Estimating and explaining the efficiency of township hospitals in Shandong province in the context of the drug policy reform: DEA vs robust non-parametric frontiers

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This is a very preliminary draft as the calculations have taken us much longer than we expected ... even in our most pessimistic forecast...

1. Abstract and objective of the paper[1]

To cope with the rising price of drugs, in 2009 the Chinese government launched a large pharmaceutical reform. Its key element is the implementation of a National Essential Medicine List, leading to a reorientation of incentives for health services providers. Health facilities are not anymore are not allowed to make any profit on drug sales ("zero mark-up policy"), what was their main source of financing. A compensation scheme has been put in place by the authorities. Therefore, it is crucial to evaluate the consequences of this reform on efficiency of health facilities, and to understand its determinants.

Most of the literature around the determinants of efficiency of health facilities adopts a two-stage methodology, using the DEA method to estimate the efficiency scores, and a Tobit model to explain them. But the literature related to efficiency has enlightened the sensibility of DEA to dimensionality and outliers, and proposed more "robust" approaches, based on partial frontiers, known as order-m (Cazals et al., 2002) and order-α (Daouia andSimar, 2007).

Using survey data from a sample of 30 Township Hospitals in Weifang, Shandong, this study aims at comparing the results of those methods with "traditional" DEA, and introducing them in a second stage analysis, to identify the determinants of efficiency, in the specific context of township hospitals which are the first referral level in the Chinese health care system.

2. Background

Since 1975, the Chinese rural population had seen its basic care system deteriorated, mainly due to the disentangling of the Cooperative Medical System, which almost ensured a universal coverage of the rural population. In 2003 the implementation of the New Rural Community Medical System (NRCMS) gave a large part of rural households the access to a basic health insurance, handled at the county level. Within a few years (from 2003 to 2010), the enrollment went from less than 10% in 2003 to more than 90 % (*WB Policy Note,3,*[2] Yip et al., 2012).

[1] This research benefited from the financial support of the the Agence Nationale de la Recherche of the French government through the program "Investissement d'Avenir" (ANR-10-LABX-14-01) and by FERDI (Fondation pour les Etudes et les Recherches sur le Développement International. We especially thank for their very fruitful collaboration Professor Anning Ma, President of Weifang Medical University, Hongqi SHENG, Director of Weifang Health Bureau. However, the analysis and comments in this study are the sole responsibility of the authors.

[2] (Yip et al. 2012)

However, the NRCMS mainly aimed at avoiding catastrophic health expenditures, that made rural households fall into poverty, or even extreme poverty. The deductibles and the copayments rates remain high in many counties, leaving high out-of-the-pockets payments to households. Health expenditures remain a financial burden in the households' budget, including for outpatient expenditures, which are poorly reimbursed by the insurance. The counties manage their benefit package within a policy guideline[3], focusing mainly on inpatient care.

At the same time, on the supply side, the incentives of health providers had spurred overpricing and overprescribing for many years. Central subsidies to public health care facilities fell off, and to offset it, hospitals were allowed to take a markup on drug sales and 'new' medical acts (tests, surgeries for instance). Simultaneously, there was a severe control of the price of 'basic'[4] cares, on which health facilities could not make any profit. Those phenomena put together created incentives for health practitioners to overprescribe high-technology tests and expensive drug rather than cheaper ones, to increase user fees. Drug benefits became the main source of hospitals financing[5], making the financial burden of health expenditures even heavier for households. On the contrary, basic care services were neglected by health providers, enhancing a problem of quality of primary health in addition.

Moreover, the structure of the pharmaceutical supply chain spurred drugs overpricing, due to the excessive number of intermediaries actors between the initial supplier and health facilities, the so-called 'drug wholesalers'[6]. Indeed, in China the pharmaceutical market was made of thousands of little manufactures, selling their production to a 'third-tier' who made the contact to another wholesaler, or to the health facilities. Every actor of the supply chain taking a benefit, this structure participated in the very high prices of drugs in China (compared to the international prices).

3. National Essential Drug Policy

To cope with the rising price of drugs and disconnect hospitals income from drug sales, in 2009 the Chinese government issued "The notice on implementation of a National Essential Drugs Policy (NEDP)". It aimed at improving the drug supply system and ensuring both equity in the access to basic care medicines and safety of drug utilization. A National Essential Medicine List (NEML) was released at the same time, updated in 2012. It includes three medicinal categories: chemical and biological drugs (317 drugs), traditional Chinese patent medicines (203 drugs) and traditional Chinese cut crude herbs (NHFPC, 2013). To meet regional specific needs, local governments were allowed to establish an additional list of essential drugs. In Shandong province, where this study area is located, the additional list (2010 version) consists of 216 drugs. All Primary Healthcare Facilities (PHF) must now prescribe exclusively essential drugs. As for other healthcare facilities, the utilization of essential drugs should be a priority, and the rate of essential drug utilization must reach the threshold defined by the health authorities (NHFPC, 2009).

Before that date, health facilities were allowed to take a 15% mark-up on the purchasing price, and used to actually "take an average margin between 30% and 40%" (Wang Dongsheng, vice-director of the Social Development Division of National Development and Reform Commission in 2006). Since October 2008, the government gradually implemented a zero-markup policy for the sales of essential drugs (NDRC, 2008).The selling price in PHF has been adjusted to the purchasing price, including delivery costs and health facilities are not allowed to fix a higher selling price anymore. This policy,

[3] (You et Kobayashi 2009)

[4] (Blumenthal et Hsiao 2005)

[5] (Yip et al. 2010)

[6] (Yu et al. 2010)

between 2009 and 2010, completely redefined the structure of PHF financial balance. Indeed, the loss of drug benefits is a huge hole in PHF revenue and could have widely disturbed their daily activity.
To compensate those losses, and ensure the stability of NEDP, different modes of financial compensation have been put in practice[7,8]. There are implemented at the county level. Due to the complexity of the compensation and of the incentives measures, the effects of the reform on THs efficiency are far from predictable and may seem contradictory.

4. Compensation schemes and separation of revenue and expenditure

Exclusive government compensation
The PHF with a financial deficit between incomes and expenditures will have their deficits financed exclusively by local government. This compensation mode provides a guarantee for implementation of NEDP, but also a lot of financial pressure for local governments, which could affect the financial viability of the NEDP. If subsidies are allocated unconditionally, this could lead to a strong decrease of efficiency, as health care providers know that the government will finance them without regards to their performances. This scheme is not applied in Weifang, but in some provinces as Anhui for example.

Incentive system
The financial losses are not directly compensated, instead the PHF encourage their medical staff to develop profitable activities such as surgery, color Doppler ultrasound.

Multiple compensations
They mainly come from government subsidies but also from health insurance funds, or other complementary compensations like the increase of the cost of some treatments. For example, some health facilities increased the cost of tests and injections, other health facilities created a general consultation fee, which includes the fee for consultation and the fee for injection, or a fee for drug prescription.
In our study of Weifang prefecture, there are supplementary capitation subsidies for the development of public health service, and in 2013, the amount of this subsidy was 30 yuans per covered inhabitant per year, which could help THs in compensating the loss of drug sales.

The separation of revenue and expenditure system
Both the revenues and the expenditures of PHF are totally managed by the county government. In other words, all the incomes of PHF are paid to the county government, and their expenses are integrated into the government budget. The government handles the wages and the cost of the zero-markup policy. This compensation mode breaks the link between revenue and expenditure, so that profit-seeking behaviors could be avoided. In our study of Weifang prefecture, the Anqiu county has adopted this mode of compensation. The effect of this system on efficiency is again hard to predict, depending upon whether the county government ensures a follow-up of THs activity and performances.

Where required, the performances of PHF are assessed for the attribution of the subsidies. The amounts are generally disbursed in several times such as once at the beginning of the period, once at the end. In some provinces, the first allocation is higher, to ensure the daily activity of PHF. In our

[7] (Yuan et Tang 2012)
[8] (Zhuo et Zou 2012)

study area, 80 % of the subsidies are allocated monthly, during the current year. The remaining 20% are disbursed in March of the next year only if the PHF meets the requirements in the assessment organized by the provincial health authority. However, leaving a TH without any financing because of its poor performances is difficult, it jeopardize its activity for the following year, so actually, the county government handles most of the financial deficits in every TH in Weifang, as long as it can do it.

5. Expected effects of the reform on TH efficiency

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 reduce catastrophic costs, all things being equal. In addition, because of the high cost of care, we can consider that the health care demand at TH level is relatively price elastic, more precisely, elastic to the amount of the residual cost borne by the households. For these reasons, and if the rate of reimbursement by NCMS does not decrease, we should expect an increase in health care. It may be a demand that was not expressed previously (renunciation to care and self-medication, only care provided at village facilities level) or a transfer of demand from stations villages or district hospitals. An additional possibility is that patients, noting the decrease in unit costs, engage in a process of more sophisticated care, which they would be given up if there was no decrease in unit costs. An almost similar effect was highlighted in Gansu province following the development of NCMS[9].

We can consider three main broad scenarios (with variants), suggesting that the effect of the reform on the efficiency of TH is unknown a priori:

i) Demand for care increases, all other things being equal: efficiency progress
ii) Demand for care increases, but its expected positive effect on efficiency is offset by an increase in the number of staff and other inputs. To anticipate and promote increased attendance in TH, the authorities may have decided to increase the number of staff, although recent studies[10] have highlighted the low staff productivity. If the demand does not increase sufficiently, the effect on the efficiency is potentially negative. It seems likely in Weifang, regarding our discussion with the local authorities.
iii) Demand remains unchanged as does the level of personnel and equipment. We can expect a decline or stagnation of efficiency 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 (lab tests, etc.) that are not supervised by the reform. The unit cost of care borne by households does not decrease. It is thus crucial to determine whether subsidies have offset the drug incomes, and to see if the incentives to spur activity are effective. Understanding the compensations and coping strategies implemented by health care providers (excessive prescriptions of injections and tests for instance) is another stake of the analysis of the pharmaceutical reform[11].
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 one coming from the decrease in the cost of care borne by households.

[9] (Wagstaff et Yu 2007)
[10] (Audibert et al. 2013)
[11] (Xiao et al. 2013)

c) Compensation is greater than the loss of income from drugs. THs operate in a context of soft budget constraints. Quality of care deteriorates. As above, the quality effect can outweigh the price (cost) effect.
d) There are shortcomings in the availability of essential drugs. The demand effect on efficiency is comparable to the previous point.

6. Study area

Database

The area of our study is the rural part of the Weifang prefecture, in Shandong province, a relatively rich coastal province. It has 12 administrative divisions, including county, township and villages. To each township is associated one Township Hospital (TH) also called Township Health Center. Our sample is made of 30 TH randomly selected, belonging to 8 of the 12 counties of the prefecture. Among this sample, 23 TH out of 30 joined in the NEDP reform in 2009, and 7 in 2010. The observation period under study runs from 2006 to 2012. Data was collected by the staff of Weifang Health Bureau, the students of Weifang Medical University and our team. Sources of data include registers of TH, Statistical and Finance Offices of townships and counties.

Important evolutions of the inputs and outputs of the TH

During this period, the level of both inputs and outputs[12] increased. The activity of TH grew drastically regarding outpatients, inpatients, lab test, medical examinations (radiology, etc.) and preventive activities. Basic information is in table 1**.** For the need of the study, we calculated two aggregate indicators, a Global Activity Index and a Public Health Index (cf. parag 7 below). Evolution confirms the dynamic development activities for almost all TH (cf. Figures 1 and 2).

Table 1. Descriptive statistics

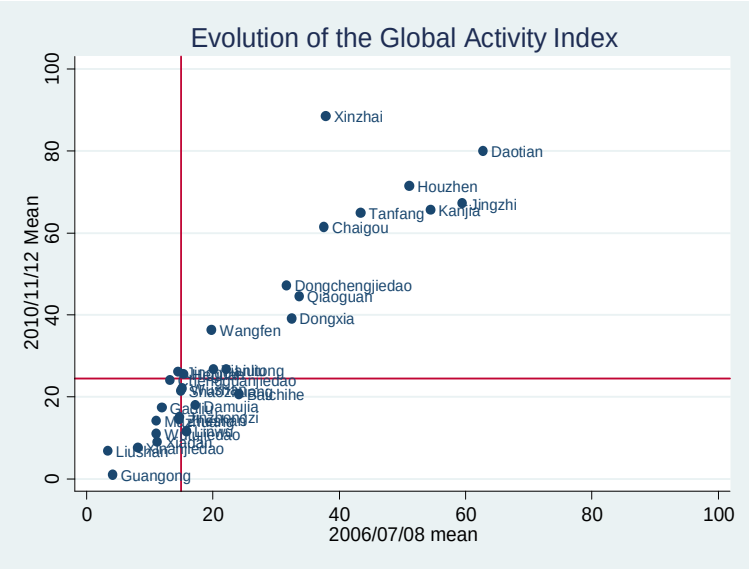
In 2006							
Variable	mean	min	max	std dev	25th perc.	median	75th perc.
Township population (10 000 people)	5.85	2.7	15.84	2.96	4.06	5.06	6.5
Annual average net income (yuans)	5510.76	3576	8993	1170.14	4856	5275	5990
Population covered by the TH	4.62	1.92	9.1	1.79	3.2	4.56	5.29
Number of beds	44.26	0	100	24.29	30	38	54
Global staff	64.83	23	150	35.91	37	56.5	83
Number of outpatients	33087.43	3390	93296	27565.57	13742	19612	58120
Number of occupied bed days	8948	0	28493	6369.93	4510	7559.5	10808

[12] Detailed information will be provided in the revised version of the paper.

In 2012							
Variable	mean	min	max	std dev	25th perc.	median	75th perc.
Township population (10 000 people)	7.13	2.95	15.98	3.30	4.71	6.7	9.48
Annual average net income (yuans)	10906.86	8536	12628	991.73	10267.5	10953.5	11500
Population covered by the TH	5.63	1.95	9.8	2.53	3.2	5.23	7.27
Number of beds	77.26	20	180	45.92	40	61	110
Global staff	76.8	24	187	40.13	40	67.5	110
Number of outpatients	60290.33	8231	237802	62230.18	21632	31982	82239
Number of occupied bed days	19299.15	3357	51566	12461.49	10120	16643.5	25925

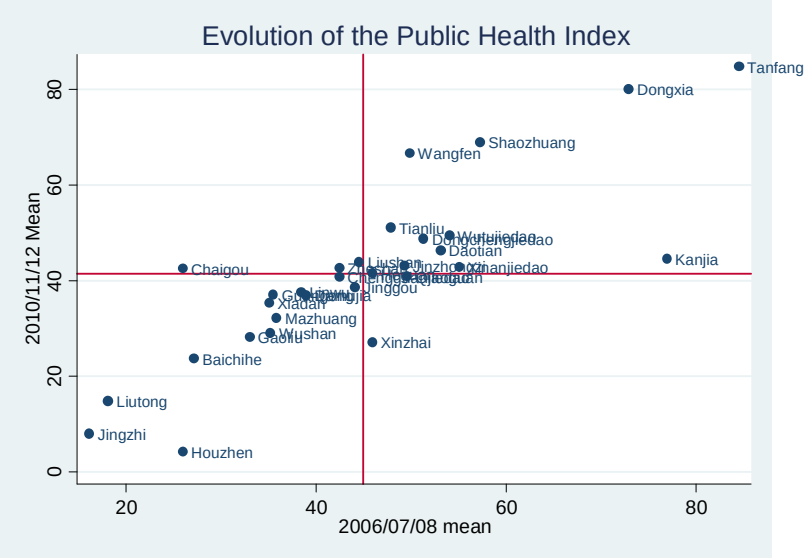
Source: Authors database

Figure 1. Evolution of Global Activity Index



Source: Authors database

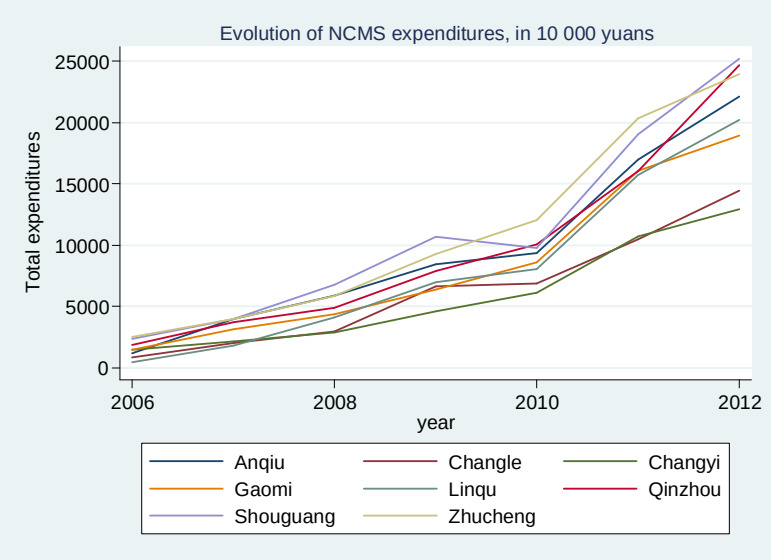
Figure 2. Evolution of the Public Health Index



Source: Authors database

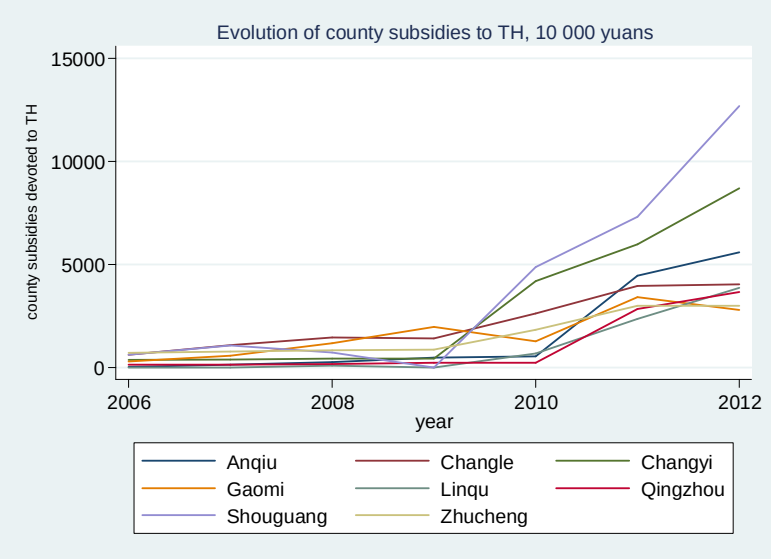
Simultaneously, the expenditures of every NCMS Bureau in our sample constantly increased, with a strong acceleration starting from 2010, as well as the county subsidies devoted to the THs (Figures 3 and 4). For the growth of NRCMS expenditures, there are mainly two explanations that can be linked to the deepening of the benefit package: on one side, the number of outpatient reimbursements increased, as well as the mean value reimbursement per inpatient case. This is a point that deserves consideration because the international literature on the effects of deepening health insurance generally provides evidence of a positive influence on the demand for care.

Figure 3. Evolution of NCMS expenditures



Source: Authors database

Figure 4. Evolution of county subsidies to TH

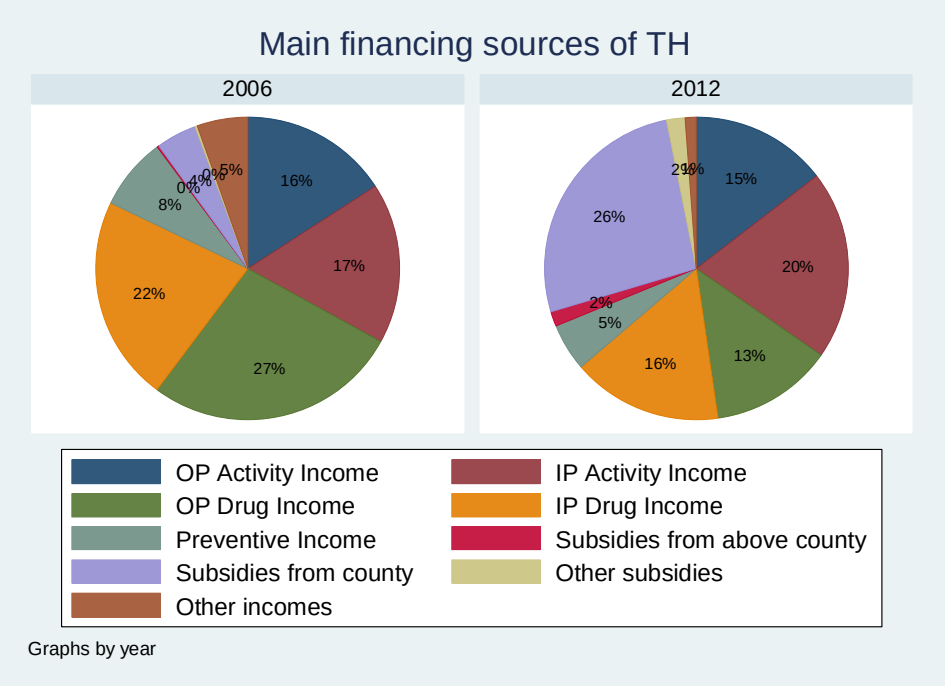


Source: Authors database

As stated previously, the NEDP reform changed sharply the income structure of PHF. In our study, the Figure 5 shows the comparison of principal sources of income for all observed TH between 2006 and 2012. In 2006, over 80% of revenues came from hospitals' activities, such as inpatient activity,

outpatient activity and drug prescription. Furthermore the drug prescription was the primary source of income, nearly the half of the total income. In contrast, activities rewarded hospitals up to 55% of its revenues in 2012. This decrease originated almost exclusively from the share of drug prescription. This lack of revenues was replaced by governmental subsidies, especially the subsidies from county level, which represented one third of hospitals' revenues.

Figure 5. Main financing sources of TH



Source: Authors database

7. Estimating efficiency of Township Hospitals

The production function

The definition of the production function has been made according to observations, and discussion with local actors. First, 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. This latter was computed using a Principal Component Analysis (PCA) which included every kind of imaging and test machine found in a TH[13].

As a hospital production is a multi-outputs function, we used the PCA to build the activity index. Variables that reflect different aspect of the activity of a TH[14] were introduced. Results allowed to selecting the first two factors. The first factor accounts for a global size effect, as it is positively related to each one of the variables introduced in the analysis. The second is positively related to the number of emergencies, of vaccinations and antenatal visits, so it reflects the Public Health activity of the TH.

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

[14] This PCA included the annual number of outpatients, admitted inpatients, emergencies, tests, surgeries, vaccinations and antenatal consultations.

Public Health is at the core of the current health system reform, which aims at rebuilding a proximity follow-up of patients, to ensure vaccinations, control visits and so on. TH role is central in this perspective: they have the responsibility of Village Health Stations (VHS), of the creation of a health booklet for each patient, for instance. Thus, it has been chosen to emphasize this aspect of TH activity, not only by including it in the PCA, but by considering a second output in the production function. Indeed, THs that perform the best in terms of Global Activity Index are not the same than for the Public Health Index, which confirms the relevance of keeping the two outputs.
THs have limited choice concerning their inputs, the county authorities decide of their size, of the importance of the staff. In this context, their strategy can only have influence on the output level, given their inputs. An output orientation was therefore chosen.
As mentioned above, the reform was implemented at the end of 2009 in 23 of 30 THs, and during 2010 in the other 7. It is assumed that in 2009, the production function had not changed yet, so two production frontiers are estimated: one going from 2006 to 2009, and the other from 2010 to 2011.

Measurement of efficiency

There are mainly two ways of assessing health facilities efficiency: a parametric one, the Stochastic Frontier Analysis (SFA), and non-parametric ones, relying on linear combinations of quantities of inputs and quantities of outputs, but without assumptions on the form of the production functions.
As pointed out by Hollingsworth[15], the Data Envelopment Analysis (DEA) method has been widely used in assessing health facilities efficiency since its apparition in 1978[16]. It avoids making any assumptions about the form of the production function, when it is unknown. Moreover, the SFA does not handle multiple outputs and multiple inputs combined as such (a radial combinations has to be computed).
Nonparametric efficiency methods can only compare DMUs 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. This method is the most represented in the literature on health sector efficiency[17][18].
The problem of the DEA method relies in its sensitivity to dimensionality, and to outliers in the considered 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 efficient units are biased.

Various attempts have been made to cope with this sensitivity. Particularly, in the last years, two methods have been presented, the so-called 'partial frontier' methods.
The first one is the order-m frontier, introduced by Cazals et al.[19]. To estimate the efficiency of a DMU in an output orientation, many samples of *m* DMU 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 also a way to detect outliers, defined as the DMUs whose score remains largely above 1 even when *m* increases.

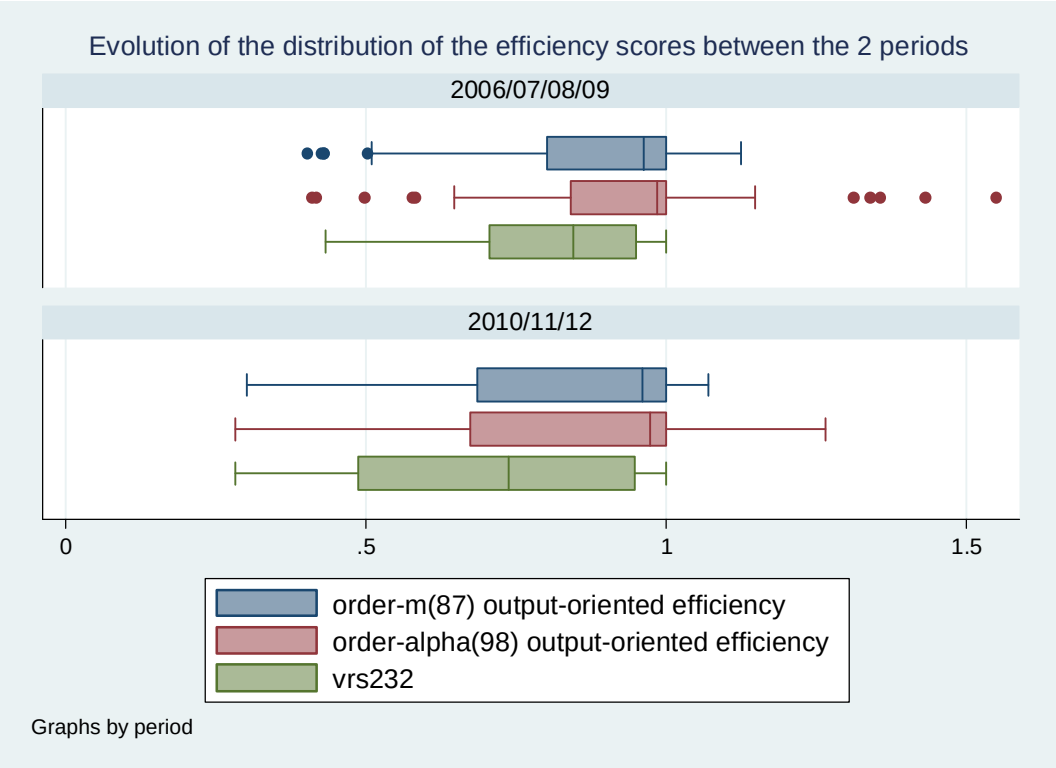
[15] (Hollingsworth 2008)
[16] (Charnes, Cooper, et Rhodes 1978)
[17] (Birman, Pirondi, et Rodin 2003)(13)Birman, P. E. Pirondi, et E. Y. Rodin, « Application of DEA to medical clinics ».
[18] (O'Neill et al. 2008)
[19] (« PII: S0304-4076(01)00080-X - Cazals_Florens_Simar_02--Nonparametric-frontier-estimation--a-robust-approach.pdf » 2014)

The second type of partial frontier analysis is developed by Daouia and Simar[20], it is the so-called order-alpha scores. The logic is close to the order-m frontier, with a difference in the way of excluding observations from the sample. In the output orientation, the production frontier is there defined so that a DMU I is compared to the level of output produced by (1-α)*100 % of the firms using at most the same level of inputs[21][22]. Again, it is possible for an observation to get a score higher than 1, meaning that the firm performed better than the partial estimated frontier. Considering the size of our sample, there is a concern about dimensionality, and some outlying DMUs. Thus, those techniques are used here to detect any potential outlier, and as robustness check of the DEA scores.

8. Comparing DEA and partial frontiers scores

The analysis of the scores obtained with the robust frontier analysis indicates that there is no outlier in our sample (there is no observation with an order-m score higher than 1.5; Figure 6). The correlation between the order-m and order-alpha scores is very high, both for the first and the second period (always superior to 0.9). A Spearman coefficient confirms that the ranking of the TH is almost the same with the two methods. But the order-alpha scores exhibit a higher number of "super-efficient units", of TH with a score higher than 1. On the contrary, thanks to its high number of replications, the order-m method shows no outlier.

Figure 6. Scores using robust frontier (order-m and alpha)



vrs232 = Variable return to scale, 2 outputs, 3 inputs, 2 periods

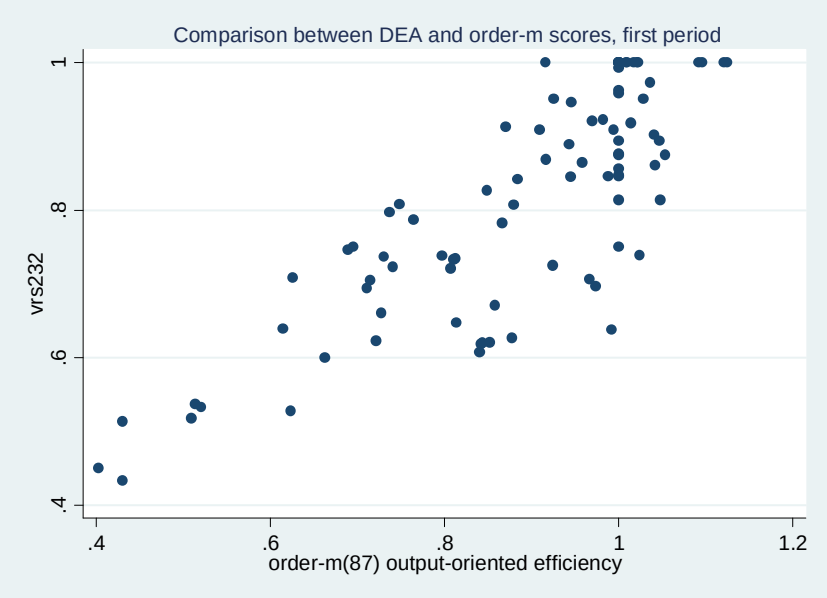
[20] (Daouia et Simar 2007)
[21] (Wilson 2008)
[22] (Daraio et Simar 2007)

As expected[23], the order-m scores are very stable with value attributed to m. The order-alpha scores appeared more sensitive to a change in the alpha parameter. In the literature, the order-m scores have an easier economic interpretation and have been proved to be more robust, and to have better statistical properties than the order-alpha scores[24]. Thus, we kept the order-m scores for the rest of the analysis, but the conclusions remain the same with order-alpha.

The correlation between the DEA and the order-m scores is 0.82 for both periods, and a Spearman test indicates that the ranking are not independent, with a statistic of 0.78 for 2007/08/09, and 0.75 for 2010/11/12.The DEA scores are generally much higher than the one obtained with the robust frontier analysis.

The analysis for more precise scatterplots shows that there is a part of the sample whose scores remain very close with the two methods (those around the diagonal on the graphics 7 and 8). Another group of TH is found more efficient with the order-m frontier, which can mean that they were compared to a super-efficient TH with the DEA method. Especially, for the second period, a group of THs are very efficient with the DEA score, but they are on the production frontier with the order-m method. Those differences of benchmarking show the interest of the partial frontier analysis, controlling for the problem of dimensionality.

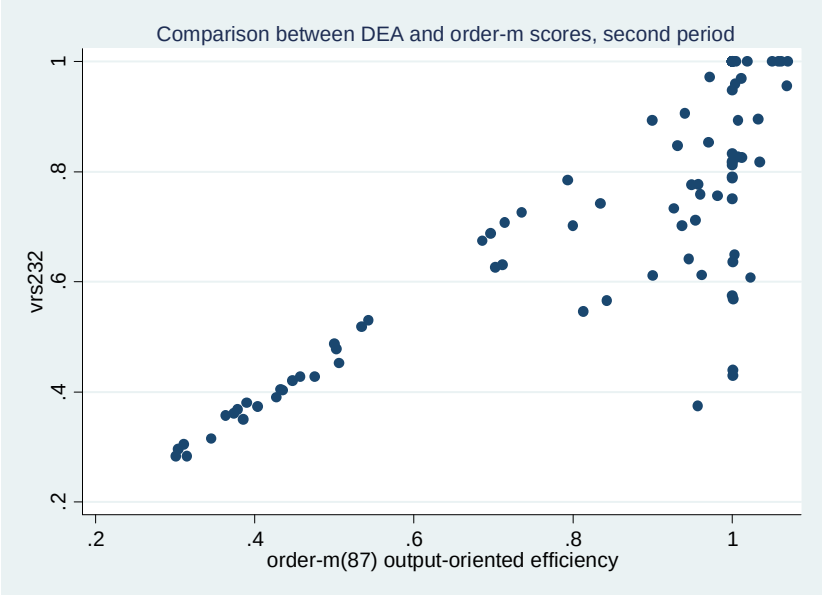
Figure 7. Comparision between DEA and order-m scores, first period



Source: Authors database

[23] (« PII: S0304-4076(01)00080-X - Cazals_Florens_Simar_02--Nonparametric-frontier-estimation--a-robust-approach.pdf » 2014)
[24] (Daouia et Gijbels 2011)

Figure 8. Comparison between DEA and order-m scores, second period



Source: Authors database

Table 2. Comparison between DEA scores and Order-m scores in each studied sub-period

if year<2010	**Order-m scores**					
DEA scores	x<0.6	0.6<x<0.8	0.8<x<1	1	1<x<1.2	Total
x<0.6	6	1	0	0	0	7
0.6<x<0.8	1	13	15	1	1	31
0.8<x<1	0	1	15	10	8	34
1	0	0	1	8	9	18
Total	7	15	31	19	18	90

If year>=2010	**Order-m scores**					
DEA scores	x<0.6	0.6<x<0.8	0.8<x<1	1	1<x<1.2	Total
x<0.6	22	0	3	1	3	29
0.6<x<0.8	0	7	12	3	3	25
0.8<x<1	0	0	5	5	8	18
1	0	0	0	12	6	18
Total	22	7	20	21	20	90

9. Estimating the determinants of THs efficiency

The two-stage approach usually uses Tobit model to deal with the censored nature of the DEA scores. This approach is not considered to be without bias. Moreover, as we used panel data, Tobit model random effects should be used. It is likely that specific effects are linked to our explanatory variables and that fixed effect model should be used. As the robust frontier analysis allows for super-efficent firms, data is not censored anymore, so, fixed effects model may be used as we did. There are two main kinds of explanatory variables. The first ones are internal ones such as the proportion of licensed staff (i.e. proportion of doctors among the medical staff), the proportion of subsidies among the TH

incomes. To check whether the role of subsidies was different in the first sub-period from the second one, an interaction of the first period with the proportion of subsidies was also introduced (prop_subs*first_period, Table 3). An estimated drug margin per unit of activity, obtained from the difference between drug expenditures and revenue, was also introduced. This variable aims at capturing to what extent THs make benefit on drug sales, which is at the core of the reform.
The second category is environmental variables: here the population covered by the TH, its density, the number of inhabitants per available bed, per medical staff, and the density of Village Health Centers (number of VHC per covered population). To test any non-linear effect, the square of the number of inhabitants per bed is also introduced. Results are presented in Table 3.

Table 3: Determinants of efficiency

VARIABLES	(1) ln_scorem	(2) ln_scorem	(3) ln_scorem	(4) ln_scorem
cov_pop_dens			-5.862*	-3.76
			-3.12	-2.75
prop_subs	-0.194**	-0.160*	-0.14	-0.200**
	-0.09	-0.09	-0.09	-0.09
prop_subs*first_period		0.14	0.17	0.19
		-0.23	-0.23	-0.23
drug_margin_per_act	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
hab_per_bed	3.012**	2.744**	2.24	
	-1.39	-1.38	-1.40	
hab_per_bedsq	-5.23	-5.52	-2.55	
	-4.09	-4.09	-4.36	
hab_per_staff		2.356**	2.796***	3.256***
		-0.99	-1.01	-1.01
nb_vhc	-0.00355*	-0.00385**	-0.00353*	-0.00481***
	0.00	0.00	0.00	0.00
prop_lic_staff	0.08	0.00	0.02	-0.03
	-0.26	-0.26	-0.26	-0.26
Constant	-0.315**	-0.473***	-0.24	-0.13
	-0.16	-0.17	-0.21	-0.17
Observations	201.00	201.00	201.00	201.00
R-squared	0.17	0.20	0.21	0.18
Number of idt_th	29.00	29.00	29.00	29.00

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Scorem = Efficiency scores

Regarding the results of the different models, some of the tested variables appear to be determinants of efficiency scores. Indeed, the variables related to the demand side exhibit the most significant and important coefficients.

(i) There is a negative effect of the proportion of subsidies in TH income. Thus, the reform, which increased the proportion of subsidies in THs revenue, very likely had a negative impact on efficiency. This can be linked to the lack of assessment of TH performances in the allocation of subsidies, which put THs in the situation of a soft budget constraint, with the related disincentives. This result is strengthened by the fact that the post reform

subsidies have often exceeded the loss of income caused by the NEDP (data will be provided in the revised version of the paper). We found the same effect of subsidies in a previous study in the context of insurance reform during the 2000-2008' period. As expected in the literature, a soft budget constraint appears to be a constant determinant of efficiency.

(ii) The number of VHS appears to be a negative impact of efficiency, showing the effect of competition between the two types of structure. However, the coefficient is almost zero, which can be linked with the very low variability of this variable across the period, in the context of a fixed-effect model.

(iii) The variables related to the demand have much wider impact. But their interactions are difficult to capture, and particularly, colinearity should be strongly controlled.

(iv) Finally, the number of inhabitants per medical staff appears to be the most robust determinant, as well as the number of inhabitants per available bed. This is consistent with the productivity of TH being (very) low, although it increased slightly during the period (the data will be provided in the revised version of the paper), and that they are some potential gains to be made in terms of inputs. Indeed, if the THs where the staff has to deal with the most important demand are the most efficient, it means that substantial gains can be made regarding the quantities of inputs. Of course, this should be analyzed with information about the quality of care, but this latter is not available in our database.

10. Conclusion

Partial frontier methods are a relatively new way of assessing efficiency of Decisions Making Units. They allow coping for the problem of dimensionality of the DEA method. The computation of the scores with our survey data shows that the scores are correlated, but with significant differences for some THs, that were wrongly assigned as inefficient. Subsequent analysis should strive to better understand the origin of these differences between both methods.

The analysis of the determinants of efficiency exhibits the negative role of subsidies on efficiency, as well as the importance of the demand side variables. The hospitals in which the ratio of covered potential patients per medical staff is higher are the most efficient. That leads to other questions: is that there is too many staff in some TH? A problem of balance between the various inputs? Probably, yes. But this imbalance should also be assessed in a dynamic perspective. As we have seen above, the authorities wanted to increase staffing in the perspective to make more attractive health care provided by TH, promoting and anticipating the growth of future demand. Therefore the issue is overstaffed TH or/and not enough demand?

Analyzes should be undertaken by the authorities to understand more that can be done with quantitative analyses, differences in efficiency, sometimes considerable, between TH. Moreover, to capture the potential effect of the reform on efficiency, more has to be done to shed the light on the shift in incentives for health care providers, and to identify the transmission channels in action. For instance, in a dynamic perspective, it is crucial to understand if the THs which relied the most on drug sales are those whose efficiency fell down the most after the reform, due to the lack of incentives to spur activity.

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