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Efficiency of township hospitals in China in the context of the drug policy reform: Progress should not get bogged in midstream

A case study from a survey in Weifang prefecture.

Laurene Petitfour, CERDI-CNRS, Université Clermont Auvergne, France (Corresponding author :

Xiezhe Huangfu, CERDI-CNRS, Université Clermont Auvergne, France

Martine Audibert, CERDI-CNRS, Université Clermont Auvergne, France

Jacky Mathonnat, CERDI-CNRS, Université Clermont Auvergne, France and FERDI (Corresponding author :

Abstract

Since the early 2000s, China has embarked on a major reform program in the field of health. Three are essential and linked: rebuilding a new health insurance system in rural areas, restructuring the organization and management of hospitals, halting the sharp rise in drug prices. To cope with the rising price of drugs, in 2009 the Chinese government launched a large pharmaceutical reform.

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… / … Its key element is the implementation of a National Essential Medicine List (NEML), leading to a reorientation of incentives for health services financing. Health facilities are no longer allowed to make any profit on drug sales ("zero mark-up policy"), while this used to be their main source of revenue. Authorities have implemented different compensation schemes. In the context of redesigning the financing structure of health care facilities, it is crucial to understand how the NEML reform has affected—or not—the activity and efficiency of health care facilities, since the search for greater efficiency in the health system is a transversal and underlying objective of the three reforms mentioned above.

This study relies on survey data from a sample of 30 randomly selected Township Hospitals (TH) in rural area from the prefecture of Weifang, in the Shandong province. Using a two-stage procedure, the study aims at assessing the technical efficiency scores of Township Hospitals and then at identifying the determinants of this efficiency. The first stage is realized with a non-parametric frontier approach, "partial frontier" method (order-m), to deal with the problem of dimensionality of the sample. The identification of the determinants of efficiency is made with fractional regressions (Ramalho, 2011). Results show that the average efficiency remains constant from 2006 to 2009 and 2010 to 2012, at around 0.65. The most significant and robust factors of technical efficiency are the share of subsidies in the TH incomes (negative effect) and the number of covered inhabitants per bed (positive effect). The study suggests that even after the implementation of the drug reform, a "soft budget constraint" effect remains, as well as financial barriers to universal access to healthcare (importance of demand-side determinants) and a phenomenon of oversizing of some THs.

1 Introduction

From the 1970s to the 2010s, due to urbanization and real-income growth of a large part of the population, China saw its lifestyle change (better access to food, less physical activity, spread of tobacco use), and faced an aging population. This caused a spectacular demographic and epidemiological transition. The emergence of cardiovascular pathologies, cancers, hypertension, and chronic diseases increased the cost of healthcare, mainly borne by households, causing a large problem with inequality in access to healthcare. From the early 1990s, China began to respond to these challenges and has embarked on a major reform program in the field of health. Three are essential and linked (Mathonnat *et al*., 2015): rebuilding a new health insurance system in rural areas, restructuring the organization and management of hospitals, halting the sharp rise in drug prices. The spectacular increase of the insurance coverage rate since 2003 (Audibert *et al*., 2013, You and Kobayashi, 2009) spurred the activity of public health facilities (Wagstaff et al., 2009) but

the financial burden of healthcare still represents a cause of impoverishment (Sun et al., 2009; Yip and Hsiao, 2009; Meng et al., 2012).

Yet the quantity of financial resources injected into the system has continued to increase for more than three decades, largely because of the rise of costs. The inefficiency of Chinese healthcare facilities (Hu et al., 2008) has therefore become critical. The daily number of patients cared for by medical staff has proven to be weaker in China than in many other countries. The reasons are both internal (inappropriate recruitments and incentives) and environmental (collapse of health insurance and problems with healthcare access). A growing defiance and dissatisfaction from patients, due to mediocre quality of healthcare in public facilities, is also a matter of concern.[1]

The rural insurance reform of 2003 did not contain the rise of costs and out-of-pocket payments. With those costs largely composed of drug expenses (Sun et al., 2008), in 2009 the government implemented a pharmaceutical reform to cut prices by using a National Essential Medicine List (NEML) and a zero mark-up policy for the sales of drugs. By reorienting the incentives for healthcare providers, it aims at using all the resources of the healthcare system more efficiently.

Relying on survey data, this study aims at estimating the technical efficiency of a sample of Township Hospitals (which are the core of the Primary Healthcare Facilities in the Chinese system) from the Weifang prefecture, in the Shandong province, with special attention given to the role of financial compensation granted by local governments on the expected improvement in the efficiency of THs after the aforementioned reform of drug policy. The study concludes that technical efficiency did not improve over the period. No significant change was observed in the factors that drive technical efficiency. Our results raise questions that go beyond the case of Weifang, concerning the difficulty of aligning incentives with the objectives of reforms in health policy.

Section 2 presents the two main reforms of the Chinese health system in the 2000s: rural insurance and the NEML. Section 3 outlines a literature review about the determinants of efficiency. Section 4 presents the main characteristics of our sample and study area. Section 5 focuses on the estimation of the TH efficiency scores, while Section 6 deals with the identification of the determinants of efficiency. Results are discussed in Section 7, before a conclusion in Section 8.

[1] The wave of violence against doctors recently observed in several provinces, and which is one extreme manifestation of this dissatisfaction, is being taken very seriously by the National Health and Family Planning Commission (issued from the 2013 merging of the Ministry of Health with the Family Planning Commission).

2 Background

2.1 The revival of the Chinese Health Insurance system in rural areas

In 1975, the Cooperative Medical System (CMS) ensured almost universal access to basic healthcare for the Chinese rural population through a pre-payment insurance system (Bloom and Xingyuan, 1997; Dong, 2009). With its unraveling in the 1980s and 90s, healthcare became a financial burden for many households due to rising prices and the absence of health insurance. In 2003, the implementation of the New Rural Community Medical System (NRCMS) gave a large part of rural households access to basic health insurance, managed at the county level. The enrollment rate rose from less than 10% in 2003, to more than 95%, in 2013 (*WB Policy Note 3,* Yip et al., 2012 and official data quoted in China Daily, 2014-06-03).

A primary aim of NRCMS was to avoid catastrophic health expenditures. However, deductibles and copayments rates remained high, leaving high out-of-pocket payments for most medical care, with, overall, ambiguous effects on catastrophic health expenditures. There are two main reasons. First, the NRCMS is administered at the county level, within a policy guideline (You and Kobayashi, 2009), but there are substantial inequalities between poor and rich counties (Meng et al., 2012) in terms of financial capacities and reimbursement rates. Second, until very recently the benefit packages have focused mainly on inpatient care[2], despite the epidemiological transition, and the fact that chronic diseases mainly lead to poorly reimbursed outpatient cares.

2.2 The National Essential Drug Policy

At the same time, on the supply side the financing modalities of health providers led to overpricing and overprescribing for many years. Central government subsidies to public healthcare facilities fell off during the 80s and 90s, and to offset it, hospitals were allowed to take a mark-up on drug sales and new medical acts such as tests and surgeries to ensure their activities. Simultaneously, there were severe controls on the price of basic healthcare needs (Blumenthal and Hsiao, 2005), on which health facilities could not make any profit. As a result, health providers neglected basic-care services, thereby lowering the overall quality of primary healthcare.

These phenomena collectively created incentives for health practitioners to overprescribe high-technology tests and expensive drugs to increase a facility's income through user fees. Drug benefits became the main source of hospitals' financing (Yip et al., 2010). Until 2009, health facilities were allowed to take a 15% financial markup on the cost of drugs, and used to "take an average margin between 30% and 40%" (Wang Dongsheng, vice-director of the Social Development Division of National Development and Reform Commission, 2006). This made the financial burden of health expenditures even heavier for households.

[2] Wagstaff et al., 2009; Our discussions with members of the National Health and Family Planning Commission.

Drug overpricing was also spurred by the national drug supply-chain, due to the excessive number of wholesalers, intermediaries between the drug producers and health facilities, and by the absence of a bidding system (Yu et al., 2010). Indeed, in China the pharmaceutical market was made up of thousands of manufacturers, selling their products to a "third-tier" who made contact with either another wholesaler or, finally, a health facility. With each link in the supply chain taking a cut, this system exacerbated the high cost of drugs in China (compared to international prices).

To contain the excessive drug prices and disconnect hospital income from drug sales, in 2009 the Chinese government implemented the National Essential Drugs Policy (NEDP). It aimed at improving the drug supply system by ensuring equal access to basic-care medicines and safety of drug utilization, and to strengthen the Township Hospitals initial missions in the health care pyramid. Township Hospitals are at the core of the Chinese health system, between the Village Health Stations (VHS), which are the most basic facilities, and the County Hospitals with wider care capacities. The missions of THs are the treatment for non-severe pathologies, the referral of severe cases to county hospitals, the management of Village Health Stations' (VHS) staff in their coverage area, and prevention services. To ensure this preventive mission, the reform included the development of public health activities: vaccinations, health records for children and the elderly, with specific subsidies for this purpose.

The reform consists of two main elements. First, a National Essential Medicine List (NEML) was released. All Primary Healthcare Facilities (PHF, i.e. Township Hospitals and Village Health Stations) must now prescribe exclusively essential drugs.

Second, since October 2009, the government implemented a zero mark-up policy on the sale of essential drugs (NDRC, 2008). PHFs were required to adjust drug prices to their purchasing price, including delivery costs, but without any mark-up.

To compensate for losses due to the zero-markup policy, and to ensure the stability of NEDP, different modes of financial compensation were implemented (Yuan and Tang, 2012; Zhuo and Zou, 2012). Counties were allowed to choose one, or mix several modes of compensation from subsidies to new activity incomes. In the Weifang prefecture, the compensation is made by subsidies, allocated on a monthly basis, during the current year.

3 Literature review and the potential effects of the zero mark-up policy on township hospitals efficiency

3.1 Expected effects of the reform

Effects on demand of healthcare

Because of the high cost of care, we consider the healthcare demand at the TH level relatively price elastic to the amount of the residual cost borne by the households. The mandatory use of essential drugs, as well as the policy of zero mark-up, should lead to a decrease in the unit cost of care and a reduction in catastrophic costs, all things being equal. For these reasons, an increase in healthcare demand is expected, and was found in various studies (Li et al., 2013; Xiao et al., 2013). This can result from a demand that was previously not satisfied for financial reasons (renunciation to care, self-medication) or from a transfer of demand from Village Health Stations, or county hospitals, to a Township Hospital. An increase may not be observed if patients, considering the decrease in unit costs, seek more sophisticated care than they would have otherwise. This effect was highlighted in the Gansu province following the development of NCMS (Wagstaff and Yu, 2007).

Considering that Township Hospitals are far from saturated, an increase in activity could lead to an increase in their efficiency. Pélissier et al., 2012, find a decreasing bed occupancy ratio (BOR) from 2000 to 2004 (from 40% to 35%), which then increases to 60% in 2008. In such a context, a surge of activity should not mean new inputs, and an increase in efficiency is expected as the physical and human resources are fully utilized.

Yet, Audibert et al., 2013, demonstrate a positive and significant impact of the NRCMS on Township Hospital activity in Weifang, but a negative impact on its efficiency. It is therefore essential, in terms of public policy, to distinguish the two analyses.

Effects on efficiency

In the precise context of the pharmaceutical reform, three main scenarios can be considered:

i) Demand for care increases, all other things being equal: efficiency progress is noted.

ii) Demand for care increases, but its expected positive effect on efficiency is offset by an increase of inputs. To anticipate increased attendance at THs, the quantity of inputs (especially staff) rise, despite their low productivity. If the demand does not increase sufficiently, the effect on the efficiency is potentially negative. This seems likely in Weifang, based on our discussion with the local authorities.

iii) Demand remains unchanged, as does the level of personnel and equipment. A decline or stagnation in efficiency is expected for several reasons:

a) Compensation for loss of income from drugs is partial; demand remains unchanged because THs develop coping strategies, for example by increasing medical activities (such as lab tests and drug injections) that are not supervised by the reform. The unit cost of care borne by households does not decrease.
b) Cost of care decreases. If there is partial compensation, and without THs coping strategies, objective and/or perceived quality of care are likely to decline. The negative effect on demand neutralizes or outweighs the positive effect coming from the decrease in the cost of care borne by households.

3.2 Potential determinants of efficiency

The literature related to this issue highlights two main types of factors: internal and external ones.

Internal variables deal with the way THs are managed and financed. Here two managerial variables are tested: the wage and bonus expenditure, per employee, and the proportion of licensed staff (i.e., proportion of doctors among the medical staff).

The financing structure of hospital income is also taken into account through its composition, between subsidies and activity revenue. In the situation of soft budget constraint (Kornai, 2009), by a mechanism of moral hazard, the dependence of hospitals on public subsidies has a negative impact on their efficiency. However, if subsidies are allocated by performance, their effect can be positive on efficiency and attributed to an incentive mechanism.

A methodological concern is the potential endogeneity of the effect of subsidies on technical efficiency, through reverse causality. In theory (according to the policy guidelines), the amount allocated to a TH is partly related to its performance, so the causality would be from efficiency to the amount of subsidy, with a positive sign. It can also be considered that in a soft budget constraint situation, if a TH is inefficient it will more likely be bailed out at the end of the year to offset its deficit and reach a financial balance. In this case, the amount of subsidies is still reliant on TH performances, but with a negative sign.

To check for the endogeneity of subsidies, we studied the determinants of subsidies in our sample through a panel data model. The results highlighted an absence of reverse causality between subsidies and efficiency scores. With neither the efficiency score, nor its lagged value being significant, the endogeneity of subsidies is thus rejected. Indeed, the amount of the subsidies allocated to each TH is largely driven by the population of the township (the size effect), by the county GDP per capita (which has a positive effect on the financial capacities of the NCMS bureau), and other unobservable factors.

The importance of subsidies is captured through several variables: the proportion of subsidies in TH total income is used as a proxy for TH dependence on public financing, and the proportion of subsidies in TH expenditures. Other proxies are successively introduced to the model: amount of subsidies per capita in the catchment area, per bed, and medical staff.

External determinants of efficiency encompass all the aspects of a hospital's environment, including competition with other healthcare facilities and the importance of potential demand in the catchment area. During a previous period (2000-2008), those variables were found to be the most determinant factors of TH efficiency (Audibert et al., 2013). We use as external determinants the population covered by the NCMS in the township, the density of population, the net income per capita, and the number of Village Health Stations under the responsibility of the Township Hospital. This last variable can have two opposite effects on TH efficiency: the phenomenon of competition, which has a negative effect, or stimulation of activity by referring patients from VHS to TH, which has a positive effect.

To check whether there was a shift in the determinants of efficiency between the beginning and the end of the period, the potential determinants were interacted with dummies corresponding to sub-periods, as well as variables at square, to test non-linear relations.

4 Study area and descriptive statistics

Database

This study relies on annual survey data from the rural part of the Weifang prefecture, a relatively rich coastal province, over the 2006-2012' period. The Weifang prefecture includes 12 administrative divisions, each formed of several townships. To each township is associated one Township Hospital. The sample is made of 30 randomly selected hospitals belonging to the eight rural counties of the prefecture. Data was collected by Weifang Health Bureau staff, colleagues from Weifang Medical University, and the authors. Sources of data include books and registers from Township Hospitals and the statistical and finance offices of townships and counties.

Every township in the sample is administratively classified as rural, and exhibits a large majority of rural population (around 90% throughout the period). The populations and densities covered by each hospital vary, creating large differences in terms of potential demand for healthcare. The average net income per capita is homogenous among the 30 townships, almost doubled from 2006 to 2012 (Table 1, 5510 annual constant yuans in 2006, 10800 in 2012).

Table 1. Characteristics of the 30 Townships of the sample

	2006			2009			2012		
	Mean	**Std dev.**	**Rel std dev**	**Mean**	**Std dev.**	**Rel std dev.**	**Mean**	**Std dev.**	**Rel std dev**
Population of the Township	58599	29615	50.54%	72950	31666	43.41%	71359	33000	46.25%
TH catchment area	46233	17979	38.89%	55143	24453	44.34%	56317	25312	44.95%
Number of VHS under the TH supervision	28	13	48.41%	34	16	48.89%	36	19	50.98%
Density of the covered population *(Inhabitants per km²*)	483	187	38.79%	503	224	44.57%	495	232	46.78%
Density of the township population (*Inhabitants per km²)*	545	408	74.93%	563	451	80.05%	553	482	87.12%
Average net income*	5511	1170	21.23%	7626	992	13.01%	10800	982	9.09%

Source: Data from Township registers. Rel. std dev= Std%mean

(*) Nominal values have been deflated by the General Retail Price Index in Shandong province, 2006=100 (from China Data Online)

The broad characteristics of the population remained stable across the period (Table 2). There is no major demographic evolution between 2006 and 2012. In the context of a randomly selected sample, the stability of demographic indicators associated with the precise missions of THs focusing on curative treatment of non-severe cases justifies a homogeneous case-mix across the THs of the sample, and across the period.

Table 2. Global statistics about the 8 counties of the sample

	2006			2009			2012		
	Mean	**Std dev**	**Rel std dev**	**Mean**	**Std dev**	**Rel std dev**	**Mean**	**Std dev**	**Rel std dev**
Rate of under 6 pop (%)	7.83	3.83	48.89%	8.00	4.09	51.20%	8.32	4.00	48.06%
Rate of above 65 pop (%)	8.97	1.31	14.61%	9.81	1.37	13.91%	11.23	2.29	20.42%
Rural net income (yuans)	5326	574	10.78%	7507	626	8.34%	11735	824	7.02%
Infant mortality *(per 1000)*	5.19	3.08	59.29%	4.32	1.62	37.57%	3.30	1.13	34.23%
Juvenile mortality *(per 1000)*	5.70	3.21	56.23%	4.87	1.84	37.85%	4.00	1.16	28.91%
Inpatient mortality *(per 1000)*	4.91	2.63	53.61%	4.68	2.74	58.59%	3.74	1.92	51.27%

Source: Data from County registers; Rel. std dev= Std%mean

Important evolution of activity

During the period under review, the level of resources and activity increased. The activity of the hospitals grew drastically regarding outpatients, inpatients, lab tests, medical examinations (radiology, etc.), and preventive activities (Table 3)**.** Nevertheless, no disruption in the trend is to be noted, the evolution being regular.

The inputs of the hospitals also rose over the period. But the number of available beds (+75%) and the equipment index (+85%) grew faster than the staff (+19%). Indeed, hospital managers frequently underlined their difficulties hiring staff in rural areas.

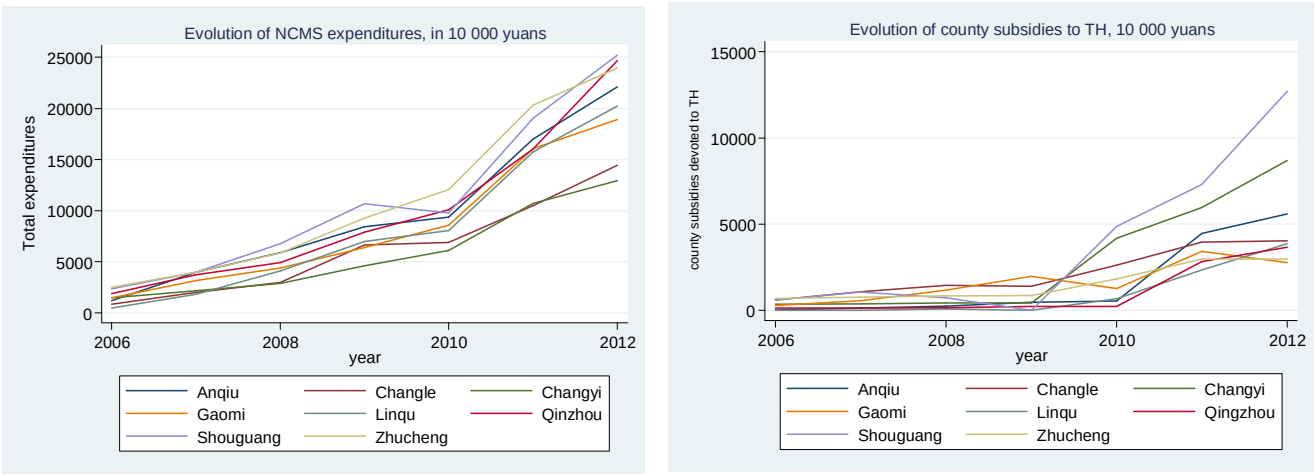
Table 3. Descriptive statistics about TH activity

	Mean			Median			Standard Deviation			Relative std deviation		
Variable	2006	Var(%)	2012	2006	Var(%)	2012	2006	Var(%)	2012	2006	Var(%)	2012
Number of outpatients	33087	82.22	60290	19612	63.07	31982	27566	125.75	62230	0.83	23.89	1.03
Number of admitted inpatients	1510	125.85	3411	1164	118.90	2548	1024	184.28	2912	0.68	25.87	0.85
Number of tests	5417	75.27	9494	3320	105.29	6815	5629	58.35	8914	1.04	-9.65	0.94
Number of surgeries	172	26.16	217	117	17.17	137	185	28.24	238	1.08	1.65	1.10
Number of vaccinations	11178	43.15	16002	11278	27.83	14416	7619	167.63	20391	0.68	86.95	1.27
Number of antenatal visits	1678	0.30	1683	1273	-24.19	965	1545	1.08	1561	0.92	0.78	0.93
Number of emergencies	605	119.95	1331	157	137.06	371	1144	88.08	2151	1.89	-14.49	1.62
Global Activity Index (see Section 5.a)	21	69.87	36	15	63.98	25	15	83.92	27	0.69	8.30	0.75
Number of available beds	44	74.55	77	38	60.53	61	24	88.99	46	0.55	8.27	0.59
Staff of the TH	65	18.46	77	57	19.47	68	36	11.75	40	0.55	-5.67	0.52
Equipment Index (see Section 5.a)	23	84.59	42	21	68.94	36	14	76.28	25	0.62	-4.51	0.59

Source: Authors' calculation from data of Township Hospitals registers; Rel. std dev= Std%mean

At the same time, the expenditures of every NRCMS bureau in our sample increased, with a strong acceleration starting in 2010, as well as the county subsidies devoted to the hospitals (Figures 1 and 2), contributing to ensure quasi-universal coverage for a selected package of outpatients and inpatients care. There are mainly two complementary explanations to the growth of NRCMS expenditures: the deepening of benefit packages (rise of the reimbursement rate per inpatient case) and an increase in PHF activity.

Figures 1 and 2. Evolution of NCMS deflated expenditures,
Evolution of deflated county subsidies to TH

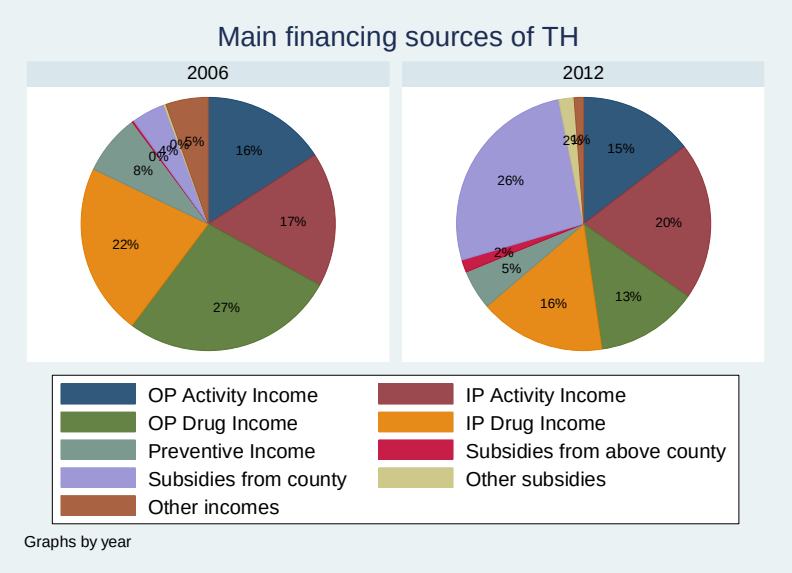


Source: Authors' database from NCMS and Health Bureaudata. Nominal values have been deflated by the General Retail Price Index in Shandong province, 2006=100 (from China Data Online).

Development of NCMS subsidies

As stated previously, the National Essential Drugs Policy reform sharply changed the PHF income structure. Figure 3 shows the comparison of principal sources of income for all observed Township Hospitals between 2006 and 2012. In 2006, over 80% of revenue was generated by hospital activities while drug prescription was the primary source of income (about 50%). In contrast, activities rewarded hospitals with up to 55% of their revenue in 2012. The huge decrease in drug income is due to the loss of drug prescription mark-ups, offset by governmental subsidies, (about one third of TH revenue), mainly from the county level.

Figure 3. Main financing sources of TH



Source: Authors' database

5 Estimating efficiency of Township Hospitals

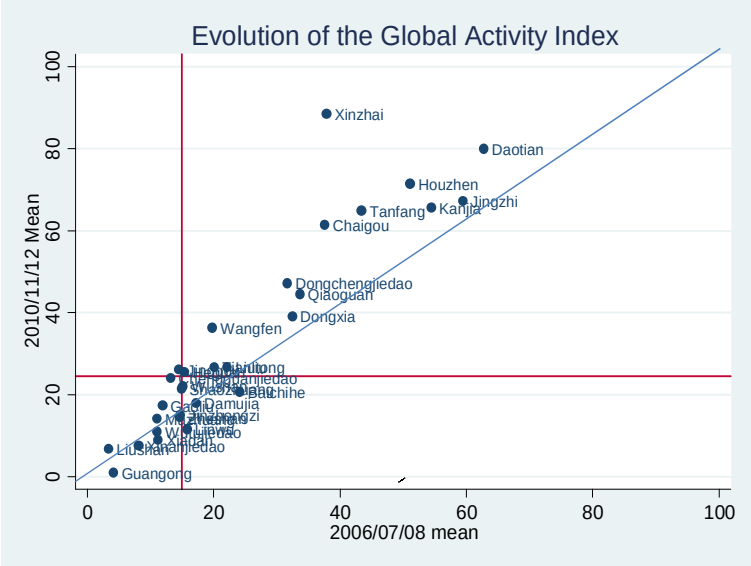
5.1 The choice of the production function

The definition of the production function has been made according to observations, as well as discussions with people involved. First, the multi-output production function of a hospital has to be dealt with. The literature on efficiency in health usually takes into account only the number of inpatients and outpatients (Yang and Zeng, 2014). Here, preventive activities (such as vaccination or antenatal consults) are at the core of a Primary Healthcare Facility, so a synthetic indicator was computed before the efficiency assessment to get a wider proxy of TH activity. Seven variables were selected, representing aspects of TH activity: annual number of outpatients, admitted inpatients, emergencies, surgeries, tests, vaccinations, and antenatal consultations. A Principal Component Analysis (PCA) was computed in order to get some synthetic factors of TH activity.

The first factor of the PCA was kept as the output in the production. It is by far the most explanatory axis, and it is positively correlated to each of the introduced variables. This axis, which captures 44% of the total variability, captures a global trend of the activity and is consistent with the characteristics of an output (an increase of any variable will increase the Global Activity Index). It is kept as the Global Activity Index and is used as the output of our model.

The evolution of the Global Activity Index confirms the dynamic development activities for almost all TH (see Figure 4), it rose by 70% in mean on the period.

Figure 4. Evolution of the Global Activity Index



Source: Authors' database

Three inputs were identified, reflecting the human and physical capital of the TH: the number of available beds, the staff of the TH, and an equipment index. The latter was computed using a Principal Component Analysis (PCA), which included every kind of imaging and test machines found in a TH[3].

5.2 Measurement of efficiency

There are mainly two ways of assessing the efficiency of health facilities: parametric, such as the Stochastic Frontier Analysis (SFA), and nonparametric, such as the Data Envelopment Analysis (DEA). As pointed out by Hollingsworth, 2008, the DEA method has been widely used in assessing the efficiency of health facilities since its introduction in 1978 (Charnes et al., 1978, Birman et al., 2003; O'Neill et al., 2008). The method avoids making assumptions about the form of the production function, when it is unknown.

Nonparametric efficiency methods can only compare DMUs (Decision Making Units) of the sample. The best performers of the sample will be defined as the efficient units and assessed a score of 1, and will be benchmarks for the other DMUs. The problem with the DEA method has to do with its sensitivity to dimensionality and to outliers in the given sample. If there is an outlier in the sample, the production frontier is distorted and the scores of all the DMUs, compared to those wrongly or artificially efficient units, are biased.

[3] The PCA included the number of radiography and computed tomography machines, of echo-graphs, electrocardiogram machines, endoscopes, anesthetic machines and ECG monitoring instruments.

To cope with DEA limits, Partial frontier methods were developed (Cazals et al., 2002; Daouia and Simar, 2007). Two close techniques are used, the so-called *order-m* and *order-α*.

In the order-m frontier, introduced by Cazals et al., to estimate the efficiency of a DMU in an output orientation, many samples of *m* DMUs are simulated, composed of DMUs using, at most, the same quantities of outputs in the sample (in an input orientation, producing at least the same quantities of outputs). For each simulated sample, an efficiency score is assessed to every firm, relatively to the estimated frontier. The procedure is repeated *n* times, then the mean score of all those simulations becomes the order-m score. This method authorizes DMUs to be above the production frontier, and the scores to be above 1. It is also a way to detect outliers, defined as the DMUs whose score remains largely above 1 even when *m* increases (Simar, 2003). In the order-α technique (Daouia and Simar, 2007), the efficiency scores are computed so that a certain percentage of DMUs in the sample, fixed *a priori,* remain above the frontier. Here, both techniques have been used, and have given very similar results. We present and discuss only the order-m results.

In the efficiency assessment, an output orientation was chosen. THs have limited choice concerning their inputs: the county authorities decide their size and the importance of the staff. In this context, their strategy can only have influence on the output level, given the level of their inputs.

The analysis of the activity evolution shows that there is no disruption in the activity trend over the period. Since our discussions with the local actors suggested that the production function, in itself, didn't change, and the case-mix remained stable (see Section 4.b), a unique production frontier was estimated.

5.3 Efficiency scores

The mean technical efficiency remained quite stable over the period, around 0.65 from 2006 to 2012 (Figures 5 and A2, Table 4). Yet, the median decreased over the period, suggesting that the gap between inefficient and efficient THs widened from 2006 to 2012

Figure 5. Evolution of order-m scores

Table 4. Evolution of efficiency scores

year	mean	min	max	p25	p50	p75	sd
2006	0.662	0.071	1.002	0.434	0.722	0.929	0.300
2007	0.678	0.153	1.010	0.357	0.657	1.000	0.305
2008	0.662	0.154	1.078	0.397	0.712	0.861	0.284
2009	0.660	0.189	1.009	0.411	0.674	0.904	0.280
2010	0.657	0.166	1.034	0.445	0.685	0.925	0.270
2011	0.666	0.241	1.070	0.427	0.653	0.949	0.274
2012	0.649	0.002	1.052	0.400	0.628	0.972	0.300

6 Estimating the determinants of THs' efficiency

6.1 Empirical strategy

The two-stage approach normally uses the Tobit model to deal with the bounded nature of the DEA scores, between 0 and 1.

Nevertheless, due to skepticism regarding the censored nature of the boundary (Ramalho et al., 2010; Wilson, 2008), some alternative methods have been proposed (Simar and Wilson, 2007, Ramalho, 2010). Ramalho, 2010, proposes an instrumentalist approach, considering that efficiency scores are *observed managerial performances* regarding a best-observed practice, and not an estimate of the *true efficiency* of a score. He proposes a second stage, based on fractional regression models (first developed by Wooldridge, 2002) that we use here. As some of our THs exhibits order-m scores higher than 1, they have been normalized so that they would be bound between 0 and 1.

This method requires several hypotheses. First we must choose either a one-part or a two-part regression model, which would estimate different partial effects for efficient and inefficient firms. Here, as the proportion of efficient firms is small, we considered a one-part model. Then, the link function (the distribution of the dependent variable conditionally to the environmental variable) for the model must be chosen, according to the results obtained by the *p-tests*.

As robustness checks, regressions were tested with different link functions and with the DEA scores instead of order-m scores.

6.2 Results

Results of the second step are presented in Table 5, for normalized scores. The conclusions are robust to the use of DEA scores as dependent variable, and to other choices of link function (Tables A3 and A4 in the Annex).

All the variables introduced to capture the effect of subsidies on efficiency exhibit a negative sign, giving evidence of a substantial phenomenon of soft budget constraint. Subsidies induce perverse incentives. No significant change is noticed between the two sub-periods, so this situation did not change with the redefinition of TH financing modalities. One of the main goals of the reform has not been reached. This negative effect of subsidies is also found in coastal Township Hospitals (Hu et al., 2012), confirming the perverse effects of inappropriate modalities of granting subsidies considering the overall context of the reform.

Regarding the environment of THs on their performance, our results suggest that the low ratio of inhabitants per bed hinders the efficiency of THs and reflects an excess of inputs relative to current demand, the THs with the lower ratio being the least efficient. Staff productivity that progresses but does not take off from a low level (per medical staff and per day, the mean number of outpatients is 1.5 in 2006 and 2.18 in 2012; of inpatients 0.08 and 0.14) raises the same issue of lack of inputs adjustment, related to demand in the catchment area (see § Discussion).

Table 5. One-part fractional regressions with normalized order-m scores

VARIABLES	(1) Order-m score	(2) Order-m score	(3) Order-m score	(4) Order-m score	(5) Order-m score	(6) Order-m score
Covered population	0.0177	0.00984	0.0141	0.0142	0.0173	0.0141
	(0.042)	(0.043)	(0.042)	(0.042)	(0.042)	(0.043)
Proportion of licensed staff	-0.496	-0.532	-0.447	-0.450	-0.468	-0.509
	(0.706)	(0.731)	(0.732)	(0.733)	(0.709)	(0.733)
Number of VHS	-0.007*	-0.006	-0.006*	-0.006*	-0.007*	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Staff expenditures per capita	0.086***	0.079***	0.077***	0.076***	0.085***	0.076***
	(0.022)	(0.025)	(0.023)	(0.023)	(0.021)	(0.023)
Test per OP	-1.150**	-1.237***	-1.211**	-1.207**	-1.170**	-1.186**
	(0.453)	(0.474)	(0.470)	(0.470)	(0.465)	(0.466)
Inhabitants per bed 2006/09	4.009***	4.240***	4.313***	4.308***	3.996***	4.339***
	(0.923)	(1.004)	(1.027)	(1.029)	(0.928)	(1.024)
Inhabitants per bed 2010/12	5.331***	4.755***	4.732***	4.693***	5.184***	5.138***
	(1.233)	(1.276)	(1.277)	(1.279)	(1.224)	(1.295)
Proportion of subsidies in TH income	-0.754***					
	(0.270)					
Subsidies per capita		-0.002				
		(0.002)				
Subsidies per staff			-0.0213*			
			(0.012)			
Subsidies per medical staff				-0.0181		
				(0.012)		
Proportion of subsidies in TH expenditures					-0.705***	
					(0.256)	
Subsidies per available bed						-0.029*
						(0.017)
Constant	0.798*	0.805*	0.766*	0.769*	0.781*	0.795*
	(0.418)	(0.429)	(0.433)	(0.434)	(0.419)	(0.431)
Observations	208	208	208	208	208	208
R2	0.822	0.816	0.816	0.815	0.822	0.816

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Link function: Probit distribution

7 Discussion

Results on the first stage of the study exhibit no positive trend in TH efficiency in Weifang prefecture between 2006 and 2012, contrary to what was expected of the pharmaceutical reform. A similar trend is found by Yang and Zeng, 2014 and Ng, 2011, suggesting that health policy reform in Weifang prefecture shares some common characteristics with other areas, feeding discussion about wider stakes of health policy reform in China ; this although the Chinese government has been engaged since several years in efforts to improve primary health care (Meng, 2015).

First, as the core of the drug reform relies on reshaping TH financing from drug margins to subsidies, it is crucial that those subsidies are allocated according to a clear formula with incentives, linking clearly subsidies and results – which is not the case, inspired by a Result Based Financing (RBF) approach. This would remove the perverse incentives stemming from the very high current probability for the THs of being simply and easily bailed out at the end of the period.

Second, the optimal size of a Township Hospital is also a matter of concern. Our results suggest that the inputs of the THs are not fully utilized, since more inhabitants per bed lead to better performance. Yet, over the 2006-12 period, the number of available beds per TH grew drastically (from 44 to 77, on average, for the sample, see Table 3). In a situation of financial constraint, the priority should rather be the improvement of healthcare quality and affordability for households. Moreover, as pointed out by Yang and Zeng (2014), oversized hospitals may lead to quality concerns. In Weifang, several TH were merged in recent years. Our results highlight this issue, pointing out that there is still latitude in that field in order to lower unit costs without harming the quality of care offered to the population. It could be done by downsizing some TH, and also it is likely that some TH can be merged. But the issue of merging, meaning that several TH will be closed, is very sensitive and has an important political dimension. The authorities put forward two arguments in favor of the status quo: according to the regulation, one TH should be in every township, and the current reforms (drug policy and the deepening of health insurance) will lead in the near future to a strong growth of TH activity. Therefore there is no need to reduce the number of beds and/or to reconfigure the geographical distribution of TH since the excess of supply at the TH level is temporary.

Third, as the demand side is still important in explaining TH efficiency, affordability of healthcare has to be improved, mainly by deepening the benefit packages of the NRCMS. In Weifang in 2006, outpatient activities were reimbursed only up to 30 %, and many cases were not reimbursed at all. In 2012, user fees represent at least half the total costs of outpatient care, and from our discussion with local NRCMS and Health Bureau officials, financial barriers to healthcare remain for some households. The authorities have decided to gradually increase the reimbursement rate for outpatient care and to widen the benefit package, which is a good step.

Fourth, availability of essential drugs, which has to face periodic shortages in several areas in China, despite the reform, is also a concern in some TH in Weifang[4]. At the national level, Li et al., 2013, points out that, because some ceiling prices have been fixed too low by the provincial government, manufacturers are reluctant to produce them, increasing the risk of shortages. A decline of quality is also a concern if cost is the crucial criteria to discriminate firms during the bidding process (Xiao et al., 2013). The lack of availability of some essential drugs has been challenging for TH daily activity and for healthcare costs (since households have to get drugs at higher prices from places other than public facilities). These problems are also observed in many low and middle income countries.

Fifthly, in spite of some modest advances, the control of hospitals and the relations between THs, NCMS and the authorities (prefecture, health bureau, and counties) are still dominated by a "command-and-control" approach, with insufficient space left to the real autonomy of THs, which is detrimental to efficiency gains. For example TH's managers have very little autonomy to hire staff (or to refuse the assigned staff decided by the authorities), to get rid of poorly performing staff, especially within the official administrative quota. Additionally, as THs staffs are much less paid than district hospitals staffs, it is difficult for THs, particularly in comparatively poor areas in Weifang prefecture, to attract and retain the best talent. This creates a vicious circle that has repercussions on attractiveness and TH's activity, trust of people in the quality of care delivered by THs, then limiting THs capacity to rewarding and promoting high performers staff[5]. There is still a long way ahead to let managers manage[6]. This necessary evolution is inextricably linked to a redefinition of incentives and to the implementation of a real and effective strategic purchasing policy at the TH and NCMS level. Addressing these issues is crucial for improving the efficiency of THs, several studies showing (Bloom et. al., 2010) that good management promotes better outcomes, better quality of care, and loosens financial contingencies.

Sixthly, since the second half of the 2000s, in Weifang prefecture, patients can go for treatment in a TH other than the one that is located in their township of residence. There is therefore an opportunity to organize a cautious and appropriate competition between TH, especially for outpatient consultations. A study by Pan et al. (2015) based on individual and aggregate data from several provinces shows that hospital competition is positively correlated with outpatient outcomes and non-significant for the inpatient indicators.

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[4] Several TH's directors in our sample have complained about the problems raised by large, prolonged and unpredictable stock-outs.

[5] Problems that TH's managers have quoted frequently in our sample. We quote two of them. "(…). Normally the quota allocated to our TH is 29 people, however the total number of staff in the quota is currently 23. Our goal is to have a complete staff. But it may be difficult, because the location of our hospital is remote, and the amount of our resources is low ...". Another pointed out that "(…) High staff turn-over is very common in our TH, medical staff does not want to stay because of low income. In addition, the evolution of the professional career is not attractive, because the "senior" grade for the medical personnel does not exist for the TH ".

[6] An extreme case of very low autonomy: in a poor district of our sample, all the TH don't manage their resources nor their expenses. It is the health bureau that is in charge of it.

Finally, our results question the alignment of incentives with improving efficiency in the health care system, which is one of the main goals of the health policy reform, beyond the issue of the drug reform. To reorient incentives, the provider payment has to be tackled in Chinese Primary Healthcare Facilities. In our sample the fee-for-service method is still used, though it has been shown , in China and elsewhere, to be linked with higher costs than prospective payment methods (Yip et al., 2010). The introduction of prospective payment is in discussion in Weifang and appears to be an essential way to push the public healthcare system on the path of a better efficiency, particularly considering the multitasking nature of healthcare (Cheng et al., 2012; Eggleston, 2005; Robyn et al., 2014).

8 Conclusion

Using a two-stage partial frontier method to assess technical efficiency, and a fractional regression model in a second stage to explain it, this study highlights the roles of public subsidies and demand-side factors in the technical efficiency of township hospitals in the rural prefecture of Weifang in the context of the drug policy reform implemented since 2009. The reform of the drug policy was likely to improve efficiency, but there is a long road ahead for this objective to be achieved substantially. It is necessary to address other factors that constitute a set of protean constraints beyond the drug policy reform.

TH activities skyrocketed, but their technical efficiency remains constant over the period. A negative effect from the use of subsidies linked to the drug reform is identified. The resulting soft budget constraint has not been efficiently tackled, showing that the method by which subsidies are currently allocated does not increase efficiency. In addition, more information must be collected regarding the real criteria of subsidies allocation, as several elements suggest that, in practice, actual processes may deviate from some of the criteria established in official texts. A greater understanding - a clear theory of change - of this is necessary to assess how well the global scheme of incentives (in subsidies and elsewhere) is aligned, or not, with the health policy objectives.

At the same time, the effect of the covered population density per available bed, and of THs being oversized in counties, highlights that focusing on the managerial aspects won't be sufficient to improve TH efficiency. Spurring activity needs outpatient healthcare to become more affordable and the NRCMS to enlarge its benefit packages, increasing reimbursement of outpatient care. Another crucial aspect is the perception of the quality of healthcare delivered in TH.

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Annex

Table A1. Descriptive statistics about explanatory variables

Variable	mean	min	max	p25	p50	p75	sd
staff - manning staff	4.05	-56	79	-11	0	17	24.14
Inhabitant per bed	0.10	0.03	0.70	0.07	0.10	0.11	0.07
NCMS reimbursment per OP (yuans)	20.605	8.328	57.718	12.929	17.675	23.225	10.451
Income from subsidies	140.56	0	1054.57	16.19	59.49	186.36	195.31
Proportion of subsidies in TH income	17.15	0	69.68	4.23	12.16	26.14	16.45
Subsidies per capita (yuans)	25.10	0	125.48	3.88	11.92	41.51	28.18
Proportion of licensed staff	0.39	0.11	0.66	0.33	0.39	0.45	0.10
Density of Village Health Centers	6.32	1.43	16.86	5.38	6.47	7.46	1.83
Density of covered population	0.05	0.02	0.15	0.04	0.05	0.05	0.02

Nominal values have been deflated by the General Retail Price Index in Shandong province, 2006=100 (from China Data Online)

Table A2. Comparison between DEA scores and Order-m scores in each sub-period

DEA	Efficiency scores with order-m, 2006/07/08 /09					
	<0.6	0.6<x<0.8	0.8<x<1	x=1	1<x<1.2	Total
<0.6	46	18	11	4	0	79
0.6<x<0.8	0	5	12	4	5	26
0.8<x<1	0	0	4	2	3	9
x=1	0	0	0	5	1	6
Total	46	23	27	15	9	120

DEA	Efficiency scores with order-m, 2010/11/12					
	<0.6	0.6<x<0.8	0.8<x<1	x=1	1<x<1.2	Total
<0.6	39	11	8	3	1	62
0.6<x<0.8	0	4	6	0	1	11
0.8<x<1	0	0	7	0	6	13
x=1	0	0	0	1	3	4
Total	39	14	21	4	11	90

Figure A1. Evolution of the distribution of efficiency scores

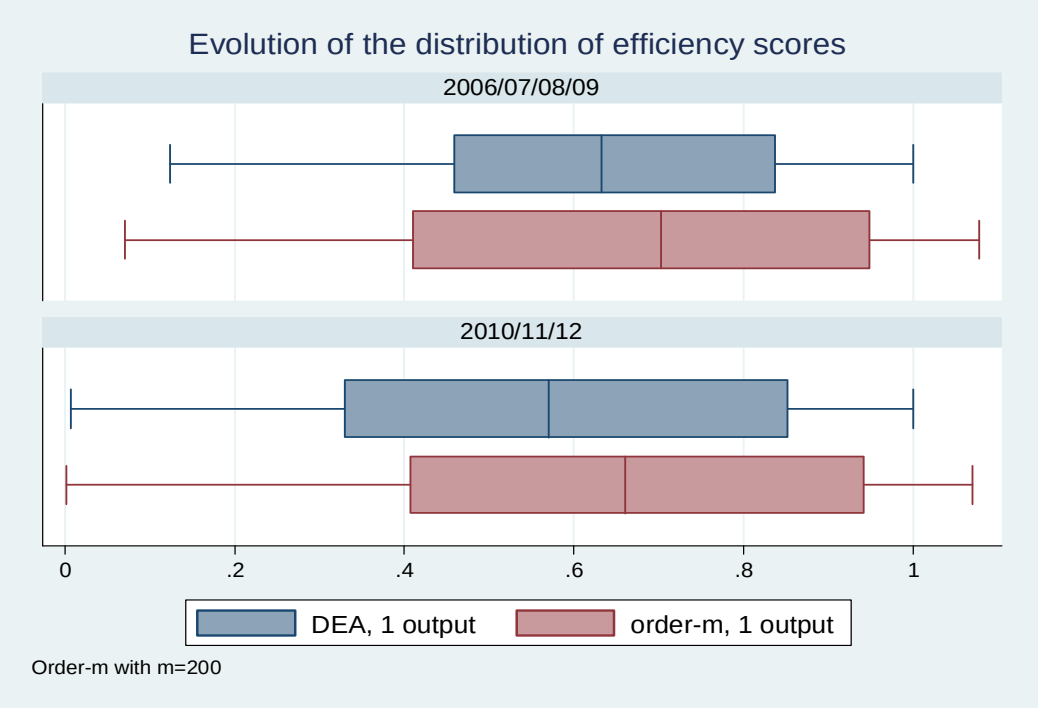


Table A3. Fractional regression with DEA scores as dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**DEA score**	**DEA score**	**DEA score**	**DEA score**	**DEA score**	**DEA score**
Covered population	0.095**	0.098**	0.0985**	0.099**	0.094**	0.095**
	-0.045	-0.045	-0.044	-0.044	-0.045	-0.045
Proportion of licensed staff	-0.608	-0.583	-0.655	-0.657	-0.585	-0.598
	-0.723	-0.764	-0.758	-0.757	-0.730	-0.755
Number of VHS	-0.003	-0.004	-0.004	-0.004	-0.003	-0.003
	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
Staff expenditures per capita	0.081***	0.055**	0.041*	0.040*	0.079***	0.062***
	-0.021	-0.022	-0.022	-0.021	-0.021	-0.020
Test per OP	-0.958**	-0.958**	-0.942**	-0.946**	-0.977**	-0.975**
	-0.460	-0.468	-0.464	-0.464	-0.466	-0.466
Inhabitants per bed 2006/09	1.876***	2.007***	1.941***	1.941***	1.886***	2.006***
	-0.577	-0.629	-0.635	-0.636	-0.584	-0.622
Inhabitants per bed 2010/12	1.711*	0.647	0.273	0.261	1.500	0.839
	-1.006	-0.985	-1.000	-0.998	-0.980	-1.054
Proportion of subsidies in TH income	-0.585*					
	-0.307					
Subsidies per capita		0.001				
		-0.002				
Subsidies per staff			0.025			
			-0.020			
Subsidies per medical staff				0.024		
				-0.019		
Proportion of subsidies in TH expenditures					-0.476*	
					-0.285	
Subsidies per available bed						-0.001
						-0.021
Constant	-0.075	-0.039	0.024	0.028	-0.080	-0.047
	-0.405	-0.416	-0.422	-0.422	-0.409	-0.414
Observations	208	208	208	208	208	208
R2	0.751	0.745	0.747	0.747	0.749	0.745

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A4 One part fractional regression with normalized order-m sores as dependent variables, and logit as link function

VARIABLES	(1) Order-m score	(2) Order-m score	(3) Order-m score	(4) Order-m score	(5) Order-m score	(6) Order-m score
Covered population	0.001	-0.017	-0.009	-0.009	0.000	-0.009
	-0.070	-0.071	-0.071	-0.071	-0.070	-0.071
Proportion of licensed staff	-0.794	-0.863	-0.713	-0.721	-0.747	-0.815
	-1.181	-1.221	-1.221	-1.225	-1.187	-1.223
Number of VHS	-0.008	-0.006	-0.007	-0.007	-0.008	-0.008
	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006
Staff expenditures per capita	0.148***	0.139***	0.135***	0.133***	0.145***	0.133***
	-0.037	-0.042	-0.039	-0.039	-0.037	-0.039
Test per OP	-2.041***	-2.196***	-2.146***	-2.139***	-2.067**	-2.105**
	-0.784	-0.822	-0.821	-0.821	-0.806	-0.819
Inhabitants per bed 2006/09	7.712***	8.264***	8.433***	8.430***	7.695***	8.495***
	-2.152	-2.367	-2.432	-2.440	-2.168	-2.450
Inhabitants per bed 2010/12	9.821***	9.043***	9.049***	8.978***	9.565***	9.738***
	-2.446	-2.604	-2.648	-2.652	-2.441	-2.673
Proportion of subsidies in TH income	-1.255***					
	-0.461					
Subsidies per capita		-0.004				
		-0.003				
Subsidies per staff			-0.0377*			
			-0.022			
Subsidies per medical staff				-0.032		
				-0.021		
Proportion of subsidies in TH expenditures					-1.169***	
					-0.438	
Subsidies per available bed						-0.0485*
						-0.028
Constant	1.267*	1.260*	1.182	1.188	1.234*	1.232
	-0.737	-0.759	-0.763	-0.764	-0.738	-0.764
Observations	208.000	208.000	208.000	208.000	208.000	208.000
R2	0.826	0.821	0.820	0.820	0.825	0.821

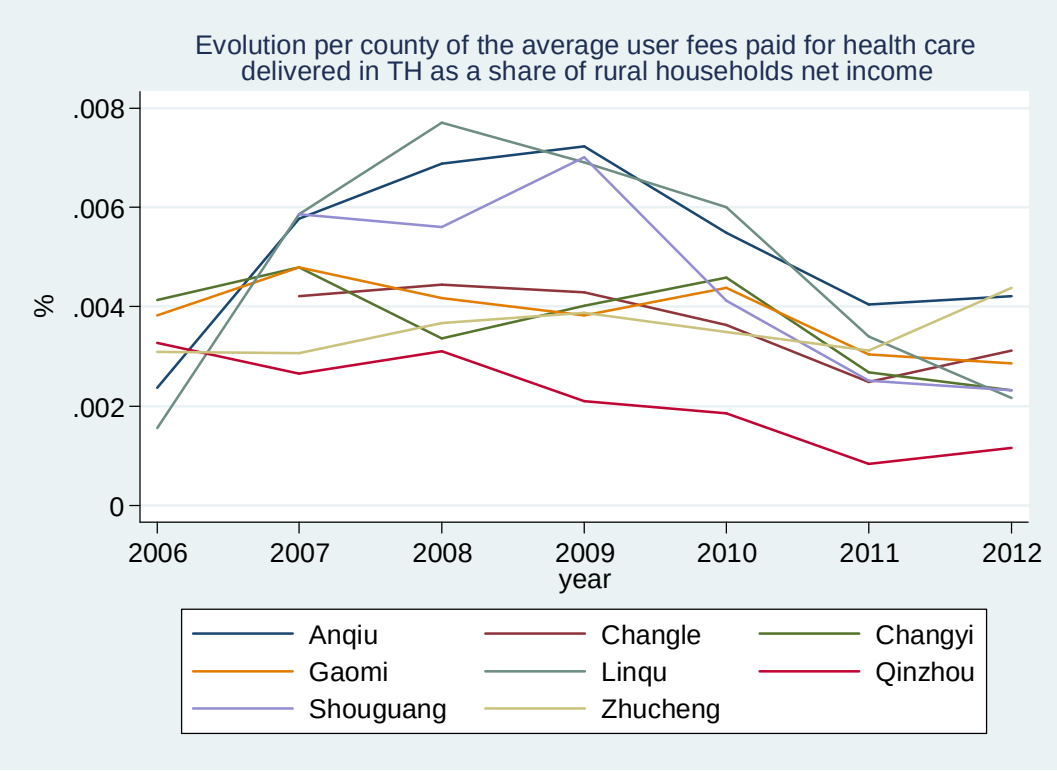
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A5. Statistics about the cost of healthcare in 2012

	Average burden of TH expenses	Mean user fees for 1 IP case in TH (yuans)	Mean user fees for 1 OP case in TH (yuans)	Mean user fees for 1 OP case in VHS (yuans)	Rural net income (yuans)
Anqiu	0.42%	17.03	28.34	35.99	10773
Changle	0.31%	23.05	13.07	37.24	11576
Changyi	0.23%	21.24	6.28	27.93	11842
Gaomi	0.29%	21.77	11.89	48.05	11774
Linqu	0.22%	8.75	13.94	11.25	10512
Qinzhou	0.12%	6.28	7.41	64.62	11797
Shouguang	0.23%	11.59	18.10	67.39	12805
Zhucheng	0.44%	22.23	33.81	51.57	12804

NB: those figures were reconstructed using actual reimbursements by NCMS bureaus and reimbursement rates to estimate the mean cost of a case, and the user fee that is the difference between the two elements. Nominal values have been deflated by the General Retail Price Index in Shandong province, 2006=100 (from China Data Online)

Figure A2. Evolution per county of the average user fees paid for health care delivered in TH as a share of rural households net income



Nominal values have been deflated by the General Retail Price Index in Shandong province, 2006=100 (from China Data Online)

"Sur quoi la fondera-t-il l'économie du monde qu'il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l'ignore."

Pascal

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Contact
www.ferdi.fr
contact@ferdi.fr
+33 (0)4 73 17 75 30