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REGIONAL INEQUALITY IN CHINA'S HEALTH CARE EXPENDITURES

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SUMMARY

This paper has two parts. The first part examines the regional health expenditure inequality in China by testing two hypotheses on health expenditure convergence. Cross-section regressions and cluster analysis are used to study the health expenditure convergence and to identify convergence clusters. We find no single nationwide convergence, only convergence by cluster. In the second part of the paper, we investigate the long-run relationship between health expenditure inequality, income inequality, and provincial government budget deficits (BD) by using new panel cointegration tests with health expenditure data in China's urban and rural areas. We find that the income inequality and real provincial government BD are useful in explaining the disparity in health expenditure prevailing between urban and rural areas. In order to reduce health-spending inequality, one long-run policy suggestion from our findings is for the government to implement more rapid economic development and stronger financing schemes in poorer rural areas. Copyright © 2009 John Wiley & Sons, Ltd.

JEL classification: C2; C3; I10

KEY WORDS: health expenditure inequality; income inequality; government budget deficits; convergence test; panel cointegration test

1. INTRODUCTION

An important feature of China's economic reforms which began in 1978 is the dramatic change in its health system from a centrally planned system to a market-based one (Ma *et al.*, 2008). Unfortunately, as admitted by the Chinese government, the reform in the health system has not been successful. The most cited problems with China's reformed health system include the heavy reliance on private financing, dramatic drop in the health insurance coverage, and rising health care costs (Yip and Hsiao, 2008; Wagstaff and Lindelow, 2008). To cite one example, between 1993 and 2003, the health insurance coverage rate in urban areas dropped from around 70 to 55%. The drop was much more dramatic in the rural areas, from a peak of around 85% in 1975 to about 9.5% in 2003 (Ma *et al.*, 2008). As a result, a majority of the rural population must pay out of pocket for all health services. The out-of-pocket share of health care spending in China has risen sharply from 20.4% in 1978 to 53.6% in 2004.[1]

There has been a growing concern on the widening inequality in health care and its socioeconomic impacts in the literature. For example, Liu *et al.* (1999) observed that the growing gap in income and health status between urban and rural residents is correlated with the increasing gaps in income and health care utilization. Yip and Mahal (2008) found an increase in interprovincial inequality in

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[1]See Table 4-1 of *Year book of Health in the People's Republic of China* 2007.

life expectancy at birth and infant mortality between 1980 and 2000. The same was the case with within-rural, within-urban, and between rural and urban inequalities in infant mortality (Zhang and Kanbur, 2005).

Possibly due to the lack of time series data, the above-mentioned studies on health status or inequalities in health spending largely rely on the survey research, or cross-sectional models, and time-series econometric methods were rarely used. Cross-section models generally do not allow the time necessary for changes in the time-dependent independent variables to have an impact on the dependent variable. To allow for time lag in the adjustment of the dependent variable, in the present paper, we investigate the relationship between health spending and income inequality in a panel setting by utilizing the pooled cross-section and time-series data. The objective of this paper is twofold. First is to examine China's regional inequalities in health spending by testing two convergence hypotheses on the health care expenditure (HCE). An understanding of how the provinces that lag behind in health-spending (followers) catch up with the leaders can be useful in evaluating recently introduced health policies being pursued by the central and local governments. Second is to investigate the relationship between health expenditure inequality, income inequality, and government BD in China by using the new panel cointegration tests of Westerlund and Edgerton (2007, 2008) in a panel setting. Our use of the government BD and the income inequality variables in the panel cointegration tests is motivated by Gerdtham and Johsson (2000) who commented on the important issues for future research on the determinants of HCE. According to them, 'Empirical studies in recent years have been remarkably unwilling to test 'new' variables as regressors in their models. One possible such 'new' candidate is government BD, which is likely to be a strong constraint on public health expenditure…. One final issue that merits further attention is the inconclusive results in the area of testing for non-stationarity and cointegration of health expenditure relationships.' In addition, we also examine how the 'new' variable on income inequality would explain the regional disparity in HCE in China. To facilitate the analysis, more disaggregate panel data on urban and rural households' per capita HCE in China are collected in 28 provinces from 1995 to 2006.[2]

The structure of the study is as follows. Section 2 describes the test methods. The empirical results are discussed in Sections 3 and 4. The major findings and their policy implications are discussed in Section 5.

2. METHODOLOGY

China currently spends about 5.6% of its gross domestic product (GDP) on health expenditure, but only about 20% of the HCE is spent in the rural areas (Evans and Xu, 2008). Regional discrepancies exist. As mentioned above, our study contains two parts. In the first part, we will investigate the HCE convergence hypotheses, and identify the convergence clusters with aggregate panel data. In the second part, we will examine the inequalities in health expenditure using panel cointegration tests with disaggregate data on health expenditures in urban and rural areas. In this section, we will briefly discuss the methods for testing the convergence hypotheses using pooled cross-section and time-series data in HCEs.

The key concept of HCE convergence comes from the income convergence of neoclassical growth models. Under neoclassical assumptions, growth models predict that the incomes of countries/regions at different initial levels of development will converge to a similar steady-state growth path in the long run. Similarly, as incomes converge across regions, HCEs, being an important component of consumption, should also show signs of convergence.[3]

[2]Disaggregate data classified by urban and rural areas are only available from 1995.
[3]See Hitiris and Nixon (2001), Okunade *et al.* (2004), and Wang (2008) for discussions on the theory of economic convergence and its implications on the study of health expenditure convergence.

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In the cross-section literature, there are two concepts of convergence: β-convergence and σ-convergence. Specifically, given N provinces with different initial levels of HCEs, if provinces with lower expenditure levels increase their spending faster than those with higher expenditure levels over a given time horizon, then this narrowing process is called β-convergence. If the cross-province dispersion in health expenditure diminishes over time, the provinces are said to experience σ-convergence. The dispersion measure is represented by the coefficient of variation (CV), that is, the standard deviation of a variable normalized by its mean.

To test for β-convergence, we estimate the test regressions as specified in Equation (A1) in Appendix A. If the test results do not produce evidence on a universal convergence in HCE for all provinces in China, we will perform a cluster analysis to estimate the number and composition of convergence clubs by utilizing the cluster method proposed by Hobijn and Franses (2000).

3. RESULTS OF TESTING FOR HCE CONVERGENCE

3.1. Data

Aggregate panel data on per capita public HCE and GDP for 28 provinces in China are collected for the period of 1978–2004.[4] Both series are adjusted for inflation rates and are expressed in constant 1990 prices. Table I provides the summary statistics for HCE in 1978 and 2004, respectively, and their corresponding average annual growth rates for each province. HCE shows wide variations in the beginning and ending years of the sample. The ratio of health expenditure between the most and least expensive provinces increased from 6.14 in 1978 to 8.89 in 2004.

3.2. Cross-section evidence: results of β- and σ-convergence

We first examine the σ-convergence using the CV. Figure 1 shows the trend pattern of the values of CV for HCE in 28 provinces for 1978–2004. The cross-regional dispersion in HCE increased 46.8% from 48.58 to 71.33 over the sample period. As the CV values for HCE show an upward trend in Figure 1, they do not support σ-convergence for HCE.

To assess β-convergence, we estimate cross-section regressions using Equation (A1) in Appendix A, with $k=1$ for $t=1, 2, \ldots, (T–1)$. Columns 2 and 3 of Table II provide the parameter estimates and their corresponding 90 and 95% confidence intervals obtained by the bootstrap method with 2000 replications. With a statistically insignificant point estimate for β (0.011), we find no evidence of absolute β-convergence in HCE. We then examine the conditional convergence by introducing the real per capita income variable, the GDP, to Equation (A1). Taking into account the impact of GDP, the estimated β coefficient is -0.029, which is statistically significant at the 5% level, supporting the conditional convergence. That is, the provincial HCE would converge at annual rate of 2.9% conditional on the provincial incomes. The estimated income coefficient for γ as listed in Table II is statistical significant, indicating that income is positively correlated with the subsequent HCE growth. This is consistent with the findings described in Section 4 that regional income dispersion is correlated with the health-spending inequality, implying that to alleviate health expenditure inequality, policies should focus on making the poorer rural areas grow faster.

To further investigate the absolute convergence, we regress long-run HCE growth on the initial level of HCE, that is, $(y_{i,T} - y_{i,1})$ on $y_{i,1}$. The results are summarized in column 4 of Table II. As the β estimate, -0.121, is statistically insignificant, it provides no evidence on the absolute β-convergence in HCE. This reinforces our earlier finding on the lack of an overall HCE convergence among different provinces, suggesting the existence of disparities in HCEs across provinces. With the presence of GDP,

[4]The data were provided by Chou (2007). Details on the compilation of the data set are available in this cited reference.

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Table I. Real per capita public health care expenditure (HCE) by province

Province	HCE in 1978	HCE in 2004	Avg. growth rate
	(RMB¥)	(RMB¥)	(%)
Beijing	14.95	62.65	5.67
Tianjin	11.16	44.42	5.46
Hebei	3.76	12.78	4.82
Shanxi	6.11	30.36	6.36
InnerMon[a]	8.84	22.79	3.71
Liaoning	8.72	15.49	2.23
Jilin	7.27	23.91	4.69
HLJ[a]	6.74	14.65	3.03
Shanghai	13.30	91.06	7.68
Jiangsu	4.19	21.09	6.41
Zhejiang	5.07	22.76	5.95
Anhui	4.43	13.59	4.41
Fujian	5.62	16.14	4.14
Jiangxi	3.61	10.25	4.09
Shandong	4.73	22.82	6.24
Henan	2.81	16.99	7.17
Hubei	4.45	23.03	6.53
Hunan	5.77	12.31	2.95
Guangdong	6.21	59.97	9.12
Guangxi	5.88	13.20	3.16
Sichuan	4.39	11.74	3.86
Guizhou	2.43	11.83	6.27
Yunnan	4.95	20.80	5.68
Shaanxi	5.54	21.32	5.32
Gansu	5.44	22.93	5.69
Qinghai	12.96	52.61	5.53
Ningxia	10.83	20.21	2.43
Xinjiang	8.52	35.77	5.67
Min.	2.43	10.25	2.23
Max.	14.95	91.06	9.12
Max/Min	6.14	8.89	4.08
Coefficient of variation	48.58	71.33	31.60

Notes: HCE is real per capita health care expenditure in constant 1990 prices. Sichuan includes Sichuan Province and Chongqing City.
[a]HLJ-Heilongjiang; InnerMon = Inner Mongolia.

Figure 1. Coefficient of variation for HCE

the point estimate for the initial level of HCE is −0.554 (column 4 of Table II), implying that HCE is converging conditional on the provincial income. The evidence for conditional β-convergence corresponds with what we obtained earlier.

Table II. β-convergence regressions for HCE

Coefficient	$(y_t y_{t-1})$ over y_{t-1}		$(y_T - y_1)$ over y_1	
	Estimate	Bootstrapped interval	Estimate	Bootstrapped interval
Absolute convergence				
α	0.025	(−0.006, 0.105) [−0.011, 0.119]	1.521**	(1.018, 2.030) [0.937, 2.128]
β	0.011	(−0.018, 0.024) [−0.023, 0.027]	−0.121	(−0.388, 0.146) [−0.444, 0.194]
R^2	0.003		0.019	
Conditional convergence				
α	−0.177	(−0.352, 0.057) [−0.394, 0.095]	−1.095	(−3.013, 0.759) [−3.370, 1.121]
β	−0.029**	(−0.043, −0.007) [−0.048, −0.003]	−0.554**	(−0.934, −0.186) [−0.996, −0.088]
γ	0.039*	(0.004, 0.063) [−0.003, 0.070]	0.520**	(0.166, 0.887) [0.093, 0.956]
R^2	0.039		0.211	

Notes: Numbers in parentheses are bootstrapped 5 and 95% percentiles of the empirical distribution of the estimates, while those in brackets are those of 2.5 and 97.5%. ** and * denote significance at the 5 and 10% levels, respectively.

3.3. Time-series evidence on convergence

In the previous section we showed that there is no nationwide convergence in heath care expenditures across provinces. We now turn to the identification of convergence clusters. Table III lists the outcome of the cluster search for HCE convergence clubs by employing the cluster algorithm of Hobijn and Franses (2000). China is historically divided into six large regions: North China, North-East China, East China, South Central China, South-West China, and North-West China. We label these regions by numbers 1–6, respectively. For the ease of interpreting our search results, we divide the 28 provinces into three groups, namely, the top one-third (*h*), the middle one-third (*m*), and the lowest one-third (*l*), according to their real median income levels. This division is given in the parentheses following the name of each province in Table III. The upper part of Table III shows that 19 provinces form eight asymptotically perfect convergence clubs of size 2–3, while the remaining nine are non-converging provinces. The finding is consistent with the lack of overall convergence of HCE obtained by the cross-section test models. Turning to the lower part of Table III, we find more evidence of asymptotically relative convergence in HCE across the 28 provinces, meaning that HCE growth rates are equal within a club in the long run. With the exception of Guangdong, all provinces belong to the 11 relative convergence clubs of size 2 or 3. Table III also indicates that none of the six traditionally classified regions form any type of time-series convergence clubs.

To illustrate, we have selected three provinces from the upper panel of Table III, namely, Hubei, Jiangsu, and Shannxi, which were shown to form the asymptotic perfect convergence club (Club No. 3 of size 3), and plot their HCE series in Panel A of Figure 2. We can see that the three provinces have similar dynamic pattern in HCE over time. Looking at the slightly different graph in Panel B of Figure 2, we can see that Guangdong province, which does not belong to any of the identified convergence clubs, in fact has very different dynamic behavior in HCE when compared with the provinces forming a relative convergence club. We will examine further the possible causes for the findings in this section.

4. PANEL TEST FOR THE RELATIONSHIP BETWEEN HEALTH-SPENDING INEQUALITY AND INCOME INEQUALITY

The lack of an overall convergence in the health expenditure across different provinces in China determined by the convergence test indicates the existence of inequality in health expenditure. To understand the factors that contributed to health-spending inequality, we turn to an alternative test

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Table III. Convergence clubs for HCE

Club no.	Club size	Member provinces		
Clubs with asymptotically perfect convergence				
1	3	Fujian (3*m*)	InnerMon (1*m*)	Zhejiang (3*h*)
2	3	Guangxi (4*l*)	Hunan (4*l*)	Sichuan (5*l*)
3	3	Hubei (4*m*)	Jiangsu (3*h*)	Shaanxi (6*l*)
4	2	Anhui (3*l*)	Guizhou (5*l*)	
5	2	Gansu (6*l*)	Yunnan (5*l*)	
6	2	Hebei (1*m*)	Jiangxi (3*l*)	
7	2	Jilin (2*m*)	Shanxi (1*m*)	
8	2	Qinghai (6*m*)	Tianjin (1*h*)	
Provinces without perfect convergence				
		Beijing (1*h*), Guangdong (4*h*), HLJ (2*h*), Henan (4*l*), Liaoning (2*h*), Ningxia (6*m*), Shandong (3*m*), Shanghai (3*h*), Xinjiang (6*h*)		
Clubs with asymptotically relative convergence				
1	3	Fujian (3*m*)	InnerMon (1*m*)	Zhejiang (3*h*)
2	3	Guangxi (4*l*)	Hunan (4*l*)	Sichuan (5*l*)
3	3	Hebei (1*m*)	HLJ (2*h*)	Jiangxi (3*l*)
4	3	Hubei (4*m*)	Jiangsu (3*h*)	Shaanxi (6*l*)
5	3	Henan (4*l*)	Shandong (3*m*)	Shanghai (3*h*)
6	2	Anhui (3*l*)	Guizhou (5*l*)	
7	2	Beijing (1*h*)	Xinjiang (6*h*)	
8	2	Gansu (6*l*)	Yunnan (5*l*)	
9	2	Jilin (2*m*)	Shanxi (1*m*)	
10	2	Liaoning (2*h*)	Ningxia (6*m*)	
11	2	Qinghai (6*m*)	Tianjin (1*h*)	
Provinces without relative convergence				
		Guangdong (4*h*)		

Notes: This table is arranged according to club size and alphabetical order of member provinces. Figures in parentheses stand for geographic locations (1, 2, …, 6) and income levels (*h*, *m*, *l*) in 1991, respectively. The geographic locations are defined as follows: 1. North China: Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia. 2. North east: Heilongjiang (HLJ), Jilin, and Liaoning. 3. East China: Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong. 4. South Central China: Henan, Hubei, Hunan, Guangdong, Guangxi, and Hainan. 5. South west: Chongqing, Sichuan; Guizhou, Yunnan, and Tibet. 6. Northwest: Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

method – the panel cointegration tests developed by Westerlund and Edgerton (2007, 2008) and use pooled cross-section and time-series data for urban and rural areas in China. The tests are designed based on the Lagrange multiplier (LM) principle, allowing for cross-sectional dependence, and which have been shown to work well in small samples. Details of the tests are described in the references cited above; thus, they will not be repeated here.

4.1. Data for health expenditure and income inequality measures

More disaggregate panel data classified by urban and rural areas are used to test the relationship between health expenditure inequality and income inequality. As the officially and privately published Gini coefficients are not useful in time-series analysis owing to the short-time span, we compute ratios of per capita disposable income of urban households to the per capita net income of rural households for 28 Chinese provinces, and use the resulting ratios as a proxy variable for the income inequality. As data with the urban–rural classification are available starting from 1995, our sample starts from 1995. Similarly, we obtain the ratios of per capita health expenditure of urban households to the per capita health expenditure of rural households and treat the resulting ratios as a proxy for health-spending inequality. Table IV lists the values of the ratios on the per capita health expenditure for three selected years 1995, 2000, and 2006. Our compiled data show that average real per capita household HCE in

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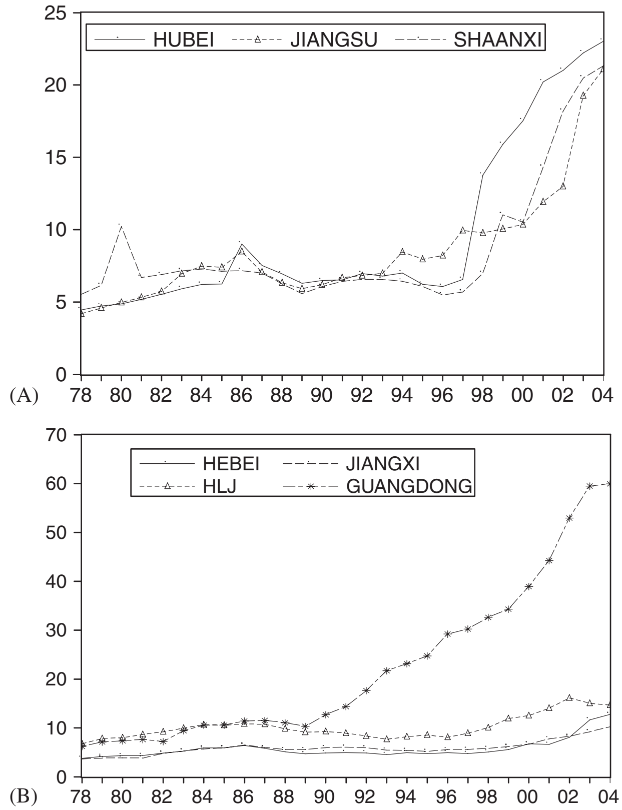

Figure 2. HCE convergence for selected provinces. Panel A: Asymptotically perfect convergence club. Panel B: Asymptotically relative convergence club and separate provinces

urban areas was RMB57.04 yuan in 1995, while that in rural households was only RMB24.53 yuan. The corresponding figures are RMB270.78 and RMB95.06, respectively, in 2006, indicating a widening urban–rural gap in health care spending over time. The health expenditure inequality between the most and least serious provinces increased from 3.70 in 1995 to 5.60 in 2000 before declining to 3.19 in 2006.

In addition to the income inequality measure, we also compute the ratio of the variability (standard deviation) of urban household income to that of rural household income. We consider a new variable on provincial government BD. The importance of this variable is given in Gerdtham and Johsson (2000). The governmental BD are likely to become a strong constraint on public health expenditure in many Chinese provinces; thus, they are of particular relevance and importance to China. Data for provincial government BD are adjusted for the inflation rates. The major sources for our data were various issues of *China Statistical Yearbook*, *Yearbook of Public Health in Peoples' Republic of China*, and various provincial Statistical Yearbooks.

4.2. Test results for relationship between inequalities in health spending and income

As mentioned in Section 1, our use of the income inequality and government BD in the panel cointegration tests is motivated by Gerdtham and Johsson (2000). Details of the test model are specified in Appendix A, linking the HCE inequality (Y) to income inequality (X) and one of the following other factors: variability in income inequality (Z_1), real government BD, and variability in real government BD (Z_2). Table V summarizes the test results of panel cointegraion[5] using the LM-type test developed in

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Table IV. Ratios of urban HCE to rural HCE by province in selected years

Province	1995	2000	2006
Beijing	1.38	2.36	2.30
Tianjin	1.57	1.51	3.99
Hebei	2.89	4.81	4.43
Shanxi	2.72	4.98	4.14
InnerMon	2.06	2.75	2.38
Liaoning	2.19	3.22	2.86
Jilin	1.76	3.27	2.62
HLJ	1.58	2.92	2.50
Shanghai	1.55	2.40	1.39
Jiangsu	1.50	2.27	2.59
Zhejiang	1.90	2.70	1.86
Anhui	1.44	3.12	2.67
Fujian	1.29	3.04	3.17
Jiangxi	1.33	2.34	2.24
Shandong	2.66	2.72	2.81
Henan	2.82	4.42	3.70
Hubei	2.53	3.00	3.00
Hunan	3.04	3.29	3.22
Guangdong	3.04	3.45	3.59
Guangxi	3.41	4.35	3.24
Sichuan	3.58	3.96	3.61
Guizhou	4.79	8.43	4.30
Yunnan	4.41	4.54	4.34
Shaanxi	2.90	3.68	3.13
Gansu	3.53	3.86	4.42
Qinghai	3.80	3.93	2.82
Ningxia	3.14	3.69	3.09
Xinjiang	2.79	4.49	2.49
Min.	1.29	1.51	1.39
Max.	4.79	8.43	4.43
(Max/Min)	3.70	5.60	3.19
Coefficient of variation	0.38	0.36	0.26

Note: Sichuan includes Sichuan province and Chongqing city.

Westerlund and Edgerton (2007),[6] which accounts for the cross-sectional dependency, an important property when using pooled cross-section and time-series data. It can be easily seen from Table V that the null hypothesis of cointegration in the panel cannot be rejected, suggesting the existence of a long-run relationship between health-spending inequality and income inequality, or between variability in income inequality and variability in real government BD, and others, in the panel. These test results suggest that income inequality (or its variability) and provincial government BD (or their variability) are useful in explaining the health care-spending inequality between the urban and rural areas in China. These results may also suggest that health expenditure inequality as evidenced by the lack of a nationwide convergence in Section 3 has a high chance of being affected by the income gap between the richer urban and poorer rural households and the local government's BD.

The recent emphasis on health care in China's government policies and the large increase in government expenditure on health indicate that the Chinese government's commitment to tackle the health sector problems is stronger than 5 years ago (Wagstaff and Lindelow, 2008). Our findings here suggest that to tackle the issue of health-spending inequalities, it is important to have policies that will make the poorer areas grow faster and the government finances become stronger. Our findings also

[5]Prior to the cointegration tests, we tested the stationarity property of the series. All series were found to be non-stationary.
[6]We also tried the tests in Westerlund and Edgerton (2008), which permits structural changes. As the test program was designed to handle only one regressor, we did not use this test.

Table V. Panel test results for relationship between health-spending inequality, income inequality, and real budget deficits

Independent variables	LM statistic[a]	p-Value[b]
Dependent variable: Health expenditure inequality (Y)		
1. Income inequality (X)	−1.073	0.944
2. Variability in X (Z_1)	−0.670	0.876
3. Real budget deficits (BD)	−0.623	0.910
4. Variability in BD (Z_2)	−0.250	0.686
5. X and BD	2.083	0.938
6. X and Z_2	1.846	0.992
7. Z_1 and BD	2.083	0.910
8. Z_1 and Z_2	1.146	1.000

Notes: Null hypothesis (H_0) is *cointegration* in the panel against alternative hypothesis (H_1) of no cointegration.
[a]LM is Lagrange multiplier. See Westerlund and Edgerton (2007) for details of the test procedure.
[b]The p-value denotes the *bootstrap* p-value.

provide supportive evidence to the Chinese government's recent policy shift from the richer coastal areas to the poorer rural areas aimed to achieve equitable growth.

5. CONCLUSIONS

Previous studies on health-spending inequalities in China largely relied on survey methods with cross-section data. In this paper, we attempt to add quantitative content to the research on health-spending inequality by using econometric methods with pooled cross-section and time-series data. The first part of the paper examines China's health-spending inequality by employing data on public HCEs to test two convergence hypotheses. Results of the convergence tests show that there is no single nationwide convergence; however, convergence by cluster is identified. These findings imply that inequalities exist in the HCE across regions. The likely causes that contributed to these divergent situations are further explored using a new panel cointegration test. In the second part of the paper, we investigate the long-run relationship between health expenditure inequality, income inequality, and government BD using panel cointegration tests with panel data for urban and rural areas. We find that income inequality and real provincial government BD are useful in explaining the long-run behavior of health expenditure inequality, more specifically, the inequality between the urban and rural areas. Moreover, we contribute to the literature by providing the earlier studies (e.g. Lou, 2008) on regional fiscal disparities that were based on the survey approaches or descriptive statistics with systematic quantitative evidence that the fiscal difficulties (or deficits) constrain the rural areas' health care spending, hence resulting in health care disparities. Our findings also suggest that to tackle the issue on health-spending inequality, it is important to make the poorer areas grow faster and improve the government finances in those areas. Finally, our test results render quantitative support for the Chinese government's recent policy shift from the richer coastal areas to the poorer rural areas aimed to achieve equitable growth.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

APPENDIX A

A.1. Cross-section models for testing β-convergence

To test for β-convergence, we use the following model specification:

$$\Delta y_{i,t+k} = \alpha + \beta y_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t}, \quad i = 1, 2, \ldots, N, \quad t = 1, 2, \ldots, (T - k) \tag{A1}$$

where $y_{i,t}$ is the natural logarithm of HCE of province i in year t; $\Delta y_{i,t+k}$ is the difference between $y_{i,t+k}$ and $y_{i,t}$ and $X_{i,t}$ is a vector of conditional variables typically including income (also in the logarithmic form). The condition for β-convergence is the test for $\beta < 0$. Equation (A1) is also called conditional β-convergence because it allows each province to converge to its own steady state. If, on the other hand, $X_{i,t}$ is empty, then Equation (A1) suggests an absolute β-convergence, meaning that all provinces converge to the same steady state.

A.2. Panel cointegration test equation for health expenditure inequality

$$Y_{it} = \alpha_1 + \beta_1 X_t + \beta_2 BD + \gamma_1 Z_{kt} + \varepsilon_{it} \qquad k = 1, 2 \tag{A2}$$

where Y is HCE inequality; X is income inequality; BD is real government BD; Z_1 is variability in income inequality; and Z_2 is variability in real government BD.

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