HEALTH ECONOMICS
Health Econ. **21**: 757–777 (2012)
Published online 10 May 2011 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/hec.1742

THE DETERMINANTS OF CHINESE PROVINCIAL GOVERNMENT HEALTH EXPENDITURES: EVIDENCE FROM 2002–2006 DATA

JAY PAN[a,c,*] and GORDON G. LIU[b,c]

[a]*School of Public Administration, Southwestern University of Finance & Economics, Chengdu, China*
[b]*Guanghua School of Management, Peking University, Beijing, China*
[c]*Center for Health Economic Research, Peking University, Beijing, China*

SUMMARY

There is great divergence in provincial government health expenditures in China. Real per capita provincial government health expenditures (GHE) over the period 2002–2006 are examined using panel regression analysis. Key determinants of real per capita provincial GHE are real provincial per capita general budget revenue, real provincial per capita transfers from the central government, the proportion of provincial population under age 15, urban employee basic health insurance coverage, and proportion of urban population. Roughly equal and relatively low elasticities of budget revenue and transfers imply that the GHE is a necessity rather than a luxury good, and transfers have yet to become efficient instruments for the fair allocation of health resources by policy makers. Moreover, severe acute respiratory syndrome outbreak has increased the GHE, but we find no statistical evidence that provincial GHE have fluctuated according to the public health status.

Received 19 September 2009; Revised 3 March 2011; Accepted 21 March 2011

JEL classification: H51; I1; C23

KEY WORDS: government health expenditures; determinant; China; panel data analysis

1. INTRODUCTION

The growth of government health expenditures (GHE) is at the forefront of health policy debates around the world. One approach to this issue uses comparisons of different GHEs. The international differences are striking. In 2006, the least GHE per capita is only $1 in Burundi and Myanmar, and the greatest is $5991 in Luxembourg. While looking at regions within one country, previous studies in Canada (Matteo and Matteo, 1998), Italy (Giannoni and Hitiris, 2002), Switzerland (Crivelli *et al.*, 2006), Spain (Costa-Font and Pons-Novell, 2007), and others have shown the same disparity. China is no exception. In 2006, GHE in Beijing is the highest and is nine times greater than the lowest in Hunan province (Table I).

What causes such differences? Provincial economic development might be the reason (see Table I). However, the lowest GHE province, Hunan Province, is not the least developed. Its gross domestic product (GDP) per capita is far greater than those of Tibet, Yunnan, Gansu, and so on. Obviously, economic development is not the whole story, thereby what other factors determine provincial GHE?

On the other hand, public health services, as one of the most important regional public goods, have strong external effects, especially the prevention and treatment of infectious diseases. As we have known, given the existence of externalities, we cannot fully price these economic costs, thus the market fails. Regarding the

*Correspondence to: Room 619, PKU Resources Plaza, 151 Zhong Guancun North Street, Beijing, P. R. China 100871. E-mail: panjie.jay@gmail.com

Table I. Provincial government health expenditures and provincial gross domestic product of 2006

	GHE per capita (RMB)	GHE per capita Rank	GDP per capita (RMB)	GDP per capita Rank	Population (%)	GDP share (%)
Beijing	551	1	49,780	2	1.2%	3.4%
Shanghai	339	2	57,115	1	1.4%	4.5%
Tibet	288	3	10,356	26	0.2%	0.1%
Tianjin	221	4	40,550	3	0.8%	1.9%
Qinghai	211	5	11,708	23	0.4%	0.3%
Zhejiang	168	6	31,611	4	3.9%	6.8%
Xinjiang	146	7	14,855	14	1.6%	1.3%
Yunnan	127	8	8938	29	3.5%	1.7%
Jiangsu	119	9	28,669	5	5.8%	9.4%
Inner Mongolia	118	10	19,989	10	1.9%	2.1%
Ningxia	116	11	11,768	22	0.5%	0.3%
Guangdong	111	12	28,165	6	7.2%	11.3%
Shanxi	105	13	14,082	15	2.6%	2.1%
Liaoning	102	14	21,660	8	3.3%	4.0%
Jilin	99	15	15,700	13	2.1%	1.9%
Fujian	96	16	21,401	9	2.8%	3.3%
Heilongjiang	95	17	16,189	12	3.0%	2.7%
Hainan	91	18	12,594	18	0.6%	0.5%
Gansu	89	19	8736	30	2.0%	1.0%
Guizhou	80	20	6074	31	2.9%	1.0%
Hubei	79	21	13,317	16	4.4%	3.3%
Shandong	79	22	23,716	7	7.2%	9.6%
Shaanxi	77	23	12,112	20	2.9%	2.0%
Hebei	73	24	16,904	11	5.3%	5.0%
Guangxi	71	25	10,232	27	3.7%	2.1%
Chongqing	70	26	12,434	19	2.2%	1.5%
Sichuan	70	27	10,574	25	6.3%	3.7%
Jiangxi	66	28	10,764	24	3.4%	2.0%
Henan	65	29	13,305	17	7.3%	5.4%
Anhui	57	30	10,063	28	4.7%	2.7%
Hunan	55	31	11,935	21	4.9%	3.3%

Data source: *China Statistical Yearbook 2007*. Data in this table are at current price. GDP, gross domestic product; GHE, government health expenditures.

features of health market, Arrow (1963) suggested that "the government, at least in its economic activities, is usually implicitly or explicitly held to function as the agency which substitutes for the market's failure." Although a lot of work has been done by the Chinese government in public health, the severe acute respiratory syndrome (SARS) crisis in China, which began at the end of 2002, nonetheless exposed many problems of this field. Thus, another question we want to answer is whether GHEs significantly target the provincial public health status.

The purpose of this paper is to analyze the determinants of differences in provincial GHE and to test whether the expenditures have fluctuated according to the status of provincial public health. These objectives will be pursued by developing and estimating an econometric model using provincial panel data from the period of 2002–2006.

The results of the paper show that the key determinants of real per capita provincial GHE over 2002–2006 are real provincial per capita income, transfer payments from the central government, proportion of the provincial population under age 15, urban employee basic health insurance scheme (BHIS) coverage rate and the proportion of urban population. However, the provincial expenditures did not fluctuate according to the public health status in which we were using the reported morbidity and mortality of infectious diseases as the proxy.

The rest of the paper is organized as follows: in section 2, we survey the literature on the determinants of health expenditures; section 3 presents an overview of the Chinese GHE; the analytical framework is

DOI: 10.1002/hec

introduced in section 4; then we discuss the econometric model and present the empirical estimate results of the panel data set in sections 5 and 6. The discussion and conclusions are drawn in the end.

2. THE HEALTH EXPENDITURE DETERMINANTS LITERATURE

2.1. Cross-section data analyses

Newhouse (1977) first proposed "What determines the quantity of resources a country devotes to medical care?" Newhouse regressed health expenditures (HE) on GDP using data of 13 Organisation for Economic Cooperation and Development (OECD) countries in 1971, and found that "over 90% of the variance in per capita medical expenditure in these countries could be explained by variation in per capita GDP". Gerdtham *et al.* (1992) used a cross-section of 19 OECD countries in 1987 and reported per capita income, urbanization, and the share of public financing to total HE as positive and significant variables. Gbesemete and Gerdtham (1992) used a cross-sectional sample of 30 African countries in 1984 and reported that per capita gross national product was the most significant factor in explaining per capita HE and other factors, such as the per capita amount of international aid; the proportion of deliveries in hospitals had significant impacts on HE.

These studies first explore the determinants of HE, and find a significantly positive relationship between HE and GDP. However, they are marked by a number of acknowledged problems: cross-sectional comparisons implicitly impose the assumption of homogeneous relationships across countries, which may appear unrealistic, their sample sizes are small, and the comparisons are static.

2.2. Panel data analyses

Gerdtham (1992) used data for 22 OECD countries for the period of 1972–1987, explored five different panel data models, including the error–correction model, and found that country and time had specific effects on HE. Hitiris and Posnett (1992) used panel data for 20 OECD countries over 1960–1987. They included country dummy variables in the model and found that GDP and proportion of population over 65 had significantly positive effects, whereas the public finance share of HE was insignificant. Gerdtham *et al.* (1998) added the supply variables of medical care and medical institutional variables into the model, and found that these factors affected HE. Hansen and King (1996), Blomqvist and Carter (1997), McCoskey and Selden (1998), Gerdtham and Jönsson (2000), and Roberts (2000) focused on non-stationarity and cointegration of HE and GDP, and reach partly divergent conclusions. These different conclusions were a result of different initial assumptions.

Phase two studies come to the conclusions that country, time, health needs factors, supply factors, and other social system factors have significant impacts on HE. By using panel data, they have the advantage of larger sample sizes, can test more variables, and apply more consistent panel methods to get much more consistent estimates. However, the heterogeneity of national health systems and mechanisms lead to important limitations. The non-uniform conclusion of different studies is an indication of this problem.

2.3. Regional analyses

Matteo and Matteo (1998) studied the determinants of Canadian provincial GHE over 1965–1991, using per capita GDP as a proxy for income, and found that the key factors were real provincial income per capita, real provincial federal transfer revenues per capita, and the proportion of the provincial population over age 65. Giannoni and Hitiris (2002) used 1980–1995 Italian data, including regional dummy variables in the model, and found that regional divergence had a large impact on GHE. Crivelli *et al.* (2006) used Swiss data from 1996 to 2002, and found that the provincial proportion of the population under five and over 75 were positively correlated with GHE. An important conclusion is that the induced demand may exist, inferred from the fact that the more doctors there are, the greater is the spending. Costa-Font and Pons-Novell (2007) studied Spanish provincial GHE and found that income, degree of autonomy, supply, and demand factors had significant impacts.

DOI: 10.1002/hec

Inter-provincial studies have succeeded in ruling out many previous problems. First, one need not worry about exchange rate differentials, and the data are more comparable.[1] Secondly, cross-institutional factors are excluded. Thirdly, these studies fully take into account the specific characteristics of the different health systems, so the results are more targeted.

2.4. Chinese analyses

Research on determinants of Chinese GHE is quite scarce. Dai (2004), Liu (2005), Li and Zhong (2006), Huang and Fang (2008), Zhao and Miao (2008) focused on the equity of GHE. Chou (2007) used the Lagrange multiplier unit root test to study the stationary properties of HE, income, and other factor variables in China. An important finding is that the government budget deficits have a significant long-run impact on Chinese health care expenditures.

These studies attribute the disparity of provincial GHE primarily to differences in local economic development. There is no systematic study of the determinants of GHE in China.

3. THE CHINESE GOVERNMENT HEALTH EXPENDITURE SYSTEM

Since 1949, when the People's Republic China was founded, a widely covered and centrally planned health care system was organized: prices were tightly regulated well below operating costs (Eggleston *et al.*, 2008), meanwhile, governments at all levels collected taxes to subsidize the demand on health insurance programs (the Cooperative Medical Scheme for farmers and the Labor Insurance Scheme and Government Insurance Scheme for state-owned enterprise workers and government officials, respectively) while directly financing supply-side public providers (Wagstaff *et al.*, 2009). After the market-oriented reforms starting in 1978, China experienced great economic transitions with significant reforms of fiscal system and health care system, leading to a profound impact on the GHE system. Under a then national guiding principle of "promoting economic growth", as a central task for China, the local governments were primarily assessed on the basis of GDP growth, which in turn provided strong incentives for local government officials to engage in GDP-driven policy priorities. This led to a highly disproportional allocation of resources towards the field of economic production and infrastructures, leaving relatively little public financing to social programs, especially health care, which received decreasing government subsidy over the years (Li and Zhou, 2005; Liu, 2005; Zhou *et al.*, 2009).

Meanwhile, many of the traditional government interventions have remained. In particular, medical pricing is continued to be regulated below cost, and state providers received subsidies but could not make up the loss because of the decreasing GHE. As an alternative, public providers were allowed to add a 15% profit margin for drugs and new high-tech diagnostic services, leading to huge incentives for over prescribing behavior, and thus rapid increase in drug cost in response to this distorted price policy (Eggleston *et al.*, 2008; Wagstaff *et al.*, 2009). As a result, the Chinese health expenditure patterns were lately featured with dramatic growth of out-of-pocket payments, a sharp reduction of public financing via GHE, and extremely high drug expenditures accounting for over 50% of total HEs.

Since the 16th Congress of the Chinese Communist Party (November, 2002), the central government has given greater priority to the improvement of population well-being, with a particular focus on increasing public financing for health care. In addition, the SARS epidemic in 2003 served as a crucial wake-up call for the Chinese top leaders to consider more investment in health and health care. Above this consensus, however, disputes largely remain as to whether GHE should be increased more through the supply-side approach or demand-side approach. The former would promote allocating the increased public funds through a budgetary process direct to public providers, which in turn can provide free services for all people. The latter, in contrast, advocates an approach of empowering people through a universal social insurance program in which the

[1] Data are generally not comparable (Schieber and Poullier, 1989). This problem is always in the international health care studies.

DOI: 10.1002/hec

government makes the major premium contribution while the individuals make the remaining contributions (with exemptions for the poor). This approach would allow more market forces and competitive mechanism to play a role in shaping the behaviors of both health care providers and users (Liu, 2009). The State Council-led health reform policy later adopted the demand-side approach to cover for all basic care with a social health insurance system (State Council, 2009). This has been accompanied with substantial increase in public funds to help expand the New Cooperative Medical Schemes (NCMS) which currently cover over 830 million of the rural population and the Urban Resident Basic Medical Insurance (URBMI). which covers over 200 million urban residents without formal jobs (Lin *et al.*, 2009).

3.1. Government health expenditures and total health expenditures

Government health expenditures, social health expenditures (SHE), and residents' health expenditures (RHE) constitute the total health expenditures (THE). In recent years, the share of THE in national GDP is about 4.7%.[2] The proportions of GHE in THE are 15.7%, 17.0%, 17.0%, 17.9%, and 18.1% during the period of 2002–2006, respectively. The increasing trend indicates that the government has taken on greater responsibility in health care in recent years, but its contribution to THE is still low.

3.2. Central and local government health expenditures

In accordance with the division of the central and local governments, GHE is divided into two parts in China, central GHE and local GHE. China's fiscal decentralization system formed gradually over the past 30 years. In 1994, according to the requirement of market development, China experienced a fundamental fiscal decentralization reform called the tax rebating system reform. This reform has an essential impact on the division of the central and local government expenditures on the public goods, especially in the field of health care, the central share of total GHE in 2006 is only 1.8%.[3] In other words, around 98% of GHE is supported by local governments; provincial GHE is the core of total GHE.

3.3. Components of government health expenditures

Chinese GHE categories have been established for 10 necessary expenses. In Table II, we provide the composition of GHE and their values during 2002–2006. From the table, it is clear that the health recurrent budget, the family planning budget, and the health administration budget are the major components, and their combined share of the total reached up to 77.8% in 2006.

The health recurrent budget, which is the most important, is used for disease prevention, vaccination, monitoring infectious diseases, funding of state-owned hospitals, specialist hospitals, nursing homes, centers for disease control (CDC), epidemic stations, first-aid centers, the Red Cross and other social health affairs. In China, most hospitals are state-owned (80.50% of beds are government-run in 2006[4]), and most of them implement balanced budget, that is, with partial support by public finance, whereas CDCs and epidemic stations implement full budget, that is, with full support by public finance.[5] "Subsidizing the supply-side" has long dominated and almost the entire health recurrent budget was directly given to the state-owned health institutions. After the re-establishment of the NCMS in 2003, the government began to provide major premium contributions as incentives and support for rural people to join the plan on voluntary basis, and the subsidy

[2]Total health expenditures accounted for the proportions of GDP are as follows: 4.81%, 4.85%, 4.75%, 4.71% and 4.67% during the period of 2002–2006, respectively.
[3]The central government shares of THE are as follows: 2.7%, 2.8%, 2.6%, 2.1% and 1.8% during 2002–2006, respectively.
[4]Data resource: Yearbook of Public Health in Peoples' Republic of China 2007.
[5]Full budget: the medical institutions turn in all their revenues and in return their costs are fully covered by the government. Balanced budget: the medical institutions keep their revenues and only receive partial subsidy from the government according to their number of beds and staff.

DOI: 10.1002/hec

Table II. Components of government health expenditures

Components of government health expenditures	2002	2003	2004	2005	2006	2006 (%)
Health recurrent budget	37.45	46.43	48.26	59.32	70.63	43.2%
Family planning budget	12.27	14.99	18.46	22.12	24.09	14.7%
Health administration budget	26.90	30.28	32.93	37.43	35.13	21.5%
Chinese medical budget	3.33	3.65	3.82	3.49	3.86	2.4%
Food and drug supervision and administration budget	1.92	2.37	2.74	3.45	3.84	2.4%
Health research funding	0.41	0.43	0.49	0.42	0.49	0.3%
Infrastructure budget	4.96	6.93	10.34	12.10	8.55	5.2%
Health administration and insurance management fees	4.78	5.45	6.20	7.25	7.93	4.9%
Other government health departments budget	5.07	5.29	5.76	5.95	6.86	4.2%
Basic health insurance fund subsidies	0.00	2.22	2.67	3.71	2.05	1.3%

Data source: *Yearbook of Public Health in Peoples' Republic of China 2008*. Data in this table are adjusted for inflation rates, measured in 2005 billion RMB.

grants were included in the health recurrent budget.[6] Although the share of government grants for NCMS in the health recurrent budget was small at the beginning, about 2.80% in 2003, it increases rapidly, 4.54% in 2004, 7.06% in 2005 and 21.31% in 2006, respectively.[7]

In addition, following the SARS crisis, Chinese government incrementally increased investments in public health, has set up all levels CDCs, and funded many projects to fight against the epidemic of AIDS, tuberculosis, schistosomiasis, and other infectious diseases, such as comprehensive AIDS response (CARES) project. In September 2003, the Chinese government announced a free national AIDS treatment program, making it one of the few countries in the world to do so (Kaufman, 2008), and some provinces have also begun to provide free medical care for certain infectious diseases.

4. ANALYTICAL FRAMEWORK

Divergence in Chinese provincial GHE may be an outcome of both random and systematic factors. This paper focuses on the latter. Systematic differences can be determined by economic, demographic, social, and political factors (Schieber and Poullier, 1989). Drawing upon the literature[8] and the Chinese GHE system, we hypothesize that GHE per capita may be primarily driven by three groups of factors: (1) income; (2) demand/need factors; and (3) other social factors.

4.1. Income factors

The inclusion of income as an explanatory variable is standard in the studies of health care expenditures. Previous studies[9] often show that there is a positive relationship between health expenditures and income. As such, we would expect higher government income provinces to spend more on health care. While GDP per capita is often used as a proxy for income in the literature,[10] more considerations are taken into account in the

[6]One of the 10 components, the "basic health insurance fund subsidies", is used to subsidize the BHIS (the medical insurance for the employees) fund when it runs deficits, not the NCMS.

[7]Both of the central and local subsidies are included here. Data are from China National Health Development Research Center (2009) and their shares of the health recurrent budget during 2003–2006 are calculated.

[8]For a general review of the literature see Gerdtham and Jonsson (2000), and section 2 of this paper.

[9]Income is a measure of the potential resources available to a jurisdiction for public expenditure and is an indicator of the ability to pay. All the studies have employed the income variable in the model used to study the determinants of HE or GHE, such as Newhouse (1977), Gerdtham (1992), Gerdtham and Jönsson (1992, 2000), Gerdtham *et al.* (1992, 1998), Hansen and King (1996), Giannoni and Hitiris (2002), Costa-Font and Pons-Novell (2007), and others.

[10]Such as Matteo and Matteo (1998), Giannoni and Hitiris (2002), Crivelli *et al.* (2006), Costa-Font and Pons-Novell (2007), and others.

DOI: 10.1002/hec

present study. First, GDP is a budget constraint of total HE but not of GHE.[11] Second, both general budget revenue and transfers from the central contribute to the total provincial government income in China, and their shares of the total are nearly 50% and 50%.[12] General budget revenues are the regular income for the provincial government and are closely linked to the local economy,[13] whereas transfers from the central government reflect central policy. Through the transfers, the central government has increased investment in the less developed areas and has supported the development of the middle and western regions in recent years. Transfers to local governments have totaled to 4.25 trillion RMB from 2003 to 2007 of which 87% was used to support the middle and western regions (Wen, 2008). Taking Tibet as an example, the central government funds over 90% of the local government income.[14] Therefore, total provincial government incomes are not fully based on the local economy or provincial GDP, which has usually been employed in previous studies. Instead, we used both the provincial government general budget revenue and transfers from the central to measure the potential resources available for GHE.[15]

4.2. Demand/need factors

Among others, population structure is often considered an important determinant of demand for health care (Denton and Spencer, 1975; Maxwell, 1981). It is well observed that HEs are unevenly distributed over the life cycle, with greater spending during both infant and older ages. Therefore, provincial age structures would affect the GHE.

Public health status is another important factor considered in the demand equation. There can be no more fundamental responsibility of government, considered from an economic standpoint alone, than the responsibility to serve and protect the public health (Bishop, 1928). In this regard, the different local public health status can be a major driving force for health care demand.

Institutional conditions of local health systems can also influence the demand and, thus, provincial GHE. Previous studies suggested that institutional conditions may be associated with supplier-induced demand or physician target income hypotheses, which can be a driving force for demand as well.[16] Moreover, as mentioned previously, most of the health institutions are government-run in China, and the government-run institutions are partly or fully financed by the government according to their number of beds and staff, so the relationship between the health institutions (quantity of beds and physicians) and GHE might shed light on true demand factors.

4.3. Other social factors

In addition, we hypothesize GHE to be determined by four more social variables, including health insurance, urbanization, gender, and education. Health insurance coverage influences GHE as the insured would generally face fewer budget constraints than the uninsured, increasing financial access to care, then improving public health and decreasing the demand for GHE. Previous studies (Kleiman, 1974; Gerdtham *et al.*, 1992; Crivelli *et al.*, 2006) also suggested that urbanization might play a role in demand for health care. One argument is that urbanization implies social change (Pfaff and Nagel, 1986). In China there is a distinct urban–rural dichotomy, which differs greatly in economic and social systems. The literature also finds physical differences between

---

[11] In the previous section, we note that GHE is only about 20% of THE in China, but in the other studies, such as Canada (Matteo and Matteo, 1998), the share of GHE is much higher.
[12] In 2002–2006, average shares of transfers in the total provincial government income are 53.61%, 52.81%, 54.09%, 51.10%, and 50.75%, respectively.
[13] The correlation between provincial GDP and general budget revenues is 0.95.
[14] In 2002–2006, transfers shares of total government revenue in Tibet are 94.72%, 94.25%, 93.14%, 94.09%, and 93.39%, respectively.
[15] In Appendix A, we tabulated the actual per capita provincial GDP, revenue, transfers, and their ranks in 2006 to reflect the relationships among them.
[16] For a review of the literature see McGuire (2000).

DOI: 10.1002/hec

genders[17] where we would consider more on gender norms and its possible effect on inequality in GHE. Population education level is another social factor, which is commonly used as a measure of socioeconomic status in epidemiological studies (Liberatos *et al.*, 1988).

Given the discussion above, an empirical model for GHE can be set as follows:

$$\mathrm{GHE}_{it} = f(\mathrm{Income}_{it}, \mathrm{Age}_{it}, \mathrm{PHealth}_{it}, \mathrm{Institution}_{it}, \mathrm{OSFactors}_{it}). \quad (1)$$

Where $f(.)$ is a function form which will be specified later, i is the province subscript, and t is the time subscript.

5. DATA AND ESTIMATES

We used a sample of panel data covering 31 provinces[18] in China during 2002–2006. These data were compiled from annual publications of *Yearbook of Public Health in Peoples' Republic of China, China Statistical Yearbook*, and *Finance Yearbook of China*. GHE, revenue, and transfers were converted into real per capita form by dividing through by provincial population and deflating using the consumer price index (CPI) with 2005 = 100.[19]

Definitions of the variables and proxy variables used in the empirical model are listed in Table III. For the sake of clarity, it is worth noting a few points on several variables.

Provincial GHE per capital is the total provincial government health expenditures, including 10 expenses in Table II.

The transfer variables used in the model is the total fiscal transfers from the central government, an important source of revenues for the provincial government. In 2006, 50.75% of provincial government revenues were from the central transfers, ranging from 17.03% in Beijing to 93.39% in Tibet.[20] In 2006, the total transfers to local governments amounted to 1358 billion RMB, with 34.82% as equalization grants (e.g., general purpose grants), 32.46% as special purpose grants (e.g., special grants for education, health, and social security), and 32.72% as tax grants (tax rebate). Tax grant amounts are determined by local upward transfers to the central government based on the local economy,[21] whereas equalization and special purpose grants reflect the will of the central government. Of the special purpose grants, only 2.6% was used for health care, corresponding to 0.84% of total transfers. Although less than 1% of transfers from the central government are specifically designated for health care,[22] the general purpose transfers and tax grants could also be potentially available for health care, depending upon local government decisions. In 2006, if we were able normalize the total per capital government revenue of the eastern provinces (developed region) to 100, the government revenue of middle and western provinces (less developed region) would have been 32 without central transfers. With the transfer redistribution, however, middle and western provinces' revenues increase to 55 and 63,

[17]It has been found that men and women are different in ways that go beyond their reproductive systems, hormones, and bone structure (Bren, 2005).

[18]31 Provinces refer to 22 provinces (Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Hainan, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai,), 4 municipalities (Beijing, Tianjin, Chongqing, Shanghai) and 5 autonomous regions (Inner Mongolia, Guangxi, Ningxia, Xinjiang, Tibet). Taiwan province and two special administrative regions, Hong Kong, and Macao are excluded from the sample.

[19]Because the variables are per capital or proportion, it automatically adjusts for the effects of inflation and population growth.

[20]The lowest three provinces are Beijing (17.03%), Shanghai (19.08), and Guangdong (19.6%), which are the three most developed provinces in China.

[21]After the 1994 reform, in order to fetch up sub-national governments' revenue losses, the central government introduced a tax rebating system. The tax revenue rebating scale is decided directly by first, the upward transfer amount from sub-national governments to the central in 1993; second, the overall revenue incremental rate of VATs and Consumption taxes; and third, whether or not did the sub-national government collect tax revenue at least as the baseline of 1993. The arrangement enabled the richer provinces to get more tax rebating, thus expanding fiscal disparities among regions (Su and Zhao, 2004).

[22]The central subsidies of NCMS are included in the special grants for health.

DOI: 10.1002/hec

Table III. Regression variable definitions

Explained variable	Government health expenditures	Provincial government health expenditures per capita (GHE)
Explanatory variables	Income factors	General budget revenue per capita (revenue)
		Transfers from the central government per capita (transfers)
	Aging factors	Percentage of population aged under 15 (A15)
		Percentage of population aged over 64 (A64)
	Public health status	Reported morbidity of infectious diseases per 1000 (morbidity)
		Reported mortality of infectious diseases per 1000 (Mortality)
		SARS
	Institutional factors	Beds per 1000 population in hospital & health central (Beds)
		Health personnel per 1000 population (personnel)
	Other social factors	Coverage rate of urban employee basic health Insurance (coverage)
		Proportion of urban population (Urban)
		Proportion of female population (female)
		Proportion of college & higher level population (college)
		Time (T)

respectively (Jin, 2007). Evidently, the central transfers play a significant role in narrowing the provincial disparity and balancing the local government potential for public services.[23]

After a significant reduction of infectious disease morbidity and mortality in China in the first 40 years of the communist regime, progress has slowed and even reversed for some important threats like tuberculosis and sexually transmitted diseases, and new challenges such as HIV/AIDS and avian influenza (Kaufman, 2008). China's SARS epidemic in 2003 exposed public health problems in China, especially the management of infectious diseases. As the primary responsibility of public health is to prevent and treat "the infectious diseases which are not exclusive and competitive, related to the population health" (Liu, 2005), and because of the relatively small proportion of GHE in total HEs, the control of infectious diseases should be the local governments' top health priority. The reported morbidity and mortality of infectious disease are employed as proxy variables for public health status.[24] In addition, the outbreak of SARS in 2003 is modeled as a special event dummy variable in the regression.

Our model employs a time–trend variable to capture the changes in public policy. Since the 16th Congress of the Chinese Communist Party, the central government has given greater priority to the improvement of population well-being, with a particular focus on increasing public financing for health care from 97.24 billion RMB in 2002 to 175.24 billion RMB in 2006.[25] Following the literature (Roberts, 1999; Freeman, 2003; Matteo, 2004; Crivelli *et al.*, 2006), a linear time–trend variable for the capture of GHE differences over time is commonly used. Our model uses the same time–trend variable to measure the long-term impact of policy. However, the time variable has the drawback of capturing all the factors that impact GHE through time, such as technological advances and changes in public expectations and preferences. Nevertheless, we can at least estimate the upper bound impact of policy.

An econometric model can be specified as follows:

$$\mathrm{GHE}_{it} = \mathrm{X}_{it}\beta + a_i + u_{it} \tag{2}$$

Where i is the province subscript; t is the time subscript; GHE is the real provincial government health expenditures per capita; X is a vector of determinants variables (varies by i, t); a_i is the unobserved time-invariant characteristics; and u_{it} is theidiosyncratic error term.

It is worth noting the functional form of the suggested relationship between the expenditure and income variables. Four possible functional forms (the log–log, linear, exponential, and semi-log) were considered in

[23]The statistical data in this paragraph is arranged from "With regard to regulating the fiscal transfer reports—June 27, 2007 at the Tenth National People's Congress Standing Committee 28th meeting" (Jin, 2007).
[24]The reported morbidity is calculated by summing the morbidities of 27 infectious diseases, and the same calculation for reported mortality.
[25]Total GHE are deflated using consumer price index (2005 = 100).

DOI: 10.1002/hec

previous studies in the field (Parkin *et al.*, 1987; Gerdtham *et al.*, 1992; Giannoni and Hitiris, 2002). In this study, we assumed a logarithmic functional form between expenditure and two income variables and others linear. Before the regression, this assumption is carefully detected within the framework of Box–Cox transformation analysis (Box and Cox, 1964). A further general check is applied to functional misspecification using Ramsey's regression specification error test (1969).

The model is quite straightforward, albeit with some estimation challenges. A major concern is the assumption of the composite error term $(a_i + u_{it})$. If $a_i = 0$, strict ordinary least squares can consistently estimate all the parameters. If a_i is itself a random variable, then for the composite error term, random-effects model (RE) is more efficient. Following the Breusch and Pagan (1980) Lagrange multiplier test (BP-LM test), one can examine whether there are random effects across the provinces. But if a_i is endogenous when unobserved provincial characteristics are correlated with X_{it}, the ordinary least squares and RE can be biased and inconsistent. In this case, if the unobserved provincial effect factors do not change over time, we may get consistent estimation using the fixed-effects model (LSDV), under the assumption that the idiosyncratic error u_{it} is strictly exogenous. It is entirely possible that unobservables, such as geographical features and local culture, which might generate endogeneity, are time-constant. Many other factors may not be exactly, but rather roughly constant over a five-year period. Since the key consideration in choosing between a RE and FE approach is whether a_{i} and X_{it} are correlated, we employ the Hausman test (1978) to check the null hypothesis that X_{it} and a_i are uncorrelated (Wooldridge, 2002).

6. EMPIRICAL FINDINGS

6.1. Descriptive statistics

The basic characteristics of our sample are presented in Table IV. During 2002–2006, GHE per capita, budget revenue per capita, and transfers from the central government per capita all increased steadily with annual average growth rates[26] of 15.99%, 16.85%, and 11.84%, respectively. The growth rate of GHE exceeded that of the total local government income. This reflects the central policy that requested the government to increase GHE in the 16th National People's Congress of the Communist Party. Alternatively, the SARS crisis may be another reason that prompted the government to increase GHE.

The population is aging. The proportion of the population under age 15 decreased, while the proportion of people aged over 64 increased each year.

Overall infectious diseases' morbidity and mortality trended upward, and average annual growth rates reached 17.03% and 10.85%, respectively. Investigating each disease,[27] we find that the first three highest-morbidity diseases are viral hepatitis, tuberculosis, and diarrhea[28]; and the first three by mortality are tuberculosis, rabies, and viral hepatitis. Most diseases' morbidity and mortality varied in the same direction. Plague, cholera, dysentery, typhoid and paratyphoid fever, gonorrhea, pertussis, epidemic hemorrhagic fever, epidemic cerebrospinal meningitis, and newborn tetanus declined. The first three diseases by decline in morbidity are dysentery, newborn tetanus, and typhoid and paratyphoid fever, which decreased by 10.68%, 18.71%, and 55.54% in 2002–2006. In contrast, the ascendant diseases are viral hepatitis, AIDS, syphilis, measles, tuberculosis, scarlet fever, hydrophobia, and malaria. AIDS, viral hepatitis, and tuberculosis raise serious concerns. Their morbidities rose by 30.82%, 54.44%, 97.88%, and mortalities were up to 409%, 219.25%, 29.25%, respectively. A general analysis of specific diseases showed that the incidences of acute and

[26]The formula for calculating the annual average increase rate is the sum of each year increase divided by number of years.

[27]Because of length constraints, we were not able to present the detailed report of the infectious diseases data; however, more can be viewed in the *Yearbook of Public Health in Peoples' Republic of China*.

[28]In 2006, the morbidities of viral hepatitis, tuberculosis, and diarrhea are 1.02, 0.86, and 0.32 per thousand. In other words, there are more than 1.3, 1.1, and 0.4 million incidences in the whole country, respectively.

Table IV. Descriptive statistics ($N = 155$)

Variables	2002	2003	2004	2005	2006
GHE (RMB)	71.037	83.308	88.785	104.501	127.911
	(60.101)	(69.763)	(75.706)	(83.855)	(100.627)
Income Factors					
Revenue (RMB)	874.463	973.942	1116.714	1378.260	1625.452
	(1028.467)	(1140.593)	(1339.385)	(1629.014)	(1793.414)
Transfers (RMB)	947.331	985.755	1151.443	1283.960	1476.598
	(932.077)	(893.306)	(880.906)	(1174.470)	(1216.938)
Aging Factors					
A15 (%)	21.138	20.276	19.257	19.737	18.570
	(4.364)	(4.622)	(4.416)	(4.891)	(4.639)
A 64 (%)	8.000	8.360	8.427	8.748	8.996
	(1.803)	(2.196)	(1.964)	(1.607)	(1.863)
Public Health					
Morbidity (1/1000)	2.004	2.252	2.865	3.006	2.972
	(0.680)	(0.846)	(0.979)	(0.813)	(0.868)
Mortality (1/1000)	0.004	0.006	0.005	0.007	0.008
	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)
Institution Factors					
Beds (1/1000)	2.740	2.657	2.710	2.762	3.043
	(0.918)	(1.053)	(1.075)	(1.088)	(1.208)
Personnel (1/1000)	3.887	3.891	3.922	3.943	4.031
	(1.579)	(1.607)	(1.626)	(1.631)	(1.713)
Other Social Factors					
Coverage (%)	0.186	0.204	0.303	0.256	0.280
	(0.069)	(0.061)	(0.094)	(0.079)	(0.102)
Urban (%)	0.311	0.335	0.356	0.454	0.464
	(0.157)	(0.157)	(0.161)	(0.154)	(0.151)
Female (%)	0.490	0.490	0.492	0.494	0.494
	(0.009)	(0.010)	(0.008)	(0.007)	(0.008)
College (%)	0.051	0.062	0.067	0.066	0.072
	(0.038)	(0.038)	(0.045)	(0.046)	(0.056)
Observation	31	31	31	31	31

GHE, revenue and transfers are adjusted for inflation rates, and measured in 2005 RMB. Numbers in parentheses show standard deviations.

malignant diseases have decreased, but the diseases relating to style of personal living have became more prevalent.

There is no clear trend in institutional factors or gender ratio. The insurance coverage rate, proportion of urbanization and proportion of college and higher education population have increased by about 50%, with average annual growth rates of 12.95%, 10.91%, and 9.64%, respectively.

7. RESULTS

The regressions and tests were run using STATA 10.1 (StataCorp, College Station,TX, USA).[29] The data were subjected to the Box–Cox estimation to test the functional form of GHE, revenue, and transfers. The test[30] indicates that the log–log form is preferred to other possible functional forms. The BP-LM test[31] shows that we cannot neglect the impact of provincial heterogeneity, and if a_i is uncorrelated with X_{it}, RE is preferred. Equation is estimated by applying a log–log form and using the random-effect model (GLS) and the fixed-effect model (LSDV).[32] Table V presents the regression results.

[29]The statistical software package, specific commands used for the regression analysis, as well as variables included in each model are reported in Appendix B.
[30]The results are reported in Appendix C.
[31]BP LM test results, $\chi^2(1) = 96.07$, $p = 0.00$, it rejects the null hypothesis there is no random effect.
[32]See "Greene WH, Econometric Analysis. Prentice Hall: New York, 2003."

DOI: 10.1002/hec

Table V. Results for regression

	(1)	(2)
	Fixed-effect model	Random-effects model
VARIABLES	Provincial government health expenditure	Provincial government health expenditure
Income factors		
Revenue	0.295***	0.406***
	(0.085)	(0.069)
Transfers	0.227**	0.404***
	(0.108)	(0.060)
Aging factors		
A15	1.767***	2.252***
	(0.556)	(0.528)
A64	1.981	0.682
	(1.412)	(1.218)
Public health		
Morbidity	−0.015	−0.010
	(0.016)	(0.018)
Mortality	−3.284	−4.162*
	(2.249)	(2.438)
SARS	0.041**	0.065***
	(0.017)	(0.017)
Institution factors		
Beds	0.034	0.036
	(0.037)	(0.042)
Personnel	0.055	0.143***
	(0.070)	(0.044)
Other social factors		
Coverage	−0.641***	−0.522***
	(0.163)	(0.196)
Urban	−0.557***	−0.504**
	(0.199)	(0.197)
Female	0.305	1.424
	(1.516)	(1.479)
College	0.655	0.339
	(0.740)	(0.741)
Time	0.121***	0.080***
	(0.026)	(0.016)
Constant	0.858	−2.866***
	(1.299)	(0.866)
Observations	155	155
Statistics		
Within R^2	0.942	0.935
Between R^2	0.876	0.868
Overall R^2	0.789	0.875
$F_{2:30}$ Public health	1.34	
P-value	0.277	
$F_{2:30}$ Institution	0.92	
P-value	0.409	
$F_{2:30}$ Female and college	0.42	
P-value	0.662	

Parentheses show robust standard errors for parameter estimation. *, **, and *** denote statistical significance at the 10, 5, 1 percent levels, respectively.

We used the Hausman test to check the null hypothesis that the explanatory variables and the provincial-specific error terms are uncorrelated. The result[33] is a rejection of the null hypothesis, and shows the differences in coefficients between the two models are systematic, that a_i is correlated with X_{it}. Ramsey's

[33]Hausman test result is $\chi^2(14) = 64.57$, $p = 0.00$.

DOI: 10.1002/hec

Regression Equation Specification Error Test (RESET) is carried out in the FE model and shows that there is no misspecification.[34] Thus, the estimation of the FE model is consistent. The following comments are based on it. One point deserving attention is that the directions of the parameters estimated by the two models are identical and differ only slightly in the significances.

The estimated coefficients of budget revenue, transfers from the central government, aged under 15, SARS, and time variables are positive; insurance coverage and urban provinces are negative; and all of these variables are statistically different from zero at the 5% significance level. In addition, the model explains 94.2% of the within group and 78.9% of the overall variation in the GHE.

The elasticities of budget revenue and transfers are 0.295 and 0.227, respectively. This is actually in line with the fact that local economy is a determinant of provincial GHE, confirming some previous studies suggesting that the disparity of health resources allocation across provinces is caused by the different local economic development (Wang, 2003; Li and Zhong, 2006; Huang and Fang, 2008; Zhao and Li, 2008). That transfers' elasticity is slightly lower than budget revenue elasticity suggests that transfers indeed create a similar impact on provincial GHE as budget revenue. Although international comparisons literature (Newhouse, 1977; Milne and Molana, 1991; Gerdtham, 1992; Gerdtham and Jönsson, 1992; Gerdtham *et al.*, 1992; Roberts, 1999; *etc.*) usually finds an income elasticity of one or greater, this result is consistent with the previous region-level analyses (Matteo and Matteo, 1998; Giannoni and Hitiris, 2002; Freeman, 2003; Costa-Font and Pons-Novell, 2007), which places it at much lower than one. It is also worth noting that our results pertain to local government income elasticity of the provincial GHE demand. The national income elasticity of the total HE might be larger. These results imply that GHE is indeed more of a necessity than a luxury good to the provincial governments.

Both population age variables (below 15 and over 64) have positive effects on GHE. A15 is statistically significant at the 1% significance level, while A64 is not, even at the 10% significance level.[35] There are two possible reasons: the government takes on more responsibilities for child health, for example, family planning and free vaccines for children; and most adult health care expenditures are supported by the social health care insurance and individuals, with the government bearing little of the cost.

In public health, the SARS event increased GHE by 4.1%,[36] but morbidity and mortality are significant neither for single T-tests nor for a joint multiple hypotheses test. This shows that facing serious outbreaks, provincial governments have made a positive response to the SARS epidemic; however, because of the continuous event, GHE has not fluctuated with infectious diseases.

The coefficients for the two institution factors are positive but not statistically significant. This fails to support the induced demand or target income hypotheses, at least for GHE, and the health institutional factors are not the true demand factors in the model.

In the other social variables, the coefficient of insurance coverage is negative and statistically significant at the 1% significance level. This is reasonable that the BHIS funding comes from corporations and individuals, and the government bears little of the cost, unless the funds run deficits. Increasing health insurance coverage will enhance public health and decrease the demand for GHE. Urbanization also has a statistically significant negative effect on GHE. For the lower urbanization, population density is smaller. Compared with the same population density, the provincial government would spend more per capita to provide the same public health service. For instance, to ensure the same health care access, there must be higher per capita medical facilities in the lower-density regions. This accords with the actual situation; in Table I, the lower population density provinces, such as Tibet, Qinghai, and Xinjiang all have higher per capita GHE. The Time–trend variable is

[34]Ramsey RESET test result: $F(3, 107) = 0.88$, $p = 0.4545$. Therefore, we can't reject the null hypothesis that the model is correctly specified.

[35]The correlation coefficient of the two age variables is −0.698. The insignificance of A64 might come from the high correlation. Because of this, we have run three more regressions, with A64, or A15, or the dependency ratio variable (the percentage of population aged under 15 and over 64). The estimators of the three more models are almost the same as the basic model. And in the model with only A64, it is still insignificant, whereas in other two regressions, both age variables are significant at the 1 percent significance level. In view of this, we believe the high correlation doesn't cause a significant problem in the model.

[36]Here we have also explored whether different provinces responded to SARS differently. Only one province (Shanghai) is statistically different from the mean value at the 5% significance level.

DOI: 10.1002/hec

significant and has increased GHE by 12.1% annually during 2002–2006. It has captured all the factors that impact GHE through time. But at least, it estimates the upper bound impact of national policy. It coincides with the central policy of the increasing GHE. Here we must pay special attention to the fact that the GHE growth rate is very high and exceeds the GDP growth rate during 2002–2006. The coefficients of female and college variables are positive as we expected but not statistically significant. They are not significant determinants of GHE.

8. DISCUSSION

8.1. Endogeneity

Endogenous bias might be caused by the transfers variable, which could be related to the actual level of GHE. This problem, however, should not be significant. Indeed, as previously discussed, the special grants for health are relatively small, less than 1% of the total. Central transfers to the less developed regions improve local potential capacity to spend on all local public goods, not only health. The inverse impact is not critical. The central transfer policy to local governments is roughly constant over a 5-year period. One of the most important policies is "China Western Development", covering 12 less developed provinces for the next 50 years, from 2001–2050.[37] As the LSDV model uses the provincial dummies to fix these time-constant effects, we expect to get consistent estimates.

Additionally, if a province with worse public health needs to invest more in health care, this can introduce adverse selection. In the meantime, an increase in GHE would improve prevention and thus may help achieve better outcomes in morbidity and mortality, which would lead to a favorable selection. If the two selections happen jointly, both morbidity and mortality effects might be insignificant because of the simultaneous selection bias. However, this may not be as serious as appears. This is because that it is usually a long-term policy effort to manage communicable diseases such as viral heptitis and tuberculosis. It's hardly for GHE to have an immediate outcome, such as a significant decrease in morbidity and mortality within a year. Regardless, we conduct an endogeneity test for the model. The number of for-profit health institutions and beds were used as the IVs for the morbidity and mortality.[38] Using the Hausman test (1978), we find no evidence to reject the null hypothesis,[39] concluding that the FE estimates are consistent.

8.2. Long-run effects

Although current infectious disease status did not affect GHE significantly, we cannot exclude long-run effects. We incrementally add 1, 2 and 3 year lagged morbidity and mortality into the model, and regress respectively. However, only in the last regression (with 3-year lags), is the 2-year lagged mortality statistically significant at the 5% significance level, and has economic significance. But the degrees of freedom in this specification are only 41, and the estimation makes little sense. To get a consistent and efficient estimation, more data are needed.

9. CONCLUSIONS

This paper has utilized a panel data set for Chinese provinces over the period of 2002–2006 to examine the determinants of real per capita provincial GHE and to test whether the expenditures have fluctuated according

[37]China Western Development is a policy adopted by the People's Republic of China to boost its less developed western regions. The policy covers six provinces (Gansu, Guizhou, Qinghai, Shaanxi, Sichuan, and Yunnan), five autonomous regions (Guangxi, Inner Mongolia, Ningxia, Tibet, and Xinjiang), and one municipality (Chongqing). These regions contain 71.4% of mainland China's area, but only 28.8% of its population, as of the end of 2002, and 16.8% of its total economic output, as of 2003.

[38]On the one hand, we assume more health access for better public health. Therefore, if there are more for-profit health facilities, it would increase the regional health access, leading to decrease in infectious diseases. On the other hand, the for-profit health facilities are all private in China, and therefore should be uncorrelated with *GHE*. As such, we use the number of for-profit health institutions and beds as the IVs for morbidity and mortality.

[39]Hausman test result is $\chi2(41) = 1.75$, $p = 1.00$. Here we do not report the detail result of the IV regression.

to the status of provincial public health. The empirical analysis shows that the key determinants of real per capita provincial GHE are real provincial general budget revenue per capita, transfers from the central government per capita, proportion of the provincial population under age 15, BHIS coverage rate and the proportion of urbanization. Moreover, the SARS event has increased GHE, but we find no statistical evidence to show that provincial GHE have fluctuated according to the public health status.

With regard to the high correlation between revenues and local GDP, we find that provincial GHE is indeed affected by the local economy, but transfers, population under age 15, medical insurance coverage, and urbanization also made significantly impacts on provincial GHE. This result contrasts with some previous studies (Dai, 2004; Liu, 2005) that attribute the disparity of GHE solely to the different local economic development. The differences caused by the factors, such as age structure and urbanization, which reflect the real health care needs and may not be affected much by the policy, could be legitimate, therefore the pursuit of absolute equalization of GHE across provinces may not be wise or even misleading. We believe that this is an important message for policy makers that it is necessary to disentangle legitimate needs factors[40] from illegitimate impacts when assessing the policy interventions towards the equality of GHE.

Another important finding is that the elasticities of general budget revenue and total transfers from the central government are relatively low and roughly equal in magnitude, in fact transfers elasticity is slightly lower; a 10% rise in local general budget revenue and transfers from central increases GHE, on the average, by 2.95% and 2.27%, respectively. This implies that local governments are not more generous when using transfers than general revenues on health care spending and that transfers do not efficiently achieve the goal of equalization of public services across regions. We suspect that the small proportion of special purpose grants for health is the reason for the inefficiency of transfers. As mentioned previously, transfers are made up of tax grants, equalization grants, and special purpose grants, each with a share of about one-third. The quantity of equalization and special purpose grants from the central government to local governments is determined by the central government. The local governments determine how to allocate the tax grants and equalization grants, as with the budget revenues but not the special purpose grants. From this point, we may infer that the elasticities of tax grants and equalization grants are similar to the one for budget revenue. Thus plus the small share of special purpose grants for health, total transfers may have a lower elasticity close to that of budget revenue. In fact, our inference agrees with our estimation results. Given these considerations and the goal of transfers to promote equalization of local public services, we suggest that the central government increase the share of special purpose grants for health, and formulate specific policies to allocate the health resources based on the actual disparity of provincial GHE. As such, we expect transfers from the central government to play an increasingly important role in equalizing the provincial GHE.

It's unfortunate that, except for SARS, there is no statistical evidence that provincial GHE has fluctuated according to the public health status during 2002–2006. In fact, some improvement has been made in infectious disease control in the post-SARS era (Kaufman, 2008). We suspect that the local governments might invest a fixed amount in infectious disease control, which increases annually. If so, this effect might be captured by province-specific dummies and the time–trend variable. Unfortunately, there is no data available on provincial GHE, specifically for infectious diseases. Nonetheless, our results provide the insight that the local financial budgeting procedures of GHE are somewhat rigid, which can prevent local governments from responding effectively to changes in public health needs and the demand for GHE. Therefore, a more flexible GHE budgeting mechanism should be considered when determining the local GHE in accordance with public health status. It is hoped that such policy changes will contribute to better health and healthcare outcomes in China.

Equality in public health services is the right of every citizen, and the fair and efficient distribution of limited public health resources should be the primary goal of the GHE system.

We nevertheless recognize that this study has a number of limitations. First, there is a need to further research which determinants are legitimate and which are illegitimate. Secondly, the simultaneity problem and

[40]The detail conception of legitimate needs factors and illegitimate factors, please see Smith *et al.* (2001).

DOI: 10.1002/hec

lag effects need further testing. Third, the estimations in this paper are elasticity and semi-elasticity; the ratios roughly reflect the relationship between growth and decline, but cannot accurately determine the magnitude of the impact. A further study with a longer time series of smaller areas can overcome these limitations.

APPENDIX A: GROSS DOMESTIC PRODUCT, REVENUE, AND TRANSFERS IN 2006

	GDP per capita (RMB)	GDP per capita rank	revenue per capita (RMB)	revenue per capita rank	transfers per capita (RMB)	transfer per capita rank
Shanghai	57,114.98623	1	8683.604408	1	2047.528926	5
Beijing	49,780.39216	2	7066.106262	2	1450.816572	11
Tianjin	40,550.23256	3	3879.515349	3	1685.797209	8
Zhejiang	31,611.46586	4	2606.836145	4	677.1301205	27
Jiangsu	28,668.98013	5	2194.280795	6	628.3449007	29
Guangdong	28,164.7356	6	2342.49871	5	571.0888865	31
Shandong	23,716.14567	7	1456.9262	10	620.4496724	30
Liaoning	21,660.38399	8	1914.473894	7	1449.55631	12
Fujian	21,401.20854	9	1520.996908	9	655.10905	28
Inner Mongolia	19,989.48686	10	1432.529829	11	2041.90947	6
Hebei	16,904.07364	11	899.5853871	19	890.2360104	24
Heilongjiang	16,188.59534	12	1011.885953	15	1601.803557	9
Jilin	15,700.03672	13	900.4939405	18	1705.224385	7
Xinjiang	14,854.92683	14	1070.550244	13	2293.380976	4
Shanxi	14,081.6	15	1728.519111	8	1197.621037	15
Hubei	13,316.91551	16	836.2590901	21	1120.408396	18
Henan	13,304.90843	17	723.1383092	26	842.772253	26
Hainan	12,593.89952	18	978.6351675	16	1250.289474	13
Chongqing	12,434.3661	19	1131.469017	12	1196.770655	16
Shaanxi	12,111.75368	20	970.4966533	17	1249.541098	14
Hunan	11,934.54746	21	753.5909808	23	1029.724535	20
Ningxia	11,767.54967	22	1015.844371	14	2364.847682	3
Qinghai	11,707.66423	23	770.870438	22	3289.330292	2
Jiangxi	10,764.07006	24	704.1286011	27	979.8070984	21
Sichuan	10,573.88909	25	743.7691272	24	942.4927164	23
Tibet	10,356.22776	26	518.1743772	31	7317.960854	1
Guangxi	10,232.06188	27	725.9563467	25	944.1780038	22
Anhui	10,063.38789	28	700.5343699	28	868.1599018	25
Yunnan	8937.586438	29	847.5801918	20	1144.672095	17
Gansu	8736.37759	30	541.884881	30	1480.584037	10
Guizhou	6073.995209	31	603.7149321	29	1041.704552	19

Data source: *China Statistical Yearbook 2007 and Finance Yearbook of China 2007*. Data in this table are at current price (2006). GDP, Gross domestic product.

APPENDIX B: THE STATISTICAL SOFTWARE PACKAGE, SPECIFIC COMMANDS USED IN THE REGRESSION ANALYSIS

We used STATA 10.1 for Windows in the regression analysis. Here we listed our major commands:

Box–Cox test

boxcox rghe rrevenue rtransfer, model(lambda)

boxcox rghe rrevenue rtransfer, model(rhsonly)
boxcox rghe rrevenue rtransfer, notrans(A15 A64 morbidity mortality SARS beds personnel coverage urban female college t _Iprovince_2 _Iprovince_3 _Iprovince_4 _Iprovince_5 _Iprovince_6 _Iprovince_7

DOI: 10.1002/hec

```
_Iprovince_8 _Iprovince_9 _Iprovince_10 _Iprovince_11 _Iprovince_12 _Iprovince_13 _Iprovince_14
_Iprovince_15 _Iprovince_16 _Iprovince_17 _Iprovince_18 _Iprovince_19 _Iprovince_20 _Iprovince_21
_Iprovince_22 _Iprovince_23 _Iprovince_24 _Iprovince_25 _Iprovince_26 _Iprovince_27 _Iprovince_28
_Iprovince_29 _Iprovince_30 _Iprovince_31) model(lambda)

boxcox rghe rrevenue rtransfer, notrans(A15 A64 morbidity mortality SARS beds personnel coverage urban
female college t _Iprovince_2 _Iprovince_3 _Iprovince_4 _Iprovince_5 _Iprovince_6 _Iprovince_7
_Iprovince_8 _Iprovince_9 _Iprovince_10 _Iprovince_11 _Iprovince_12 _Iprovince_13 _Iprovince_14
_Iprovince_15 _Iprovince_16 _Iprovince_17 _Iprovince_18 _Iprovince_19 _Iprovince_20 _Iprovince_21
_Iprovince_22 _Iprovince_23 _Iprovince_24 _Iprovince_25 _Iprovince_26 _Iprovince_27 _Iprovince_28
_Iprovince_29 _Iprovince_30 _Iprovince_31) model(rhsonly)
```

Random effect regression

```
xtreg lnrgher lnrrevenue lnrtransfer A15 A64 morbidity mortality SARS beds personnel coverage urban female
college t, re robust
```

BP-LM test

```
xttest0
```

Fixed effect regression (LSDV)

```
xi: reg lnrgher lnrrevenue lnrtransfer A15 A64 morbidity mortality SARS beds personnel coverage urban
female college t i.province, robust
```

Ramsey RESET test

```
estat ovtest
```

Hausman test fixed effect model and ramdom effect model

```
xi: reg lnrgher lnrrevenue lnrtransfer A15 A64 morbidity mortality SARS beds personnel coverage urban
female college t i.province
est store fixed
xtreg lnrgher lnrrevenue lnrtransfer A15 A64 morbidity mortality SARS beds personnel coverage urban female
college t, re
est store random
hausman fixed random
```

IV regression

```
xi: ivreg lnrgher lnrrevenue lnrtransfer A15 A64 SARS beds personnel coverage urban female college t
i.province (morbidity mortality = profitinstitutionnumber profitbeds),robust
```

Hausman test IV regression and fixed effect model

```
xi: ivreg lnrgher lnrrevenue lnrtransfer A15 A64 SARS beds personnel coverage urban female college t
i.province (morbidity mortality = profitinstitutionnumber profitbeds),robust
est store iv
xi: reg lnrgher lnrrevenue lnrtransfer A15 A64 morbidity mortality SARS beds personnel coverage urban
female college t i.province, robust
est store fixed
hausman iv fixed
```


DOI: 10.1002/hec

APPENDIX C: BOX-COX TEST

	Constraint (null hypothesis)				
Form	L_y	L_x	L_{max}	$X^2(2)$	P-Value
Log-log	0	0	-669.78	0.75	0.386
Linear	1	1	-757.86	176.92	0.000
Exponential	0	1	-669.86	10.74	0.001
Semi-log	1	0	-807.37	100.47	0.000

Note 1: The Box-Cox model assigns two parameters to each regressor in the way: $GHE_{it}^{L_y} = \beta_1 + \beta_2 Revenue_{it}^{L_x} + \beta_3 Transfers_{it}^{L_x} + u_{it}$, where $L(L_y; L_x)$ are the Box-Cox transformation parameters (Box and Cox, 1964). The transformations are carried out as (Z = GHE, Revenue, Transfers): $Z^L = (Z^L - 1)/L$ for $L \neq 0$ and $Z^L = \ln Z$ for $L = 0$. For example, the restriction $L(L_y; L_x) = (0, 0)$ implies that $\ln GHE_{it} = \beta_1 + \beta_2 \ln Revenue_{it} + \beta_3 \ln Transfers_{it} + u_{it}$. The Box-Cox model is used to find the maximum likelihood estimates of the unknown parameters $L(L_y; L_x)$, and these estimates are used to test the null hypotheses about particular $L(L_y; L_x)$ values, and L_{max} represents the restricted log likelihood. *Note* 2: The extended Box-Cox model includes all other covariates which are not subject to the transformation, meaning: $GHE_{it}^{L_y} = \beta_1 + \beta_2 Revenue_{it}^{L_x} + \beta_3 Transfers_{it}^{L_x} + \beta_4 A15_{it} + \beta_5 A64_{it} + \beta_6 Morbidity_{it} + \cdots u_{it}$, is also tested, and the similar results are obtained.

APPENDIX D: RESULTS FOR REGRESSION-ADDING LAGGED VARIABLES

	FE (1)	FE (2)	FE (3)	FE (4)
Public health				
Morbidity	–0.015	–0.006	–0.028	0.029
	(0.015)	(0.016)	(0.021)	(0.040)
Mortality	–3.284	–3.460	–2.435	–6.353
	(2.182)	(2.475)	(2.766)	(7.676)
$Morbidity_{-1}$		–0.025	0.001	0.066
		(0.020)	(0.015)	(0.050)
$Mortality_{-1}$		–1.456	–0.646	–8.476
		(2.136)	(2.975)	(6.588)
$Morbidity_{-2}$			–0.029	–0.005
			(0.024)	(0.032)
$Mortality_{-2}$			2.807	8.070**
			(2.470)	(3.876)
$Morbidity_{-3}$				0.066
				(0.049)
$Mortality_{-3}$				–0.350
				(6.916)
SARS	0.041**	0.153***		
	(0.018)	(0.054)		
Income factors				
Revenue	0.295***	0.114	0.172	–0.068
	(0.106)	(0.103)	(0.157)	(0.278)
Transfers	0.227**	0.267**	0.382***	0.047
	(0.108)	(0.114)	(0.133)	(0.299)
Aging factors				
A15	0.018***	0.017**	0.005	0.027
	(0.005)	(0.007)	(0.007)	(0.017)
A64	0.020	0.004	0.016	0.026
	(0.015)	(0.014)	(0.014)	(0.033)
Institution factors				
Beds	0.034	–0.124	–0.080	–0.476***
	(0.042)	(0.076)	(0.071)	(0.135)
Personnel	0.055	0.089	0.145	–0.055
	(0.074)	(0.104)	(0.098)	(0.190)

(*Continues*)

DOI: 10.1002/hec

APPENDIX D. (*continued*)

	FE (1)	FE (2)	FE (3)	FE (4)
Other social factors				
Coverage	−0.641***	−0.255	−0.570	1.212*
	(0.192)	(0.347)	(0.427)	(0.715)
Urban	−0.557**	−0.356	−0.552	2.204
	(0.255)	(0.353)	(0.464)	(1.973)
Female	0.305	2.000	1.318	1.389
	(1.616)	(1.774)	(2.026)	(4.515)
College	0.655	0.366	1.296	3.191
	(0.766)	(1.114)	(1.116)	(1.985)
Time	0.121***	0.198***	0.160***	0.318***
	(0.035)	(0.035)	(0.042)	(0.084)
Constant	−0.048	0.188	−0.651	1.862
	(1.049)	(1.169)	(1.587)	(5.169)
Observation	155	124	93	62
Number of provinces	31	31	31	31
Overall R^2	0.789	0.364	0.776	0.089

Parentheses show robust standard errors for parameter estimation. *, **, and *** denote statistical significance at the 10, 5, 1 percent levels, respectively.

ACKNOWLEDGEMENTS

We are grateful to Qingshuang Yin (Southwestern University of Finance and Economics), Juyan Zhang (Southwestern University of Finance and Economics), the editor, Winnie Yip, and two anonymous referees for their helpful comments. We have also benefited greatly from Judy Xu (Southwestern University of Finance and Economics), Mingshan Lu (University of Calgary) and Peng Wang (Southwestern University of Finance and Economics). We along are responsible for any errors.

REFERENCES

Arrow KJ. 1963. Uncertainty and the welfare economics of medical care. *The American Economic Review* **53**: 941–973.
Bishop EL. 1928. Responsibility of government in public health work. *American Journal of Public Health* **6**: 705–709.
Blomqvist AG, Carter RAL. 1997. Is health care really a luxury? *Journal of Health Economics* **16**: 207–229.
Box GEP, Cox DR. 1964. An analysis of transformations. *Journal of the Royal Statistical Society (Series B)* **26**: 211–252.
Bren L. 2005. Does sex make a difference? *FDA Consumer* **39**: 10–15.
Breusch TS, Pagan AR. 1980. The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies* **47**(1): 239–53.
China National Health Development Research Center. 2009. China Total health expenditures report (in Chinese).
Chou WL. 2007. Explaining China's regional health expenditures using LM-type unit root tests. *Journal of Health Economics* **26**: 682–698.
Costa-Font J, Pons-Novell J. 2007. Public health expenditure and spatial interactions in a decentralized national health system. *Health Economics* **16**: 291–306.
Crivelli L, Filippini M, Mosca I. 2006. Federalism and regional health care expenditures: an empirical analysis for the Swiss cantons. *Health Economics* **15**: 553–541.
Dai Y. 2004. Public health expenditures: the size and allocation. *Public Finance Research* **6**: 30–32 (in Chinese).
Denton FT, Spencer BG. 1975. Health care costs when the population changes. *Canadian Journal of Economics* **8**: 130–135.
Eggleston K, Ling L, Qingyue M, Lindelow M, Wagstaff A. 2008. Health service delivery in China: a literature review. *Health Economics* **17**: 149–165.
Freeman DG. 2003. Is health care a necessity or a luxury? Pooled estimates of income elasticity from US state-level data. *Applied Economics* **35**: 495–502.
Gbesemete KP, Gerdtham UG. 1992. Determinants of health care expenditure in Africa: a cross-sectional study. *World Development* **20**: 303–308.

DOI: 10.1002/hec

Gerdtham UG. 1992. Pooling international health care expenditure data. *Health Economics* **1**: 217–231.
Gerdtham UG, Jönsson B. 1992. International comparisons of health care expenditure: conversion factor instability, heteroscedasticity, outliers and robust estimators. *Journal of Health Economics* **11**: 189–197.
Gerdtham UG, Jönsson B. 2000. International comparisons of health care expenditure: theory, data and econometric analysis. *Handbook of Health Economics* **1**: 12–49.
Gerdtham UG, Jönsson B, MacFarlan M, Oxley H. 1998. The determinants of health expenditure in the OECD countries: a Pooled data analysis. *Developments in Health Economics and Public Policy* **6**: 113–114.
Gerdtham UG, Sögaard J, Andersson F, Jönsson B. 1992. An econometric analysis of health care expenditure: a cross-section study of the OECD countries. *Journal of Health Economics* **11**: 63–84.
Giannoni M, Hitiris T. 2002. The regional impact of health care expenditure: the case of Italy. *Applied Economics* **34**: 1829–1836.
Hansen P, King A. 1996. The determinants of health care expenditure: a cointegration approach. *Journal of Health Economics* **15**: 127–137.
Hausman JA. 1978. Specification tests in econometrics. *Econometrica* **46**(6): 1251–1271.
Hitiris T, Posnett J. 1992. The determinants and effects of health expenditure in developed countries. *Journal of Health Economics* **11**: 173–181.
Huang X, Fang Q. 2008. Study of China's financial support for regional differences in health care. *Public Finance Research* **4**: 41–45 (in Chinese).
Jin R. 2007. With regard to regulating the fiscal transfer reports–June 27, 2007 at the Tenth National People's Congress Standing Committee 28th meeting. *Ministry of Finance People's Republic of China* (in Chinese).
Kaufman JA. 2008. China's health care system and avian influenza preparedness. *The Journal of Infectious Diseases* **197**(Suppl 1): S7-S13.
Kleiman E. 1974. The determinants of national outlay on health, in Perlman M. (ed), *The economics of health and medical care*. John Wiley and Sons: New York.
Li HB, Zhou LA. 2005. Political turnover and economic performance: the incentive role of personnel control in China. *Journal of Public Economics* **89**: 1743–1762.
Li S, Zhong W. 2006. Empirical research of China's health services' equity and efficiency. *Management World* **4**: 146–147 (in Chinese).
Liberatos P, Link BG, Kelsey JL. 1988. The measurement of social class in epidemiology. *Epidemiologic Reviews* **10**: 87–121.
Lin W, Liu GG, Chen G. 2009. The urban resident basic medical insurance: a landmark reform towards universal coverage in China. *Health Economics* **18**: S83-S96.
Liu GG. 2009. *Beijing's perspective: the internal debate on health care reform*. The Center for Strategy and International Studies (CSIS): Washington DC.
Liu J. 2005. Under public finance: the government health expenditures and management mechanism. *Review of Economic Research* **94**: 1–20 (in Chinese).
Matteo LD. 2004. What drives provincial health expenditure? *Canadian Tax Journal* **52**(4): 1102–1120.
Matteo LD, Matteo RD. 1998. Evidence on the determinants of Canadian provincial government health expenditures: 1965–1991. *Journal of Health Economics* **17**: 211–228.
Maxwell RJ. 1981. *Health and wealth*. Lexington books: Lexington.
McCoskey SK, Selden TM. 1998. Health care expenditures and GDP: Panel data unit root test results. *Journal of Health Economics* **17**: 369–376.
McGuire TG. 2000. Physician Agency. *Handbook of Health Economics* **9**: 461–535.
Milne R, Molana H. 1991. On the effect of income and relative price on demand for health care: EC evidence. *Applied Economics* **23**: 1221–1226.
Newhouse JP. 1977. Medical care expenditure a cross-national survey. *The Journal of Human Resources* **12**: 115–125.
Parkin D, McGuire A, Yule B. 1987. Aggregate health expenditures and national income: is health care a luxury good? *Journal of Health Economics* **6**: 109–127.
Pfaff M, Nagel F. 1986. Consequences for hospital resulting from demographic, social and morbidity changes: a European perspective. *The International Journal of Health Planning and Management* **2**: 311–333.
Ramsey JB. 1969. Tests for specification errors in classical linear least-squares analysis. *Journal of the Royal Statistical Association* **71**: 350–371.
Roberts J. 1999. Sensitivity of elasticity estimates for OECD health care spending: analysis of a dynamic heterogeneous data field. *Health Economics* **8**: 459–472.
Roberts J. 2000. Spurious regression problems in the determinants of health care expenditure: a comment on Hitiris (1997). *Applied Economics Letters* **7**(5): 279–283.
Schieber GJ, Poullier JP. 1989. Overview of international comparisons of health care expenditures. *Health Care Financing Review*, Annual supplement: 1–7.

Smith PC, Rice N, Carr-Hill R. Capitation funding in the public sector. 2001. *Journal of the Royal Statistical Society* **164**: 217–257.

State Council. 2009. Opinions of the Communist Party of China Central Committee and the State Council on deepening the health care system reform (in Chinese).

Su M, Zhao Q. 2004. China's fiscal decentralization reform. The research institute for fiscal science, Ministry of Finance, China (in Chinese).

Wagstaff A, Yip W, Lindelow M, Hsiao WC. 2009. China's health system and its reform: a review of recent studies. *Health Economics* **18**: S7–S23.

Wang S. 2003. Chinese public health crisis and turning point. *Comparative Studies* **7**: 52–88 (in Chinese).

Wen J. 2008. The State Council report on the work of the government.

Wooldridge JM. 2002. *Econometric Analysis of Cross-Section and Panel Data*. MIT Press: Cambridge, MA.

Zhao JG, Miao L. 2008. Empirical analysis of the fairness of China's health care expenditure. *Public Finance Research* **7**: 44–47 (in Chinese).

Zhou H, Ruan Y, Wang J. 2009. The problem and causes analysis of government's investment in public health in financial view in China. *Health Economics Research* **4**: 11–13 (in Chinese).

DOI: 10.1002/hec