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**Curative Activities of Township Hospitals in Weifang Prefecture, China:  
An Analysis of Environmental and Supply-Side Determinants**

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## Summary

Township hospitals, which are an important link of the Chinese rural healthcare system, were affected by the successive socio-economic reforms since the 1980s. As a consequence, their utilization declined. From longitudinal data covering nine years (2000-2008) and 24 township hospitals randomly selected in Weifang prefecture (Shandong province, China), this article analyses the environmental and supply-side determinants of the volume of township hospitals curative activities, measured by the number of outpatient visits and that of discharged patients. The Hausman-Taylor and the Fixed-Effect Vector Decomposition estimators are used in order to cope with time-invariant variables. Results of the estimations are confronted and highlight similar outcomes. Findings show that the New Rural Cooperative Medical Scheme, introduced in 2003, has contributed to increase the activity of township hospitals, although financial barriers remain to the access to expensive medical services. The analyses underline also that referral practices between health facilities levels should be reinforced and that the size of the township hospitals needs to be adequate with environmental factors as they appear to be over-sized.

## Résumé

*Activités curatives des hôpitaux municipaux de la préfecture de Weifang (Chine) : une analyse des déterminants environnementaux et des facteurs d'offre*

Les hôpitaux municipaux, qui sont un maillon essentiel du système de santé rural Chinois, ont été affectés par les réformes économiques successives depuis les années 1980 et ont ainsi vu leur fréquentation s'affaiblir. À partir d'observations longitudinales sur neuf années (2000-2008) et 24 hôpitaux municipaux sélectionnés de façon aléatoire dans la préfecture de Weifang (Province du Shandong, Chine), cet article analyse les facteurs d'environnement et d'offre qui influencent le volume des activités curatives des hôpitaux municipaux, mesuré par le volume de consultations externes et d'hospitalisations. Afin d'estimer l'effet de variables invariantes dans le temps, deux estimateurs sont utilisés : Hausman-Taylor et Fixed-Effect Vector Decomposition. Les résultats des estimations des deux estimateurs sont similaires. Ils montrent que le système d'assurance mutualiste graduellement introduit à partir de 2003 influence positivement l'activité des hôpitaux municipaux, même s'il subsiste des barrières financières à l'accès aux soins de santé coûteux. L'analyse souligne aussi que les liens de référencement entre les différents niveaux de structures de santé devraient être renforcés et que la taille des hôpitaux municipaux, qui semble surestimée, doit être adaptée en fonction des facteurs environnementaux.

J.E.L: G22, I1, I38, O12

Keywords: China, Healthcare services, Health insurance, Hausman-Taylor, Fixed-effects vector decomposition

Mots Clés: Chine, Services de santé, Assurance maladie, Hausman-Taylor, Vecteur de décomposition des effets fixes

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## 1 Introduction

In Chinese rural areas, a three-tier system guarantees the delivery of health services, with from lower- to upper-level, village health stations, township hospitals (THs) and county hospitals. This pyramidal hierarchy allowed effective cooperation between health facilities. The lower-level health facilities deliver basics medical services, and are also responsible for referring patients to the upper-level ones. The complexity of medical services offered enhances with the hierarchy level of the health facility and the upper-levels offer technical support to the lower ones.

THs have a crucial function in the Chinese rural healthcare system. They make the link between village health stations and county hospitals. They supervise the quality of services delivered at village health stations and offer them technical backup. They also should play the role of “gate keeper”, filtering patients in need to upper-level hospitals (county, provincial or central hospitals). Precisely, THs have four missions: offering curative treatment for non-highly severe diseases (medical consultations and basic inpatients care), ensuring the diffusion of preventive services, training health workers at village health stations and administering them (Personal communication from Weifang Health Bureau). Curative and preventive activities are delivered in two distinct departments, which possess their own medical staff. Thus, THs are therefore the main provider of primary healthcare in rural areas (Hillier and Shen, 1996). However, with the process of economic transition implemented since the 1980s, the efficiency of the system, and especially that of the THs, declined considerably (Liu *et al.*, 1996).

The functioning of the rural healthcare system was seriously impeded by the social mutation caused by economic reforms, which is one of the main reasons for the failure of THs (Hsiao, 1995; Eggleston *et al.*, 2008)<sup>1</sup>. The budget decentralization process (1979) led to a decrease of public spending. As government subsidies were major financial resource of THs, this change caused serious financial problems for many of them. Due to the shortage of public financing and the management reform of hospitals in 1983, health facilities and particularly THs, were incited to make up the budget deficit by increasing business income (Hillier and Shen, 1996; Liu *et al.*, 1996). These trends forced THs to look for other financial resources to cover their costs. Moreover, the rule to allocate subsidies was not clearly defined and not linked to the performance of the health facilities. As a consequence, in the 1990s, several dysfunctions were observed such as a drastic raise in healthcare prices, an increase of the average length of stay, an overuse of expensive technologies and excessive prescription of drugs, an overall deterioration of productivity and efficiency (Hillier and Shen, 1996; Liu *et al.*, 2003b). The supply of expensive curative activities increased to the detriment of preventive and basic curative cares (Hsiao, 1995; World Bank, 1997). In addition, the medical services delivered by THs overlapped in part those delivered at county hospitals or village health stations. Until today, market

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<sup>1</sup> For more details about the history of the health care system in China, see: Hsiao (1984, 1995), Hillier and Shen (1996), Liu *et al.* (1996), Liu *et al.* (2003a), World Bank (1997), Eggleston *et al.* (2008), Yip and Hsiao (2008), Wagstaff *et al.* (2009b).

competition pushed many THs into further financial hardship which eventually caused the decline of healthcare quality and efficiency (Hsiao, 1995). On the patient-consumer side, the implementation of the household production responsibility system in rural areas (1981) caused the collapse of agricultural communities and consequently that of the Cooperative Medical Scheme (CMS) (Hsiao, 1984). At the beginning of the 1990s, less than 10% of the rural population was covered by a medical insurance system, whereas in 1975, quasi-universal coverage was achieved. The failure of the CMS perturbed the medical referral system. Patients went directly to county or upper-level hospitals for services with better quality (Liu *et al.*, 1996; World Bank, 1997). This trend was strengthened by the increase in rural income (Liu *et al.*, 1996) and the worsening quality of health services at TH level.

Organizational reforms were set up, particularly with the aim to reinforce the delivery of basic medical healthcare services at community level (i.e. village health stations and THs). At the same time as the strengthening of the supply-side, the government introduced since 2003 the New Rural Cooperative Medical Scheme (NCRMS), a community-based health insurance for the rural population in order to support the demand-side. Administered at county level, the NRCMS is a household voluntary-based scheme financed by local and central government subsidies and households premiums. The objectives were to reduce the financial burden caused by the cost of health services and to improve the access to healthcare for the rural population (Wagstaff *et al.*, 2009b). Consequently, an improvement of the THs activity is expected.

In order to bring some highlights on that potential effect, it appeared essential to wondering which factors explained the activity level of the THs. This paper analyses the environmental and supply-side determinants of THs curative activities. As the health policy is mainly driven by local governments and considering the significant differences existing between province in China (Feng and Song, 2009), the empirical study is conceived as a case study which focuses on a sample of THs<sup>2</sup> in Weifang prefecture (Shandong province).

The remainder of the paper is organized as follows. Section 2 presents the data and the characteristics of the sample. The methodology is examined in Section 3. This is followed by a presentation of the empirical results (Section 5), before concluding with a summary of the main findings and their implications for policy (Section 6).

## 2 Data

Data are from a survey undertaken among a sample of 24 randomly selected THs, over a nine-year period (2000-2008) in Weifang prefecture. The survey was conducted in collaboration with the Center for Studies and Researches on International Development (CERDI) of Auvergne University, the Weifang Health Bureau, and the Medical University of Weifang. Data were collected from the

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<sup>2</sup> The sample represents 14% of the total number of THs of Weifang prefecture.

Weifang Health Bureau database and the registers of the THs, and were verified and completed with interviews. They include characteristics for the county and township administrative divisions, the THs as well as data concerning THs' medical activities, financing, staff and equipment.

Located in Shandong province, Weifang is a city-prefecture (“*dǐjǐshì*”) which has under its jurisdiction 12 counties (“*xian*”). The 24 THs of the sample, representing 14% of the entire THs of Weifang prefecture, belong in six counties and are situated in 24 rural townships (“*zhen*”).

Table 1 presents the descriptive statistics on the environmental characteristics of the THs. Over the period, the THs operate into a quite changing environment. The population density increased by 6% but the population remained mainly rural. The rural net income per capita (constant prices) reached on average 3,338 Yuan in 2000 and rose to 5,557 Yuan in 2008, corresponding to a 66% increase over the period. The cover rate of the NRCMS increased between 2003 and 2008 and reached about 97.51% of the population of the townships. The implementation of the NRCMS was gradual among the townships studied from 2003 to 2006. In 2006, all townships are covered by the NRCMS. Besides, the number of village health stations increased, from on average 25 village health stations per township to 37 between 2000 and 2008. The reinforcement of the grassroots of the rural health structure can pressure the competition between village health stations and THs. Nevertheless, the ratio of the number of village health stations per 1,000 households reflecting the physical accessibility to village health stations remains quite stable over the period. The distance of the THs to the county hospital is between 10 and 50 kilometers with an average of 25 kilometers. The good quality of roads in Weifang prefecture (information from our interviews) lowers the physical constraint to the access to the county hospital or upper-level ones and then contributes to higher competition between THs and county hospitals.

Table 1: *Environmental characteristics of township hospitals*

<i>Mean of:</i>	2000-2008	2000	2003	2006	2008	2000-2008 (%)
Number of household per square kilometers	129	125	127	129	133	6.40
Share of rural (%)	92.79	94.46	93.56	91.86	92.57	-2.00
Rural net income per capita (Yuan)	4,259	3,338	3,751	4,938	5,557	66.48
Village health stations	31	25	30	32	37	47.06
Village health stations per 10,000 households	24	24	25	25	21	-14.29
Distance to the county hospital (km)	24.85	24.85	24.85	24.85	24.85	0.00
NRCMS coverage (%)	44.2	0	17.08	93.5	97.51	-

*Source:* Authors' database.

Note: Monetary terms are in Yuan and are expressed in 2000 constant prices, given the price index of Shandong province.

According to our dataset (Table 2), the size of the THs is relatively small with on average 39 beds and 45 curative medical staff over the period. THs can be either central or general: central THs are larger than general ones. The dataset consist of nine central THs and 15 general THs. General THs count on average 32 beds and 31 employees over the period, whereas central THs register respectively 49 beds and 70 employees. Furthermore, central THs are better equipped than general ones. Overall, the size of THs, as measured by the human and physical resources available, increased over the period.

Table 2: *Human and physical resources of township hospitals*

<i>Mean of:</i>	2000-2008			All THs				
	All THs	Central THs	General THs	2000	2003	2006	2008	
Curative medical staff	45	70	31	39	43	45	60	
Beds	39	49	32	33	34	37	59	
Equipment	X-ray	1.35	1.65	1.16	1.21	1.21	1.33	1.75
	Echograph	1.55	1.91	1.33	1.29	1.33	1.63	2.17
	Electrocardiogram	2.05	2.64	1.69	1.71	1.71	2.04	3.17

Source: Author's database.

THs offer two kinds of curative healthcare services: *medical consultations and inpatient care*, respectively measured by the volume of outpatient visits and that of inpatients discharged. Table 3 summarizes the average activity of THs. THs' activity mainly consists of medical consultations, accounting for at least 95% of the volume of curative healthcare services delivered over the period. The pattern is similar when central and general THs are observed separately. Nevertheless, central THs register on average a more important volume of curative activities than general ones, particularly as regard to the number of outpatients treated (almost two times more outpatient visits). In contrast, the *increase* in the volume of curative activities is higher for general THs than for central THs, especially when the volume of medical consultations is considered. Overall, the volume of outpatient visits and that of inpatients discharged increases from 2006 (year from which all townships are covered by the NRCMS), while they remained quite stable over the period 2000-2005.

Table 3: *Trends in the average volume of the township hospitals' curative activities*

<i>Mean of:</i>	All THs		Central THs		General THs	
	Outpatient visits	Inpatients	Outpatient visits	Inpatients	Outpatient visits	Inpatients
2000	26 135	921	38 413	1 120	18 768	801
2001	27 187	997	42 372	1 156	18 077	902
2002	25 554	899	40 358	1 230	16 671	702
2003	25 350	864	40 703	1 263	16 138	624
2004	26 561	955	40 600	1 308	18 137	744
2005	26 641	1 082	39 248	1 481	19 076	842
2006	29 269	1 476	41 509	1 991	21 926	1 167
2007	38 643	1 863	49 084	2 255	32 878	1 628
2008	48 245	2 184	65 540	2 633	37 867	1 915
2000-2008 (%)	845	137	71	135	102	139

Source: Authors' database.

The performance of THs is rather weak as shown by the productivity of curative medical staff and the bed occupancy rate. On the one hand, the productivity of the curative medical staff is low over the period with on average three outpatient visits per curative staff per day and four discharged patients per month. Besides, the productivity of the curative medical staff is on average higher in general THs than in central ones. On the other hand, the bed occupancy rate reaches only 47% on average. Central THs perform better than general THs on average over the period. To conclude, the productivity and the bed occupancy rate decline until 2003 (the year of the introduction of the NRCMS) and then augment.

Table 4: *Performance of township hospitals*

<i>Mean of:</i>	2000-2008			All THs			
	All THs	Central THs	General THs	2000	2003	2006	2008
Outpatients per curative staff per day	3.13	2.75	3.35	2.84	2.62	3.02	4.94
Inpatients per curative staff per month	4.05	2.93	4.71	3.38	2.89	5.16	5.56
Bed occupancy rate (%)	46.78	55.78	41.37	44.12	37.69	54.77	61.47

*Source:* Authors' database.

### 3 Methodology

This study deals with the estimation of the determinants of the volume of THs' curative activities, namely medical consultations and inpatient care, in two separate regressions.

#### 3.1 Framework

Medical care utilization is a function of societal and individual factors as explained in Andersen and Newman (2005). A large body of the literature concentrates on the individual determinants of the healthcare utilization (Sahn *et al.* 2003; Brown and Theoharides, 2009; Quian *et al.*, 2009; Lopez-Chevallos and Chi, 2010). From household survey, studies try to capture individual motivation, in relation to individual capabilities, pre-disposing factors and health needs, in the decision to seek healthcare and where. They are looking for the characteristics which differentiate individuals' behavior in the consumption of healthcare. The important contribution of this paper is that, by considering the supply-side and how it may attract sick persons, it takes a complementary view as health facilities are not passive units which undergone the actions of individuals. Two major components may influence the utilization of healthcare services: the resources of health facilities and the organization which structures the access and delivery of healthcare. Health facilities are decisional units, with proper characteristics, and they can have interest in attracting patients. Moreover, their behavior and the volume of curative activities they deliver are influenced by the societal factors and the healthcare system organization.

Based on the literature and on the specificity of the Chinese/Weifang context, we concentrate our investigations on three categories of determinants which could affect the curative activity of the THs: the environmental factors which characterize the townships where THs are located, the characteristics of the THs which are linked to their resources dimensions (Andersen and Newman, 2005), and the TH's non-curative activity (mainly preventive), which represent the second activity of THs, and may concurrence curative activity.



### 3.1.1 *Environmental factors*

The environmental factors can be viewed as “enabling characteristics of the community” in which the townships are located and which “can affect the use of services” (Andersen and Newman, 2005). They are set at township level. Three categories of factors are considered.

The density of the population in the township (*density*), measured by the number of households per square kilometers, reflects the potential demand for curative activities.

Financial barriers can constrain the utilization of curative medical services of the TH. The rural net income per capita<sup>3</sup> (taken in logarithm,  $\ln(\text{rural net inc. p.c.})$ ) in the township, represents the township economic development level, and gives an indication of patients’ capacity to pay. Numerous empirical studies on China have shown that the out-of-pocket payment plays a big part in medical expenditures (World Bank, 1997; Wagstaff *et al.*, 2009b) and the access to health care services directly depends on the individual’s capacity to pay (Wagstaff *et al.*, 2009b). By introducing (the logarithm of) the rural net income per capita, we expected to capture changes in the volume of THs curative activities with regard to the level of township economic development. The distribution of the revenue within the township could also be an important element in the demand for medical services (Audibert *et al.*, 2002). However, this information is not available in our dataset. Besides, the insurance aims at increasing the capacity to pay of the insured, and thus is expected to increase the demand for medical services (Henderson *et al.*, 1998; Dong *et al.*, 1999; Hu *et al.*, 1999; Liu *et al.*, 2002). Three variables are used to capture different dimensions of the insurance system: i) a dummy variable, *participation*, that takes the value one if the township in which the TH is located is covered by the NRCMS, and zero otherwise; ii) the percentage of the population covered by NRCMS (*NRCMS coverage*), which captures the insurance coverage rate in the township; iii) the reimbursement rates for outpatient visits or inpatient care at TH level (*reimbursement rate*) which measures the depth of insurance protection. Each variable is introduced into three different models because of the high correlation between them.

The availability of alternative health facilities, both at village and at county level, can also affect the THs’ volume of medical activities by offering a more or less number of healthcare options available at TH level. First, as THs, village health stations deliver primary health care, even if they refer patients in need to TH level. Their availability may have a complementarity effect or a substitute one. Secondly, THs deliver inpatient care, some of them being also available at county hospital level. Some studies highlight the competition between the TH and the county hospital, as some patients go directly to the county hospital, bypassing THs because of their reputation for providing rather low-quality healthcare (World Bank, 1997). Two variables are used in order to capture those effects: the number of households per village health station available in the township (*# HH per VHS*) and the

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<sup>3</sup> All the monetary terms are in Yuan and are normalized to 2000 constant prices, given the price index of Shandong province.

distance between the TH and the county hospital (*distance to CH*), as a great distance may lead to choose the nearest health facility.

Some variables which can reflect the environmental characteristics of THs are not taken into account. The percentage of the rural population is not included because of the low disparity across townships: the vast majority of inhabitants are rural ones. Concerning the characteristics reflecting health status in the township, information available at this level is of weak quality and according to our Chinese partner, the sanitary and health profile within Weifang prefecture is not significantly heterogeneous.

### 3.1.2 *Township hospitals characteristics*

The characteristics of THs can be divided into three sets of variables: the type of the TH, their physical and financial characteristics which reflect the resources dedicated to health services delivery.

As previously saw, THs can be either central or general. The dummy variable *hospital level* takes the value one if the TH is central and 0 otherwise (i.e. general).

The physical characteristics are measured by the number of curative health staff (*curative staff*) and the number of operational beds (*# of beds*). They measure the hospital's capacity to respond to the demand for healthcare and are supposed to exercise an attractiveness effect. The two indicators cannot be added to the model at the same time, due to their high correlation. Thus, according to our discussion with Chinese experts, we decided to include the first indicator in the estimations on the number of outpatient visits and the second one into the estimations on the volume of inpatients<sup>4</sup>.

THs have to face financial constraints. We suppose that more restrictive financial constraints will spur the medical activities of THs. Two variables are considered: the subsidies received by THs (*subsidies*) and the budget balance. The government subsidy is an important source for the hospital to make up the budget deficit. Subsidies are paid at the beginning of the year and the amount of subsidies can be predicted, as it is the result of the negotiation between the government and hospitals. This financial source depends more on the interpersonal relationship "guan xi" between government officials and hospital administrators than on the hospital's own results, cost-efficiency performance or activities. It is then interesting to assess the effect of subsidies on THs' activities. We use the total subsidies received in the current year, more preferable to that received in the preceding year, because the amount of subsidies changes considerably from one year to another and is the result of in-year discussion with the Health Bureau. We may consider that THs' staff bases their current activity less on past subsidies than on their ability to obtain greater subsidies for the current year. The budget balance is considered as a financial constraints faced by THs. Contrary to the general belief that health facilities might not be in deficit and should maintain a positive budget balance, the majority of THs in

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<sup>4</sup> In Section 2, we stressed that the size of the TH is linked to its type, central or general. Such a relationship can create a correlation coefficient bias. In order to control for this, we verify that coefficients of variables are stable when one of these two variables is removed.

our sample are in “business” deficit (only 3 THs during one year and 1 TH during two different years experienced a surplus). Although to some extent this deficit is reduced by government subsidies, a large gap between resources and expenditures is still observed in many THs. According to discussions with Chinese experts, the financial constraint is not so hard. THs are not encouraged to reach the budget balance or to make a surplus. For that reason, this variable is not included in the analysis, because THs seem not to care so much about their financial situation, as it could be observed in the 90’s.

### 3.1.3 *Non curative activities*

In the 1990s, THs privileged curative healthcare to the detriment of preventive care (World Bank, 1997) for financial reasons. However, the provision of preventive healthcare is an integrate part of the function of THs. The substitutability of curative and preventive services from a “supply side perspective” is not an acutely relevant issue, because THs normally dispose of specific staff dedicated to preventive activities. Here we expect a rather complementarity between the two kinds of services. By offering preventive care, the hospital can identify patients who need curative care services. It can also build up its reputation, “attracting” patients to its curative care (and vice versa). To measure the preventive activities, we use the actual number of vaccination per preventive staff carried out by the TH (*vaccination per preventive staff*) as an overall proxy variable. In the empirical literature, the link between preventive and inpatient activities is often studied over the time. Authors test whether the utilization of preventive activities in an initial period has an influence on the use of inpatient services later (Chen *et al.*, 2007; Tian *et al.*, 2010).

## 3.2 Choice of the econometric model

### 3.2.1 *Panel data analysis of unobservable heterogeneity*

As Fisher statistics (Table 4) show the existence of individual specific effects, we use the panel data approach rather than the pooling data method in order to take into account the presence of unobservable heterogeneity. The choice has to be made between the fixed- or random-effects. It concerns the way in which the unobservable heterogeneity will be treated in the estimations. The first approach deals with the unobservable heterogeneity by including a dummy variable for each cross-section unit whereas in the second approach the individual heterogeneity is captured in the error term<sup>5</sup>. Each method has advantages and drawbacks. The fixed effect model offers consistent estimators but does not allow for us to estimate time-invariant variables since it is based on the within operator (it subtracts from the variables their mean over time, so time-invariant variables have a mean equals to their value and the within estimator leads to a null value of the within transformation of these variables). The random-effects model increases the efficiency of estimations but imposes a strong assumption that individual effects are not correlated with explanatory variables.

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<sup>5</sup> Cf. Wooldridge (2002) and Baltagi (2005).

In order to discriminate between these two approaches, a Hausman test should be calculated. Two robust<sup>6</sup> Hausman tests are conducted: the test proposed by Hausman (1978)<sup>7</sup> and the test proposed by Mundlak (1978)<sup>8</sup>. Under the null hypothesis of the Hausman test, the estimators from the random effect model are not systematically different from those from the fixed effect. If the null hypothesis cannot be rejected (probability of the test higher than 10%), we consider the estimators from the random effect model to be consistent. Otherwise, if the null hypothesis is rejected, (probability lower than 10%), only the fixed-effect model is consistent and unbiased. Both tests led to the conclusion that the null hypothesis is rejected for our estimations (Table 5). The test derived from Mundlak (1978) and explained in Wooldridge (2002), gives the same probability and so confirms the choice that the fixed-effect model is more appropriate for this study (Table 5).

Table 5: *Test of the model*

	Outpatient visits	Inpatients care
<u>Presence of individual effects</u>		
Fisher statistic	0.000	0.000
<u>Fixed-effect versus random-effect</u>		
Hausman test, regression-based (Wooldridge, 2002)	0.0384	0.0026
Mundlak approach, regression-based (1978)	0.0450	0.0002

*Source:* Authors' calculation with STATA.

Note: the probability of the test is given. Tests are performed on the basic model; that is to say, with the participation dummy as indicator for the NRCMS. For the two others specifications (NRCMS coverage and reimbursement rates as indicator for insurance) conclusions are similar. Standard errors are corrected for heteroskedasticity and clustered at township level.

### 3.2.2 *Dealing with time invariant variables*

The Hausman test leads to the rejection of the random-effect model and concludes that the fixed-effect model should be chosen to analyze the determinants of THs' curative activities. But, with such an estimator, it is not possible to estimate time-invariant variables. So, two approaches, derived from the basic fixed-effect model, will be used to estimate both time-varying and time-invariant covariates. The first one is the Hausman-Taylor (1981) estimator. The second one is a three-stage approach developed by Plumper and Troeger (2007): the "Fixed-Effect Vector Decomposition".

*The Hausman-Taylor estimator* is an approach by instrumental variables. It combines the random-effect and the fixed-effect models. We have explained before that the random-effect model allow us to estimate time-invariant variables but imposes the null correlation between the specific effects and the covariates. Hausman-Taylor deals with this restrictive assumption by allowing some variables considered as endogenous i.e. correlated with individual effects. The variance matrix of the composite errors keeps the random structure but the variables suspected to be correlated with the individual effects are instrumented by their within transformation (Wooldridge, 2002). According to Hausman-Taylor (1981), four types of variables need to be defined: X1, X2, Z1 and Z2. Variables labeled X refer to the time-varying variables, while variables labeled Z are the time-invariant

<sup>6</sup> Tests are performed with standard errors corrected for heteroskedasticity and clustered at township level.

<sup>7</sup> The statistic is computed with a Wald test on a regression-based estimation (Wooldridge, 2002).

<sup>8</sup> Mundlak tests (1978) an alternative form of the null correlation hypothesis (Wooldridge, 2002).

variables. They are indicated 1 when they can be considered as exogenous and 2 when they are endogenous (the endogeneity nature comes from the potential correlation with individual fixed-effects). How to define the endogenous and exogenous variables? The Hausman-Taylor estimator should produce estimations close to the fixed-effect estimator for time-varying variables. Thus, a Hausman test between the fixed-effect model and the Hausman-Taylor model allows choosing the best specification.

*The fixed-effect vector decomposition (FEVD)* allows us to estimate time-invariant (or rarely changing variables<sup>9</sup>) with a fixed effect model. The process follows a three-stage procedure<sup>10</sup>. First, the basic fixed-effect model is run. The “estimated unit fixed-effects” are retained. Secondly, these “estimated unit fixed-effects” are regressed on the time-invariant variables. The objective is to separate the unit fixed-effect into two parts: an explained part (by the time-invariant variables) and an unexplained part, which is simply the residual of the second stage regression. Thirdly, the basic model from stage 1 is re-estimated with the pooled OLS, but with an added covariate: the residual from stage 2. According to the Monte-Carlo experiment: “the FEVD performs better than the Hausman-Taylor model, pooled ordinary least square, and the random-effect model”.

### 3.2.3 *The econometric model*

Let  $Y_{it}$  be the number of outpatient visits and the volume of inpatients discharged, and  $X_{it}$  containing at once: constant, explanatory variables varying across time and between cross-sections, time-invariant variables and residuals of the outpatient regressions in the inpatient estimations<sup>11</sup>. The general model estimated is:

$$\ln Y_{it} = X_{it}\beta + \lambda_t + v_{it} \quad (1)$$

Year dummies ( $\lambda_t$ ) are introduced in order to capture common shocks affecting THs at the same time<sup>12</sup>. For continuous explanatory variables, the interpretation of the coefficient is the following: when X increases per one unit, Y varies per  $(\beta*100)\%$ . Concerning dummies' explanatory variables, the elasticity is calculated by the following formula:  $[e^{(\beta)}-1]*100$ .

Two qualifications need to be made about the specification of the Hausman-Taylor and FEVD regressions. With the Hausman-Taylor estimator, six time-varying variables are considered as endogenous (X2): the density, the curative health staff or the number of operational beds, the total subsidies and the number of vaccinations per preventive staff. With the FEVD estimator, two kinds of

<sup>9</sup> A variable is defined as “rarely changing” when the ratio of the between variance over the within variance of the variable is at least equal to 2.8 (Plumper and Troeger, 2007).

<sup>10</sup> Cf. Plumper and Troeger (2007) for more details about the methodology.

<sup>11</sup> The volume of inpatients can be partly determined by that of outpatient visits. But determinants are supposed to be the same for both activities. To include the number of outpatient visits in the inpatient estimation leads to an endogeneity issue. So, in order to take into account both problems, residuals from the outpatient regressions are included in the estimations of the determinants of the number of inpatients (in logic of instrumental variables estimations).

<sup>12</sup> Fisher statistic shows that year dummies are jointly significant:  $P=0.0289$  and  $P=0.0049$ , respectively for outpatient and inpatient specifications.

variables need to be defined: the time-invariant variables and the rarely time-invariant variables. The first type consists of the distance and the hospital level variables. No variables are considered as time-rarely variables.

## 4 Results

Results are presented in Table 6 for the volume of outpatient visits and in Table 7 for that of inpatient care. For each curative activity, the results of the Hausman-Taylor and FEVD methods are listed<sup>13</sup>. For each method, three specifications are presented with regard to the insurance indicator used in the estimation: i) column 1 shows the specification with the participation dummy, ii) column 2 with the coverage rate of the NRCMS in the township and, iii) column 3 with the reimbursement rate as an insurance measure.

In spite of the attractiveness of the FEVD estimator, the literature remains quite skeptical about the estimating strategy of this method and the calculation of the variance-covariance matrix (Greene, 2011). Hausman-Taylor is more consensual, even if the specification of each type of variable lacks of objective criteria. Both methods have partisan and detractors. *Our results show that Hausman-Taylor and FEVD estimations give similar results for both kinds of activities.* Significant variables are the same, as well as the sign of the coefficient of significant explicative variables. Moreover, coefficient under Hausman-Taylor and FEVD specification are very close to each other.

### 4.1 Environmental factors

We expected that an increasing density reflects an increasing potential volume of demand for healthcare services at THs (Tables 6 and 7). However, the results indicate that the density of population influences negatively the volume of medical consultations and that of inpatients care at TH level. A study of Zhang *et al.* (2011) also stresses the negative link between density of population and outpatient visits at village health stations in China. Crowded townships are better endowed in alternative healthcare facilities<sup>14</sup>, able to deliver the same medical services than those proposed by THs, and they are also closer to urban areas offering also substitute health facilities. Moreover, the THs seem to be oversized in townships with high density<sup>15</sup>. Such elements show the importance of an adequate mapping of healthcare facilities and for the size of township hospitals regarding the environment in which TH fitted. Coverage plan and size of healthcare facilities are often based on population criteria. Furthermore, that result is also underlined by the significance of the coefficient on the village health stations density variable. When the density of VHS decreases, the volume of THs medical activities increases. Results show that for an increase of 100 households per village health

<sup>13</sup> The results of estimations with the fixed-effect estimator are available upon request. Coefficients obtained on the time-variant variables with the fixed-effect estimator are not statistically different from those obtained with Hausman-Taylor and FEVD estimations.

<sup>14</sup> The coefficient of correlation between the number of households in the township and the number of village health stations in the township equals 0.6403.

<sup>15</sup> The size of THs (nature of the TH, number of beds and number of curative medical staff members) is positively correlated with the density, respectively coefficients of correlation are equals to 0.4325, 0.3348 and 0.4093.

stations, the number of THs outpatient visits increases by around 9% (Table 6) and that of discharged patients by around 7% (Table 7). Two explanations can be put forward. The first one is relative to the referral mechanism. As the population deserved by village health stations increases, the number of referred cases from village health stations to THs increases. But, when the number of households per village health stations augments, it indicates that the access to the health station is more difficult because waiting line can also rise. As a consequence, THs benefit of an increase of medical activities thanks to a switch of the demand from village health station to turn towards TH for medical consultations. From a policy perspective, it will be useful to know for which kind of disease this situation occurs, but the data are not available.

In contrast, the distance to the county hospital does not matter (Tables 6 and 7). THs located far away from county hospitals are not in a better position than THs located close to them. Yet, interviews with Chinese partners revealed that the geographical barriers to the access to county hospital are weak as the quality of the road network is good and descriptive statistics show that on average county hospitals are close to the townships (cf. Section 2). However, the non-significance of the coefficient doesn't mean that there is no competition effect between THs and county hospitals but that distance is not a factor influencing the choice to consult at TH or county hospital. The quality of healthcare services delivered at both level is certainly a discriminating factor of choice but it cannot be tested given the available data.

The curative activity is also supported by the NRCMS (Tables 6 and 7). Whatever the insurance indicator considered, insurance plays a positive role on the volume of outpatient visits and on that of discharged patients. When the NRCMS is available in the township, outpatient volume at TH level improves by 16% (Table 6, Column 1) and the volume of discharged patients increases by 57% (Table 7, Column 1). In the same way, when the coverage rate of insurance increases by 10 percentage points, the medical consultations at THs increased by 2% (Table 6, Column 2) and, when the reimbursement rate increases by 10 percentage points, it raises by 9% (Table 6, Column 3). Similarly, the volume of inpatient care increases respectively by 6% and 9% (Table 7, Columns 2 and 3). The effect of the NRCMS is higher for inpatient care than for medical consultations. This effect is not surprising as the NRCMS is "hospitalization-oriented" (Dong, 2009).

The NRCMS has a greater positive effect on the volume of outpatient in the poor areas<sup>16</sup> than in the non-poor areas (Table 6, column 4). In contrast, the effect on the volume of inpatient care delivered is not significantly different between poor and non-poor areas (Table 7, column 4).

The development level of the townships has a heterogeneous effect as regard to the curative service delivered. The development level of the township does not affect the volume of outpatient visits at THs (Table 6). The rapid and huge expansion of the NRCMS in all townships can explain this result. The insurance lower the financial barriers for the access to basic primary healthcare services at

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<sup>16</sup> Poor is calculated from the rural net income per capita of the township. A township is considered as poor when it belongs to the quintile 1 (townships belonging to the 20% of the poorest townships).

THs level for the majority of the population. With the implementation of the NRCMS, the THs, which are the first referral level in rural areas, are more financially accessible for the population whatever the development level of the township. However, the increase of the rural net income per capita influences positively the volume of inpatient care delivered indicating that development level continue to be a major determinants to the access to hospitalization services. The growth in the living standard in the township leads to a decrease of the financial barriers to hospitalization services, which are expensive. Even if the NRCMS is designed to lower more particularly the cost of hospitalization and in spite of the impressive development of the scheme over the period 2003-2008, the financial burden engendered by inpatient care remains.

#### **4.2 THs' characteristics<sup>17</sup>**

Besides the important role of environmental factors, the characteristics of THs play differentiated roles on medical consultations and inpatient care.

Considering the estimations on outpatient visits (Table 6), central THs treat on average over the period two more times outpatients than general ones. This difference in the volume of outpatients, which was highlighted in the descriptive statistics (cf. Section 2), is significantly confirmed by the econometric estimations. However, the size of the TH, as measured by the number of curative staff does not influence the volume of medical consultations, indicating that it is not a factor of attractiveness. In contrast, a negative effect of the amount of subsidies received by the TH is underlined by the estimations.

Results are quite different when we consider the estimation on discharged patients (Table 7). The nature of the TH, either central or general, does not affect the volume of discharged patients. Maybe the composition of treated inpatients cases is different, but we cannot test this given the available data. The number of operational beds has a significant and positive influence on the volume of discharged patients: more important is the number of available beds, higher is the volume of discharged patients. The number of beds reflects the capacity of the THs to welcome inpatients. The residual of medical consultations is significantly and positively linked with the volume of inpatients discharged, indicating a complementary relationship between medical consultations and hospitalization services.

#### **4.3 Preventive activity**

The hypothesis that preventive activity may positively induce the demand for curative activity is confirmed, but only for the hospitalization activity, what is quite surprising (Table 7). The volume of preventive activities per preventive staff is significantly and positively linked with the volume of discharged patients. This relation is not observed with the outpatient visits: the coefficient of the volume of vaccination delivered is not significant in the estimation (Table 6). That result underlines

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<sup>17</sup> We verified that significance, sign and magnitude of the coefficients on hospital level variable and on size variables (curative medical staff and number operational beds) are not altered when indicators are entered simultaneously or at the same time into the regression.



that curative and preventive activities are complementary in short term in our sample, while Tian *et al* (2010) show that they are substitute in a long term perspective.

Table 6: *Estimation of the determinants of the outpatient visits of THs*

	Hausman-Taylor			Fixed-Effect Vector Decomposition			
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Density	-0.00321* (0.00168)	-0.00327* (0.00168)	-0.00304* (0.00167)	-0.00429** (0.00175)	-0.00434** (0.00174)	-0.00415** (0.00174)	-0.00399** (0.00174)
Ln(Rural net inc. p.c)	-0.285 (0.282)	-0.309 (0.282)	-0.261 (0.280)	-0.423 (0.289)	-0.448 (0.290)	-0.398 (0.287)	-0.369 (0.288)
Participation	0.149* (0.0837)			0.150* (0.0840)			0.0892 (0.0881)
Participation *Poor							0.163** (0.0780)
NRCMS		0.00204** (0.00103)			0.00208** (0.00104)		
Reimbursement rate			0.00903** (0.00372)			0.00889** (0.00373)	
# HH per VHS	0.000761*** (0.000244)	0.000767*** (0.000243)	0.000729*** (0.000242)	0.000941*** (0.000259)	0.000946*** (0.000258)	0.000909*** (0.000257)	0.000931*** (0.000256)
Distance to CH	-0.00441 (0.0130)	-0.00464 (0.0131)	-0.00384 (0.0130)	-0.00741 (0.0128)	-0.00763 (0.0128)	-0.00687 (0.0127)	-0.00752 (0.0126)
Hospital level	0.722** (0.319)	0.724** (0.321)	0.727** (0.318)	0.735** (0.312)	0.737** (0.313)	0.740** (0.310)	0.707** (0.309)
Curative health staff	0.00323 (0.00285)	0.00313 (0.00284)	0.00296 (0.00283)	0.00371 (0.00286)	0.00361 (0.00286)	0.00349 (0.00284)	0.00475 (0.00288)
Subsidies	-0.00339* (0.00181)	-0.00327* (0.00181)	-0.00303* (0.00181)	-0.00357* (0.00182)	-0.00345* (0.00181)	-0.00322* (0.00181)	-0.00340* (0.00180)
Vaccination per preventive staff	-6.75e-07 (2.39e-05)	6.60e-07 (2.38e-05)	3.58e-06 (2.38e-05)	-8.23e-07 (2.40e-05)	5.49e-07 (2.39e-05)	3.11e-06 (2.39e-05)	1.90e-06 (2.38e-05)
Constant	9.411*** (0.544)	9.392*** (0.545)	9.413*** (0.540)	9.358*** (0.537)	9.339*** (0.538)	9.367*** (0.533)	9.364*** (0.532)
Observations	216	216	216	216	216	216	216
R-squared							

Source: Author's calculation with STATA.

Note: year dummies variables are included into the specification but they are not listed. \*\*\* indicates significance at 1%; \*\* at 5%; and, \* at 10%. For each kind of econometric methodology (Hausman-Taylor and Fixed-effects Vector Decomposition), three specifications are listed in function of the insurance indicator retained: participation dummy (column 1), NRCMS rate of coverage (column 2), and outpatient reimbursement rate (column 3). The last column contains an interactive term: "participation\*poor".

Table 7: *Estimation of the determinants of inpatient care of THs*

	Hausman-Taylor			Fixed-Effect Vector Decomposition			
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Density	-0.00499* (0.00275)	-0.00469* (0.00275)	-0.00476* (0.00278)	-0.00597* (0.00312)	-0.00608* (0.00311)	-0.00599* (0.00315)	-0.00569* (0.00314)
Ln(Rural net inc. p.c)	1.623*** (0.476)	1.602*** (0.476)	1.618*** (0.481)	1.605*** (0.515)	1.544*** (0.515)	1.567*** (0.523)	1.658*** (0.519)
Participation	0.440*** (0.147)			0.440*** (0.149)			0.381** (0.158)
Participation *Poor							0.160 (0.139)
NRCMS		0.00581*** (0.00181)			0.00596*** (0.00183)		
Reimbursement rate			0.00944** (0.00372)			0.00920** (0.00377)	
# HH by VHS	0.000413 (0.000370)	0.000412 (0.000371)	0.000407 (0.000371)	0.000751* (0.000447)	0.000765* (0.000446)	0.000750* (0.000451)	0.000727 (0.000448)
Distance to CH	-0.000334 (0.0124)	-0.000266 (0.0126)	0.000174 (0.0122)	-0.00431 (0.0131)	-0.00481 (0.0133)	-0.00419 (0.0130)	-0.00429 (0.0130)
Hospital level	0.185 (0.293)	0.174 (0.298)	0.189 (0.289)	0.175 (0.300)	0.177 (0.305)	0.189 (0.297)	0.172 (0.299)
# of operational beds	0.00764* (0.00406)	0.00708* (0.00405)	0.00789* (0.00410)	0.00792* (0.00413)	0.00742* (0.00411)	0.00816* (0.00417)	0.00850** (0.00417)
Subsidies	-0.00272 (0.00307)	-0.00235 (0.00307)	-0.00300 (0.00310)	-0.00272 (0.00309)	-0.00228 (0.00309)	-0.00297 (0.00312)	-0.00240 (0.00311)
Vaccination per preventive staff	0.000123*** (4.15e-05)	0.000125*** (4.13e-05)	0.000114*** (4.20e-05)	0.000132*** (4.22e-05)	0.000136*** (4.21e-05)	0.000123*** (4.27e-05)	0.000136*** (4.24e-05)
Residual of OP	0.639*** (0.133)	0.632*** (0.133)	0.657*** (0.136)	0.634*** (0.133)	0.626*** (0.133)	0.652*** (0.136)	0.623*** (0.135)
Constant	8.309*** (0.747)	8.261*** (0.749)	8.271*** (0.753)	8.319*** (0.757)	8.275*** (0.759)	8.280*** (0.764)	8.328*** (0.757)
Observations	216	216	216	216	216	216	216
R-squared							

Source: Author's calculation with STATA.

Note: year dummies variables are included into the specification but they are not listed. \*\*\* indicates significance at 1%; \*\* at 5%; and, \* at 10%. For each kind of econometric methodology (Hausman-Taylor and Fixed-effects Vector Decomposition), three specifications are listed in function of the insurance indicator retained: participation dummy (column 1), NRCMS rate of coverage (column 2), inpatient reimbursement rate (column 3). The last column contains an interactive term: "participation\*poor".

## 5 Conclusion

The study deals with the analysis of environmental and supply-side factors affecting the volume of curative activities delivered by a sample of THs in Weifang prefecture. In the Chinese healthcare system, the THs have an essential function by providing curative and preventive cares to the rural population. However, their role has been weakened since the socio-economic reforms have been implemented in the 1980s (Liu *et al.*, 1996; World Bank, 1997). The government tries to reverse the trends since the beginning of the twentieth century (Wagstaff *et al.*, 2009b). This paper highlights that environmental factors, rather than the specific characteristics of THs, influence the volume of curative medical services delivered by THs.

As the competition between health facilities exists and as the road network is good, the distribution of health facilities within the prefecture and the counties is essential in order to avoid bypassing and overlapping of medical services. Moreover, the Chinese government wants to strengthen the medical service delivery at community level by reinforcing capacity of village health stations and THs. Therefore in that perspective, the low level of activities and productivity of numerous THs in our sample raises the double issues of improving health care coordination at the county level, and of addressing the question of the geographical distribution of health facilities in order to rationalize the health care supply capacities within and amongst counties. All these elements push in favor of a clear definition of the mission of health facilities at every level, and strengthening relationships between them in order to built up a consistent referral system. These issues are crucial for THs which are above village health stations and below county hospitals.

In the same way, our results suggest that it would be misleading to think about enlarging THs to provide care to more patients, as the bed occupancy rate and the productivity of medical staff remains low for outpatients and inpatients over the period (cf. Section 2). THs should be re-scaled as they appear to be too large considering their volume of activity, although it has increased.

Our results highlight complementarities between the different kinds of medical activities delivered at THs level, showing the importance of keeping a comprehensive set of services if THs want to attract more patients.

The increase of the activity is largely supported by the development of the NRCMS. Nevertheless, the scheme is quite new and the increase of the activity could be influenced by potential adverse selection problems as it is highlighted by some studies on the NRCMS (Wang *et al.*, 2006; Wagstaff and Lindelow, 2008; Wang *et al.*, 2008; Wagstaff *et al.* 2009b; You and Kobayashi, 2009). Hospitalization cares are also influenced by the economic development level, indicating that the scheme does not alleviate all the financial barriers to the access to expensive healthcare services. Thus, our results are in line with the absence of effects of the NRCMS on out-of-pocket expenditures, well referenced in the literature (Sun *et al.*, 2009; Wagstaff *et al.*, 2009a; Yi *et al.*, 2009; Barbiaz, 2010). As the scheme is now covering the vast majority of the rural population, incentives need to be

concentrated on the characteristics of the benefit package, on the reimbursement modalities, and on the payment provider system.

Regarding the limitations of our study, one may argue that our results lie on a relatively small THs' sample. We could answer they are representative of THs in Weifang Prefecture as they represent about 14% of all the THs. Moreover, the randomized process of selection of the hospitals and the nine years of the survey period compensate for the relatively small number of THs surveyed.

From a methodological aspect, one of the contributions of this paper is that it uses a new, but still seldom used approach in the literature, the FEVD technique. Our analysis confronts the results between the classical Hausman-Taylor approach and the FEVD estimator. It shows that both methods lead to similar conclusions.

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