure 2 Regression fit plots for models (1) to (6).

divided into three stages. Initially, the slack growth and cost consumption index decreased accordingly, which can be explained by the opinion of Holzhacker *et al* that moderate reserve capacity can mitigate congestion costs.[60] Cost control has always been an important issue in China's new healthcare reform, and slack in this phase can mitigate excessive growth in healthcare costs.[61] Consequently, slack leads to cost growth, suggesting that the ongoing investment of resources is not being used in a benign way. Driven by financial pressures, hospitals' behaviour tends to conflict with the public interest, leading to higher healthcare costs.[62 63] Therefore, while government investments are increasing, hospitals should be focused on optimising resource allocation to ensure that healthcare resources are being used to their full potential. In the third stage, slack helps control healthcare costs. When slack increases to a certain level, it can provide clinical teams and patients with more treatment options to choose from, which then reduces the pressure on patients to purchase healthcare services or products, reducing patients' financial burden of illness.

Unlike in tertiary hospitals, slack resources in secondary hospitals are positively correlated with the cost consumption index, which means that slack resources increase the burden of healthcare for residents. Therefore, secondary hospital managers are supposed to maintain slack at a low level and improve hospital capacity and competitiveness through slack resource utilisation. Human resources have been proven to be a key factor in improving hospital performance, and secondary hospitals can take advantage of slack resources to train potential talent and improve technology in order to better serve patients from tertiary hospitals and primary care.[64] In addition, secondary hospitals can also consider "transformation". As China's ageing process is currently accelerating, secondary hospitals can consider combining medical care with elderly care.[65] It would help improve the utilisation of medical resources and enhance residents' trust in secondary hospitals.

The contributions of this study include the following points. First, there is innovation in the research subject. Many previous studies of organisational slack focused on firms,[66–68] while few have explored the relationship between slack resources and healthcare costs in hospitals.[69 70] In this study, organisation slack theory is applied to Beijing public hospitals, enriching and innovating the theory's research area. Second, due to the different functional positioning, this research focused on tertiary and secondary hospitals, respectively. There are some surprising differences in the results, which can provide targeted inspiration for hospital managers at different levels. Third, China, as an emerging economy, is undergoing an economic transition, and this study offers experience in health management for other countries during the same timeframe. In addition, China's public hospitals are the main part of the healthcare system and are government-led organisations that reflect the public welfare. The large population puts great pressure on China's hospitals to provide healthcare. This research also provides empirical support for countries with similar health systems that face the same challenges.

There are still some limitations in this research. First, the number of tertiary hospitals and secondary hospitals selected for this study is different because tertiary hospitals dominate the healthcare market in Beijing. Such a sample proportion of hospitals better reflects the real situation of healthcare resource distribution in Beijing. Second, the relationship between slack and healthcare costs may be dynamic, and whether slack resources

are used efficiently will be reflected in healthcare costs to a certain extent, which makes it more difficult for managers to assess. Third, this research only uses data up to 2019, since COVID-19 occurs at the end of the year. By this time, public hospitals will have much more complex social responsibilities than before, and data comparability will be affected. In future research, the data after 2019 can be collected to explore what role slack plays in healthcare costs against the background of COVID-19.

CONCLUSIONS

This research measured the slack resources of 51 public hospitals in Beijing and explores their relationship with healthcare costs. The results showed that from 2015 to 2019, slack resources were consistently more severe in secondary hospitals than in tertiary hospitals, and healthcare costs were consistently higher in tertiary hospitals than in secondary ones. In tertiary hospitals, slack resources show a transposed S-shaped relationship with the cost consumption index. In secondary hospitals, slack resources are positively correlated with the cost consumption index. This suggests managers of tertiary hospitals should keep slack within a moderate range to control healthcare costs based on operating conditions, government reform policies, and future development plans. In addition, secondary hospitals should not keep too many slack resources. Managers should make full use of resources to improve competitiveness or consider service transformation to explore new development opportunities.

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REFERENCES

1 World Health Organization (WHO). Global expenditure on health: public spending on the rise? 2021. Available: https://www.who.int/publications/i/item/9789240041219 [Accessed 25 Apr 2022].
2 World Health Organization (WHO). Global spending on health 2020: weathering the storm. 2022. Available: https://www.who.int/publications/i/item/9789240017788 [Accessed 30 Jun 2022].
3 National Health Commission of China. *2020 China health statistics yearbook (in Chinese)*. Beijing: National Health Commission of China, 2021.
4 National Health Commission of China. *2011 China health statistics yearbook (in Chinese)*. Beijing: National Health Commission of China, 2011.
5 Fang P, Hu R, Han Q. Effects of healthcare reform on health resource allocation and service utilization in 1110 Chinese county hospitals: data from 2006 to 2012. *Int J Health Plann Manage* 2017;32:400–15.
6 Hu X, Wang P. Has China's healthcare reform reduced the number of patients in large general hospitals? *Int J Environ Res Public Health* 2022;19:5428.
7 Li LQ, Zhao L, Li JW, *et al*. Coordinated development of primary care resource allocation and economy as well as associate factors in China: a fuzzy-set qualitative comparative analysis (in Chinese). *Chinese General Practice* 2022;25:8.
8 Gong S, Gao Y, Zhang F, *et al*. Evaluating healthcare resource inequality in Beijing, China based on an improved spatial accessibility measurement. *Transactions in GIS* 2021;25:1504–21.
9 Beijing Municipal Health Commission. *Compilation of statistics on health work in beijing*. Beijing Municipal Health Commission, 2019.
10 Lu C, Zhang Z, Lan X. Impact of China's referral reform on the equity and spatial accessibility of healthcare resources: a case study of Beijing. *Soc Sci Med* 2019;235:112386.
11 Beijing Municipal Health Commission. 2020 Beijing health work statistics. 2022. Available: http://www.phic.org.cn/tjsj/wstjjb/202106/P020210618453831202703.pdf [Accessed 14 Jun 2022].
12 Wang J, Jia W. Resources allocation and utilization efficiency in China's healthcare sector. *China Finance and Economic Review* 2021;10:88–109.
13 Chan JL, Clark TN, Troha MA. Organizational slack in municipal governments: a cost variance analysis. *J Urban Aff* 1983;5:95–107.
14 Nohria N, Gulati R. IS slack good or bad for innovation? *Acad Manage J* 1996;39:1245–64.
15 Miller JL, Adam EE. Slack and performance in health care delivery. *Int J Qual Reliab Manage* 1996;13:63–74.
16 Mogha SK, Yadav SP, Singh SP. Slack based measure of efficiencies of public sector hospitals in Uttarakhand (India). *Benchmarking* 2015;22:1229–46.
17 Valdmanis VG, Rosko MD, Mutter RL. Hospital quality, efficiency, and input slack differentials. *Health Serv Res* 2008;43:1830–48.
18 Youn KI, Wan TTH. Effects of environmental threats on the quality of care in acute care hospitals. *J Med Syst* 2001;25:319–31.
19 Puro N, Borkowski N, Feyereisen S, *et al*. The role of organizational slack in buffering financially distressed hospitals from market exits. *J Healthc Manag* 2021;66:48–61.
20 Zinn JS, Flood AB. Commentary: slack resources in health care organizations--fat to be trimmed or muscle to be exercised? *Health Serv Res* 2009;44:812–20.
21 Baker A. *Implementing innovation in NHS trusts: exploring the dissemination and implementation of NICE workplace health and wellbeing guidance in three organisational case studies*. Torrington Place: University College London, 2017.
22 Cheng JLC, Kesner IF. Organizational slack and response to environmental shifts: the impact of resource allocation patterns. *J Manag* 1997;23:1–18.
23 Zona F. Corporate investing as a response to economic downturn: prospect theory, the behavioural agency model and the role of financial slack. *Brit J Manage* 2012;23:S42–57.
24 Baker A. Book: crossing the quality chasm: a new health system for the 21st century. *BMJ* 2001;323:1192.

25 Peng X, Ye Y. Uncover the black box of nurse slack-performance relationship. *Proceedings* 2020;2020:17521.
26 Xiong J, Jin C, Zhou Y, *et al*. Necessity study of health resource allocation reasonable redundancy considering the fluctuation of health demand (in Chinese). *Chinese Hospital Management* 2016;36:5–7+18.
27 Huang W, Liu W. Study on the organizational slack of medical care institutions based on data envelopment analysis (in Chinese). *Chinese Hospital Management* 2014;34:14–6.
28 Liu M, Liu W, Zhang J, *et al*. Introduction to DRGs-based performance evaluation platform for inpatient healthcare services (in Chinese). *Chinese Journal of Hospital Administration* 2015;11:878–80.
29 Wang Y, Lu X, Peng L, *et al*. Analysis of the effect of DRG medical insurance payment on the performance of hospital service in hunan province. *In Review* [Preprint].
30 Yuan X, Li C, Han F, *et al*. Adjusted cost consumption index of major diagnosis-related group data in hospital medical performance evaluation. *Chinese Journal of Hospital Administration* 2017;33:818–21.
31 Greenwald L, Cromwell J, Adamache W, *et al*. Specialty versus community hospitals: referrals, quality, and community benefits. *Health Aff (Millwood)* 2006;25:106–18.
32 Langland-Orban B, Pracht E, Salyani S. Uncompensated care provided by emergency physicians in Florida emergency departments. *Health Care Manage Rev* 2005;30:315–21.
33 Thorpe KE, Phelps CE. The social role of not-for-profit organizations: hospital provision of charity care. *Econ Inq* 1991;29:472–84.
34 Clement JP, Smith DG, Wheeler JR. What do we want and what do we get from not-for-profit hospitals? *Hosp Health Serv Adm* 1994;39:159–78.
35 Nunamaker TR. Measuring routine nursing service efficiency: a comparison of cost per patient day and data envelopment analysis models. *Health Serv Res* 1983;18:183–208.
36 Ozcan YA, Luke RD. A national study of the efficiency of hospitals in urban markets. *Health Serv Res* 1993;27:719–39.
37 Sherman HD. Hospital efficiency measurement and evaluation. Empirical test of a new technique. *Med Care* 1984;22:922–38.
38 Pritpal S, Prikshat A. Analyzing efficiency and Slack of tertiary hospitals of Punjab: a case of data envelopment analysis. *IJCRR* 2021;13:78–83.
39 Dong S, Zuo Y, Guo S, *et al*. Data envelopment analysis for relative efficiency measurement of Chinese hospitals: a systematic review. *RHS* 2017;2:79.
40 Ersoy K, Kavuncubasi S, Ozcan YA, *et al*. Technical efficiencies of Turkish hospitals: DEA approach. *J Med Syst* 1997;21:67–74.
41 Harrison JP, Coppola MN, Wakefield M. Efficiency of federal hospitals in the United States. *J Med Syst* 2004;28:411–22.
42 Lin C-S, Chiu C-M, Huang Y-C, *et al*. Evaluating the operational efficiency and quality of tertiary hospitals in Taiwan: the application of the EBITDA indicator to the DEA method and TOBIT regression. *Healthcare* 2022;10:58.
43 Charnes A, Cooper WW, Rhodes E. Measuring the efficiency of decision making units. *Eur J Oper Res* 1978;2:429–44.
44 Dong S, Zuo Y, Tao H, *et al*. Study on DEA-based Chinese hospital efficiency and applied indicators (in Chinese). *Chinese Journal of Health Policy* 2014;7:6.
45 Goldstein SM, Iossifova AR. Ten years after: interference of hospital Slack in process performance benefits of quality practices. *J Oper Manag* 2012;30:44–54.
46 Mehrtak M, Yusefzadeh H, Jaafaripooyan E. Pabon LASSO and data envelopment analysis: a complementary approach to hospital performance measurement. *Glob J Health Sci* 2014;6:107–16.
47 China Union Medical University. *China health statistical yearbook 2020*. China Union Medical University, 2021.
48 Jiang S, Min R, Fang P-Q. The impact of healthcare reform on the efficiency of public county hospitals in China. *BMC Health Serv Res* 2017;17:838.
49 Zhu J, Song X. Changes in efficiency of tertiary public general hospitals during the reform of public hospitals in Beijing, China. *Int J Health Plann Manage* 2022;37:143–55.
50 Ma S, Gao G, Zhang H, *et al*. Analyzing the functional orientation and development difference between tertiary and secondary public hospitals from the performance appraisal policy of public hospitals (in Chinese). *Chinese Health Quality Management* 2021;88:89–92+100.
51 Hao C. 2020 analysis of the current situation and growth prospects of the secondary general hospital industry (in Chinese). 2021. Available: https://www.chinairn.com/hyzx/20200724/143441170.shtml [Accessed 21 Jul 2022].
52 Zhu C. Practice and exploration of the development of urban secondary general hospitals (in Chinese). *Chinese Hospital Management* 2011;31:79–80.
53 Pengqian F, Qiuxia H, Qiaoli X, *et al*. Urban secondary hospitals and the hierarchical medical system: development strategy study. *Chinese Journal of Hospital Administration* 2016;32:502.
54 Cui C, Zuo X, Wang Y, *et al*. A comparative study of patients' satisfaction with different levels of hospitals in Beijing: why do patients prefer high-level hospitals?. *BMC Health Serv Res* 2020;20:643.
55 Shang M, Wu L. Research on the causes and countermeasures of the development dilemma of urban secondary hospitals in the context of new medical reform (in Chinese). *Chongqing Medicine* 2013;23:2808–9.
56 Li Y, Gong W, Kong X, *et al*. Factors associated with outpatient satisfaction in tertiary hospitals in China: a systematic review. *IJERPH* 2020;17:7070.
57 McCollum R, Chen L, ChenXiang T, *et al*. Experiences with primary healthcare in fuzhou, urban China, in the context of health sector reform: a mixed methods study. *Int J Health Plann Manage* 2014;29:e107–26.
58 Sangwan A, Prinja S, Aggarwal S, *et al*. Cost of trauma care in secondary- and tertiary-care public sector hospitals in North India. *Appl Health Econ Health Policy* 2017;15:681–92.
59 Jiang C, Zhao S. The relationship between organizational slack and performance: an empirical time-series study of Chinese listed companies. *Manage World* 2004;5:108–15.
60 Holzhacker M, Krishnan R, Mahlendorf MD. Unraveling the black box of cost behavior: an empirical investigation of risk drivers, managerial resource procurement, and cost elasticity. *Account Rev* 2015;90:2305–35.
61 Zang X, Zhang M, Wei S, *et al*. Impact of public hospital pricing reform on medical expenditure structure in Jiangsu, China: a synthetic control analysis. *BMC Health Serv Res* 2019;19:512.
62 Shi L, Liang F, Shao H, *et al*. Preliminary development of a reference conceptual framework about social responsibility of public hospitals in China. *JHA* 2015;4:23.
63 Liu W, Shi L, Pong RW, *et al*. How patients think about social responsibility of public hospitals in China? *BMC Health Serv Res* 2016;16:371.
64 Amelia D, Sijabat R. The impact of human resources management practices on job performance: the case of nurses at Siloam Lippo village hospital. *Jur Kep Soed* 2020;15:205–15.
65 Shen X, Wu S. Dilemma and outlet of the development of secondry hospitals in China (in Chinese). *Chinese Journal of Hospital Administration* 2021:864–7.
66 Guo F, Zou B, Zhang X, *et al*. Financial slack and firm performance of SMMEs in China: moderating effects of government subsidies and market-supporting institutions. *Int J Prod Econ* 2020;223:107530.
67 Zhang Y, Li J, Hu Y, *et al*. The effects of slack resource of R&D professionals on firm performance: evidence from traditional manufacturing firms in an emerging economy. *Int J Hum Resour Manag* 2020;31:1594–616.
68 Tabassam AH, Khan S. Corporate governance and firm performance: exploring the mediating role of financial Slack. *JAFEE* 2021;7:511–22.
69 Marlin DR, Geiger SW. An examination of the hospital Slack and performance relationship. *Proceedings* 2017;2017:17471.
70 Geiger SW, Marlin D, Segrest SL. Slack and performance in the hospital industry: a configurational approach. *MD* 2019;57:2978–96.

Supplementary Table 1. Correlation Analysis of Variables

Variables	Mean	SD	COST	slack	lnbed	lnsta	lnincome	lnaging	lndensi	lnurban
Tertiary hos										
COST	0.947	0.163	1							
slack	0.162	0.124	0.0130	1						
lnbed	6.597	0.611	-0.228***	0.106	1					
lnsta	7.320	0.629	-0.264***	0.130*	0.914***	1				
lnincome	10.98	0.265	0.325***	-0.029	0.354***	0.310***	1			
lnaging	2.473	0.217	-0.015	-0.062	0.476***	0.449***	0.673***	1		
lndensi	8.437	1.497	0.286***	0.068	0.380***	0.415***	0.816***	0.605***	1	
lnurban	4.507	0.167	0.503***	0.018	0.172**	0.161**	0.792***	0.408***	0.805***	1
lnexpen	1.838	0.250	0.071	-0.062	0.057	0.080	0.146*	-0.010	0.174**	0.127
Secondary hos										
COST	0.890	0.185	1							
slack	0.103	0.117	0.392***	1						
lnbed	6.087	0.567	0.236**	0.266**	1					
lnsta	6.789	0.488	0.196*	0.357***	0.912***	1				
lnincome	10.94	0.273	0.399***	0.051	-0.406***	-0.305***	1			
lnaging	2.473	0.175	0.214**	0.073	0.056	0.053	0.349***	1		
lndensi	8.011	1.747	0.568***	0.107	-0.278***	-0.178*	0.868***	0.322***	1	
lnurban	4.477	0.198	0.588***	0.235**	-0.275***	-0.176*	0.835***	0.168	0.886***	1
lnexpen	1.754	0.233	-0.124	-0.266**	0.167	0.027	-0.276***	0.271***	-0.260**	-0.407***

Notes: SD, standard deviation; COST, cost consumption index; lnbed: logarithm of the number of beds; lnsta: logarithm of the total number of staff; lnincome: logarithm of disposable income per capita; lnaging: logarithm of the proportion of the elderly population; lndensi: logarithm of resident population density; lnurban: logarithm of the level of urbanization; lnexpen: logarithm of health expenditure as a percentage of general public budget expenditure; * $p<0.1$, ** $p<0.05$, *** $p<0.01$.