The challenge of improving efficiency of Soum Health Centers in Mongolia - What data tell us for Soum Health Centers in five provinces?

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The challenge of improving efficiency of Soum Health Centers in Mongolia*

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Abstract

Mongolia is facing strong constraints on the public financing of health expenditures since the economic crisis that started in 2012. In this context, achieving universal health care requires an improvement of health facilities' efficiency. No published study has quantitatively investigated the efficiency of primary care facilities in former soviet health systems that are still over-reliant on inpatient and specialized care. We study the efficiency level and determinants of Soum Health Centers (SHCs) that provide primary care in rural areas of Mongolia.

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Keywords: Efficiency; Data Envelopment Analysis; Double bootstrapping; Primary care; Mongolia.

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… / … Data on activity and resources were collected in all SHCs of five rural regions between 2013 and 2015, for which it was possible to get complete and reliable data. We use a double bootstrap Data Envelopment Analysis (DEA) procedure to estimate SHCs' efficiency and its determinants. SHCs of our sample exhibit a rather low (and declining) level of efficiency since they could, in average, increase activity by 47% without an increase in inputs. Results point to the role of demand-side factors in explaining SHCs' efficiency. We find that the size of the population in the catchment area, the share of the nomadic population and the dependency ratio are positively correlated with SHCs' efficiency. On the contrary, the poverty level of the catchment population is negatively correlated with SHCs' efficiency.

1. Introduction

1.1. The global context

Since the mid-90's, Mongolia has made significant progresses in health. Between 1995 and 2014, life expectancy at birth increased from 61 to 69 years while under-five mortality rate and maternal mortality ratio were divided by four, from 85 to 24 per 1000 live births and from 205 to 46 per 100.000 live respectively (World Health Organization - WHO - estimates). They have been favored by various reforms, a radical change in the structure of economic growth and a favorable international environment.

But things changed, and new financial constraints have emerged. The economic situation of Mongolia has deteriorated considerably since 2012 up to 2016. At the root causes of the crisis, there are reasons coming from exogenous factors to which the authorities responded with measures that were not compatible with the precariousness of the situation. External demand weakened due to a continued dampening of the commodity market and slower growth in China, leading to a drop in Mongolian exports and fiscal revenues. There is therefore an extremely challenging environment for public finances while the state budget contributed 62% of the financing of health expenditure in 2016 (Center for Health Development, 2016).

The strong constraints linked to the macroeconomic situation also have repercussions on the financing of health by the insurance system. Health insurance is mainly financed by the contributions of employers and employees, and by the self-employed in the various sectors, including the informal sector of which herders constitute a large part. The insurance premiums subsidized by the state budget represent in 2016 nearly 16% of the total resources of the health insurance fund (Center for Health Development, 2016). And every year, because of economic difficulties a number of households, including herders and in-migrants, cannot pay their premiums and are therefore without health insurance (Ministry of Population Development and Social Protection, 2013).

As a corollary of this situation, very heavy constraints weigh on the public financing of health expenditures.

In addition to the fiscal constraint, the rise of non-communicable diseases and the sharp increase in private health expenditures are two major trends that underline the importance of improving efficiency in the health system. Non-communicable diseases, including cardiovascular diseases and diabetes, are the leading causes of years of life lost in Mongolia. Diabetes, which was quite rare in Mongolia 30 years ago, now hits about one in seven persons. The diabetes rate has been multiplied by six and diabetes-related mortality by four between 2005 and 2014 (WHO, 2015). Regarding health expenditures, between 1995 and 2012, out-of-pocket (OOP) health expenditures rose in Mongolia from 12% to 42% of total health expenditures (WHO). The current level of OOP health expenditures is slightly above the average (39%) of the lower middle income countries (World Bank). Furthermore, global worldwide experience suggests that universal health coverage is difficult to achieve if OOP expenditures represent a high share of total health expenditures (Savedoff et al., 2012). Let's add that the Mongolian government has committed itself in 2013 to provide effective universal primary health care services for all and wants also to expand the costly Child Money Program to reach at least 80% of children from the poorest families .

In this very restrictive context for financing an ambitious health care policy, improving efficiency is a compelling challenge[1].

1.2. A lack of knowledge about the efficiency of health systems in the countries of former Soviet Central Asia.

The interest to study the efficiency of health facilities in Mongolia is reinforced by the fact that Central Asian post-soviet health systems have been ranked amongst the least studied over the world (McKee et al., 2012) despite the radical change in health care organization they experienced after the fall of the Soviet Union. As other former soviet health systems, the Mongolian health system was organized according to the Semashko model until 1990. The health system was then characterized by its centralized planning, administration and financing. It provided universally accessible and free basic health care but was heavily focused on curative and inpatient care while neglecting preventive and primary outpatient care. This health system became financially unsustainable after losing the subsidies of the Soviet Union and Mongolia engaged in major health

[1] In 2017, the economic situation of Mongolia improved significantly due to favorable external environment and a sound macroeconomic policy (IMF, 2018). Mongolia benefited from a sharp increase in coal exports, positive terms of trade and large foreign investments in the commodities sector. This buoyant external context has been accompanied by a significant reduction in the fiscal deficit (increase in fiscal resources, containment of expenditures) and by a prudent monetary policy. But beyond this improvement, significant risks and challenges still lie ahead, including the level of debt, questioning regarding the dynamics of copper and coal exports and therefore the growth of fiscal revenues, limited diversification of the economy, and domestic political situation leading to ask about the political feasibility of the vigorous reform agenda in which the government is committed with a possible risk of skidding off due to popular opposition. In other words, that means that the current improvement in the macroeconomic situation does not detract from the strong need to improve efficiency in the health system.

system reforms after 1990. These reforms focused on increasing efficiency through scaling back secondary and tertiary hospitals and strengthening primary care.

In recent years, a growing literature has emerged on the efficiency of primary health care facilities in in low- and middle-income countries. Available studies focus on African countries such as Ghana (Alhassan et al., 2015; Novignon and Novignon, 2017), Sierra Leone (Kirigia et al., 2011), Ethiopia (San Sebastian and Lemma, 2010) or Burkina Faso (Marschall and Flessa, 2009), on South-American countries such as Guatemala (Hernandez and Sebastian, 2014) or Chile (Ramírez-Valdivia et al., 2011) and on Asian countries such as Pakistan (Razzaq et al., 2013) or China (Audibert et al., 2013; Cheng et al., 2016). However, to the best of our knowledge, no published study has investigated with quantitative methods the efficiency of primary care facilities in countries with former Semashko health systems that are still facing major challenges linked to their over-reliance on inpatient and specialized care.

1.3. Soum Health Centers in the Mongolian health system

Mongolia is administratively divided into 21 aimags (provinces) which are in turn split, for rural areas, into 329 soums (districts). The Mongolian health system is based on a two-tier model that provides primary health care at the primary level and specialized health care at secondary and tertiary levels (Tsilaajav et al., 2013).

In rural areas, primary health care is mainly delivered by Soum Health Centers (SHCs) on which our analysis focuses. SHCs are public health facilities owned by local governments and run by salaried staff, i.e. doctors, nurses, midwives and support staff. SHCs provide antenatal and postnatal care, minor surgeries and normal deliveries as well as preventive activities such as immunization, diabetes/hypertension testing or health education. In 2011, a revision of the health act stressed the focus of SHCs on primary health care and prevention while reducing their hospital functions. Nevertheless, SHCs kept providing both outpatient and inpatient services. The double mission of SHCs is explained by the geographic and demographic characteristics of Mongolia where the rural and nomadic populations are sparsely distributed. In SHCs, inpatient admissions, outpatient visits or routine immunization are provided free of charge for all patients. However, the reimbursement rate of outpatient essential drugs varies between 5% and 91% of cost price. Only patients with Social Health Insurance (SHI) entitlement, i.e. patients who paid their insurance contributions for the last 12 months, are eligible for outpatient drug reimbursement. An important source of OOP expenditures for SHCs' patients is then copayment for essential drugs or full drug costs if uninsured. In 2011, pharmaceuticals represented 94% of health OOP payments among the very poor in Mongolia (Tsolmongerel et al., 2011).

The paper is structured as follows. Section 2 details the methodology and Section 3 presents the dataset. Section 4 displays the results that are discussed in Section 5.

2. Methods

We use a two-stage model to estimate SHCs' efficiency and its determinants. We apply the double bootstrap DEA procedure developed by Simar and Wilson (2007) to calculate bias-adjusted DEA scores and to study the factors associated with SHCs' efficiency.

Technical efficiency refers to the capacity of a Decision Making Unit (DMU), a SHC in our case, to transform a certain amount of inputs into a certain quantity of outputs through the production process. In an output orientation, technical efficiency reflects the ability of a SHC to obtain a maximal level of outputs from a given set of inputs. In an input orientation, it reflects the ability of a SHC to minimize inputs given a level of production. For the efficiency analysis, as SHCs have to deal with fixed amounts of resources, the output orientation was chosen. Two methods are available to estimate the technical efficiency of SHCs: a parametric one using the Stochastic Frontier Analysis (Aigner et al., 1977) and a non-parametric one, which includes several methods such as the DEA (Farrell, 1957; Charnes et al., 1978) or the Free Disposal Hull (FDH) (Deprins et al., 1984). As the parametric method requires an *ad hoc* assumption on the functional form of the production function we use a non-parametric approach. Among the different non-parametric methods, DEA is the most often used to estimate health facilities' efficiency (Hollingsworth, 2008). The purpose of the DEA method is to construct a piecewise linear envelopment frontier over the data points such that all observed points lie on or below the production frontier. The efficiency level of each SHC is then measured by calculating the difference between the point representing the observed values of inputs and outputs of this SHC and the frontier that determines the best observed practices in the whole sample. In DEA, technical efficiency can be measured using either constant or variable returns to scale. The assumption of constant returns to scale is appropriate if all SHCs operate at the optimum scale. If it is not the case, efficiency estimates will include scale economies while we aim to measure pure technical efficiency. We therefore consider variable returns to scale in the DEA analysis.

The use of two-stage models to study the factors associated with efficiency has been challenged (Simar and Wilson, 2007). The controversy lies on the nature of the efficiency scores used as the dependent variable in the second-stage. The instrumentalist approach considers the estimated efficiency scores as descriptive measures of the relative technical efficiency of sampled DMUs (McDonald, 2009; Ramalho et al., 2010). Efficiency scores can then be treated as a standard dependent variable and classical regression analyses carried out in the second stage are thought to provide valid inference. On the contrary, the conventionalist approach looks at efficiency scores as estimates of true efficiency scores (Simar and Wilson, 2007; Simar and Wilson, 2013). Efficiency scores are assumed to reflect not only efficiency but also noise because of measurement errors in inputs and outputs. Moreover, since the estimated frontier can only be a subset of the true but unknown technology, efficiency scores are biased due to sampling variability. Additionally, given that efficiency scores estimated through non-parametric approaches are dependent on each other, efficiency estimates are considered serially correlated. Consequently, the conventionalist approach regards the standard approaches of inference used in the second-stage regression analysis as invalid.

Simar and Wilson (2007) propose a double bootstrap procedure that produces bias-adjusted DEA score and provides valid inference for the regression of non-parametric DEA efficiency estimates on a set of explanatory variables in the second stage. First, bias-corrected DEA scores are calculated by subtracting the bootstrap bias estimate from the original DEA estimates. Bias-corrected DEA scores are then regressed on a set of explanatory variables using a bootstrapped truncated regression that produces unbiased parameter estimates and confidence intervals. We use the Algorithm 2 of Simar and Wilson (2007) after conducting outliers' detection based the method developed by Simar (2003). Algorithm 2 proceeds in the following seven steps:

S1: Estimate output-orientated Shephard DEA efficiency scores $\widehat{\theta_\iota}$ with varying returns to scale for all SHCs in the sample.

For each SHC i=1,…,n with observed outputs y_i and inputs x_i, output-oriented Shephard DEA efficiency estimate $\widehat{\theta_\iota}$ is the solution of the following linear program:

$$\widehat{\theta_\iota} = (\max\{\theta > 0 \mid \theta y_i \leq \sum_{i=1}^{n} \gamma_i\, y_i;\ x_i \geq \sum_{i=1}^{n} \gamma_i\, x_i;\ \sum_{i=1}^{n} \gamma_i = 1\,;\ \gamma_i \geq 0, \mathrm{i} = 1, \dots, \mathrm{n}\})^{-1} \tag{1}$$

For all i=1,…,n, $\widehat{\theta_\iota} \leq 1$. A SHC is technically efficient if $\widehat{\theta_\iota}$=1 and technically inefficient if $\widehat{\theta_\iota} < 1$. The proportional increase in output that can be achieved by an inefficient SHC with no increase in inputs is equal $\left(\frac{1}{\widehat{\theta_\iota}} - 1\right)$*100 per cent.

S2: Estimate Equation 2 by employing truncated maximum likelihood to yield estimates $\hat{\beta}$ and $\widehat{\sigma_\varepsilon}$.

$$\widehat{\theta_\iota} = z_i\beta + \varepsilon_i \leq 1 \qquad (2)$$

In Equation (2), z_i is a vector of variables assumed to influence the values of y and x, β is a vector of parameters to be estimated and ε_i is a continuous iid random variable independent of z_i with distribution N(0,σ_ε^2).

S3: For each i = 1,…,n, loop over the following four steps (i-iv) L_1 times (100 times in our case) to obtain a set of bootstrap estimates $B_i = \{\hat{\theta}_{ib}^{*}\}_{b=1}^{L_1}$.

(i) For each i=1,…,n, draw ε_i from the N(0,$\widehat{\sigma_\varepsilon}$) distribution.

(ii) For each i=1,…,n, compute θ_i^*=$z_i\hat{\beta} + \varepsilon_i$.

(iii) Construct a pseudo data set (x_i^*, y_i^*) where x_i^*=x_i and y_i^*=$y_i(\frac{\widehat{\theta_\iota}}{\theta_i^*})$

(iv) Using the pseudo data set and Equation 1, compute pseudo efficiency estimates $\hat{\theta}_i^*$ for all i=1,…,n.

S4: For each SHC i=1,…,n, compute the bias-corrected estimator $\hat{\hat{\theta}}_i = \hat{\theta}_i$-Bias($\hat{\theta}_i$) where the bias term is estimated as: Bias($\hat{\theta}_i$)=($\frac{1}{L_1}\sum_{b=1}^{L_1}\hat{\theta}_{ib}^*$)- $\hat{\theta}_i$.

S5: Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\theta}}_i$ on z_i to yield estimates $\hat{\hat{\beta}}$ and $\widehat{\widehat{\sigma_\varepsilon}}$.

S6: Loop over the following three steps (i-iii) L_2 times (1000 times in our case) to yield a set of bootstrap estimates $\Phi = \{(\widehat{\widehat{\beta^*}}, \widehat{\widehat{\sigma_\varepsilon^*}})_b\}_{b=1}^{L_2}$.

(i) For each i=1,…,n, draw ε_i from the N(0,$\widehat{\widehat{\sigma_\varepsilon}}$) distribution.

(ii) For each SHC i=1,…,n, compute θ_i^{**}=$z_i\hat{\hat{\beta}} + \varepsilon_i$.

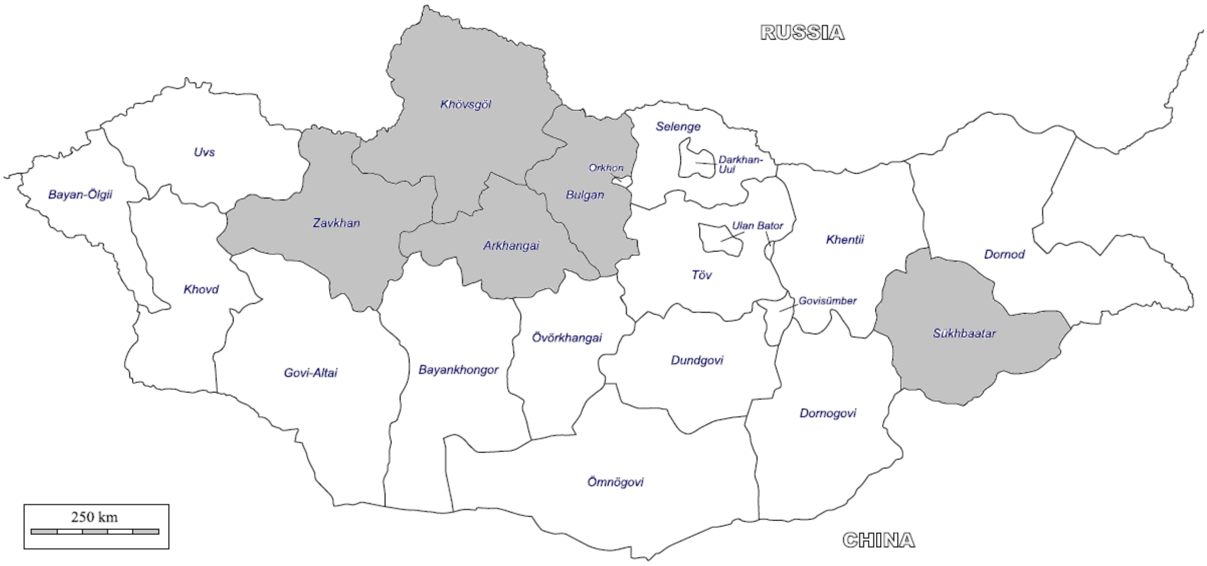
(iii) Use the maximum likelihood method to estimate the truncated regression of θ_i^{**}on z_i to yield estimates $\widehat{\widehat{\beta^*}}$and $\widehat{\widehat{\sigma_\varepsilon^*}}$.

S7: Use the boostrap values in Φ and the original estimates $\hat{\hat{\beta}}$ and $\widehat{\widehat{\sigma_\varepsilon}}$ to construct estimated confidence intervals for each element of β and σ_ε. The (1-α) per cent confidence interval of the j[th] element of vector β, where 0<α<1, is constructed as the Pr(-$b_{\alpha/2}$ ≤ $\widehat{\widehat{\beta_j^*}}$ - $\hat{\hat{\beta}}_j$ ≤ -$a_{\alpha/2}$) ≈ 1-α such that the estimated coefficient is [$\hat{\hat{\beta}}_j$+$a_{\alpha/2}^*$, $\hat{\hat{\beta}}_j$+$b_{\alpha/2}^*$].

3. Data

The analysis focuses on five regions (aimag) for which we obtained complete and reliable data on SHCs' activity and resources use between 2013 and 2015: Arkhangai, Bulgan, Khuvsgul, Sukhbaatar and Zavkhan (Figure 1).

Figure 1: Regions of provenance for SHCs data



3.1. Inputs and outputs

We select three inputs: the numbers of beds, doctors and nurses. We distinguish nurses from doctors given the specific shortage of doctors in rural areas (Erdenee et al., 2017) and the fact that nurses might not substitute to doctors in the realization of all medical acts. In the main analysis (model 1), we also consider three outputs: the number of preventive visits, the number of non-preventive visits and the number of inpatients. We differentiate preventive and non-preventive visits since the 2011 revision of the Mongolian health act stressed out the focus of SHCs on primary preventive care. The number of inpatients is included since SHCs also have for mission to provide inpatient care for rural populations whose access to secondary level health facilities (aimag general hospitals) in aimag centers is difficult. As a robustness analysis, we consider alternative outputs in models 2 to 8 (Table 1). We successively decompose non-preventive outpatient visits into SHC and home visits, replace the number inpatients by the number of beds days and substitute the number of preventive visits by the number of controlled pregnant women and the number of diabetes and hypertension tests performed.

Table 1: Presentation of the alternative models

	Outputs				
Model 1	Inpatients	Preventive visits	Non-preventive visits		
Model 2	Bed days	Preventive visits	Non-preventive visits		
Model 3	Inpatients	Preventive visits	Non-preventive visits (SHC)	Non-preventive visits (home)	
Model 4	Bed days	Preventive visits	Non-preventive visits (SHC)	Non-preventive visits (home)	
Model 5	Inpatients	Controlled pregnant women	Diabetes and hypertension tests	Non-preventive visits	
Model 6	Bed days	Controlled pregnant women	Diabetes and hypertension tests	Non-preventive visits	
Model 7	Inpatients	Controlled pregnant women	Diabetes and hypertension tests	Non-preventive visits (SHC)	Non-preventive visits (home)
Model 8	Bed days	Controlled pregnant women	Diabetes and hypertension tests	Non-preventive visits (SHC)	Non-preventive visits (home)

3.2. Potential determinants of efficiency

We consider two kinds of variables that might affect SHCs' efficiency; external variables that are not under the control of the SHCs; and internal variables whose value is discretionary to the health authorities.

Regarding external variables, we first consider the characteristics of the soum population: the size of the population, the poverty rate measured by the poverty headcount ratio (Coulombe and Altankhuyag, 2012)[2], the age structure of the population measured by the dependency ratio and the share of the population living in ger. We expect to find a positive correlation between the population of the soum and the efficiency of SHCs through a demand effect. The poverty rate in the catchment area of a SHC might have several effects on its efficiency. If poorer people tend to exhibit more deteriorated health states, a higher poverty rate in the catchment area of a SHC could lead to an increase in its activity and efficiency. On the other hand, given the existence of OOP payment for outpatient drugs in SHCs, a higher poverty rate might increase health care renouncements. Furthermore, travelling expenses to the SHC might constitute a significant financial burden for poor population, leading to more health care renouncements. The age structure of the population in its catchment area may also affect the activity of a SHC. As children

[2] Poverty data are not available yearly at the soum level in Mongolia. Therefore, we use the United Nations Development Programme data for 2011, which are the latest poverty data available at the soum level.

and seniors consume more of both preventive and curative care (Gan-Yadam et al., 2013), a high dependency ratio in the soum might be associated with more activity and increased efficiency for the SHC. The share of the soum population living in ger is also likely to influence SHCs' activity. As nomads live in remote areas, they might have difficulties in accessing health facilities. On the other hand, their harsher living conditions might lead to a higher prevalence of (infectious) diseases, which could translate into more demand for SHCs.

We also consider two geographical variables, the area of the soum in square kilometers and the distance of the SHC to the aimag general hospital in kilometers. The area of the soum is likely to affect the volume of demand faced by SHCs. A negative correlation between the area of the soum and the efficiency of SHCs could be observed if populations living in larger soums experience more difficulties to reach the SHC. The distance of the SHC to the aimag general hospital might be positively correlated with its activity and efficiency if the lack of accessibility of the soum population to the aimag general hospital translates into more demand for the SHC. Moreover, people might be less keen to bypass the referral system if the aimag general hospital is located further.

Based on the data available for the purpose of this study, we include one internal variable that might influence SHCs' efficiency, the share of doctors in medical staff (in %). The share of doctors might be positively correlated with SHCs' efficiency if doctors are more efficient than nurses in the delivery of health care and then treat more patients. However, this could also lead to fewer revisits through a "quality of care" effect, and then to a decrease in the global level of SHCs' activity and efficiency.

3.3. Main characteristics of SHCs and of their catchment area

Table 2 provides key statistics for the sample of SHCs used in model 1.

The mean number of inpatients is 331 while the mean number of bed days is 2361. In average, SHCs realized 3119 preventive outpatient visits and 4593 non-preventive outpatient visits per year. Non-preventive visits in the SHC are higher than home visits with means of 3221 and 1373 respectively. Among SHCs of our sample, the mean annual number of controlled pregnant women is 401 while the mean annual number of hypertension and diabetes tests is 843. In average, SHCs have 9.7 beds. The mean numbers of doctors and nurses are 2.6 and 7.2 respectively. In average, 39.2% of the population lives below the poverty line and 77.6% lives in ger. The correlation between the poverty headcount and the share of the population living in ger is low (0.0409) and non-significant at a 10% level. The mean dependency ratio is high and equal to 51.8%. Soums measure an average of 4061 square kilometers and host an average of 3199 habitants. The mean distance of SHCs to the aimag general hospital is 144 kilometers and the mean share of doctors in medical staff is 27.1% among SHCs of our sample.

Table 2: Descriptive statistics of the sample

	Obs	Mean	Std. Dev.	Min	Max
Inpatients	221	330.6968	108.5792	108	832
Preventive visits	221	3119.018	2147.682	116	13980
Non-preventive visits	221	4593.294	2571.983	775	15755
Bed days	220	2360.736	742.8844	971	5317
Non-preventive visits in SHC	221	3221.176	2007.224	553	13118
Home non-preventive visits	221	1372.692	932.167	114	4979
Pregnant women controlled	221	401.3484	183.4399	104	1110
Hypertension and diabetes tests	204	843.2255	493.0895	0	2458
Beds	221	9.642534	3.64365	4	21
Nurses	221	7.162896	2.748666	3	15
Doctors	221	2.556561	1.141257	1	7
Poverty headcount	221	39.2009	6.645155	27.4	50.5
Dependency ratio	221	51.79909	4.620586	40.9	66.1
Living in ger (%)	221	77.63484	16.13893	11.2	95.5
Population	221	3198.91	1291.659	938	6549
Area (km²)	221	4060.955	2592.972	626.9087	17002.7
Distance general hospital	221	144.4344	74.64943	22	307
Doctors (% medical staff)	221	27.13697	9.713719	6.25	60

4. Results

As DEA scores are highly sensitive to the presence of outliers in the sample, we run a preliminary analysis to detect outliers. We use the leave-one out outliers' detection methodology developed by Simar (2003). Details of the procedure are available in Appendix A. After several repetitions to control for masking effects, we exclude three outliers: Tynel and Byrentogtokh SHCs in Khuvsgul in 2013 and Ikh-Uul SHC in Zavkhan in 2013.

4.1. Efficiency

Table 3 gives the summary statistics of the efficiency scores for all models. Mean efficiency in the main model (model 1) is equal to 0.682, which means that, in average, SHCs could increase output by 46.67% without an increase in inputs. Mean efficiency decreases over time in model 1, from 0.72

in 2013 to 0.62 in 2015 ($t = 5.2232$, $p < 0.001$). On the contrary, efficiency scores' heterogeneity does not evolve over time as the standard deviation is equal to 0.11 in all years. The mean efficiency score is between 0.665 and 0.748 in models 2 to 8. The highest correlation of efficiency scores between models is seen for model 1 and model 3 where the number of non-preventive visits is split between home and SHC visits. The correlations between the efficiency scores of model 1 and alternative models are much lower when the number of preventive visits is replaced by the number of controlled pregnant women and the total number of diabetes/hypertension tests. This result is logical since preventive visits in SHCs integrate other activities such as immunization or health education.

Table 3: Summary statistics of the efficiency scores

	Observation	Mean	Standard deviation	Min	Max	Correlation with model 1
Model 1	221	0.6817818	0.1204662	0.3889395	0.9368711	-
Model 2	220	0.6652675	0.1322318	0.3462393	0.9307621	0.8747***
Model 3	221	0.7024325	0.1210076	0.3994593	0.9355465	0.9502***
Model 4	220	0.686424	0.1345401	0.3630884	0.9390115	0.8187***
Model 5	200	0.7270786	0.12205	0.366824	0.9329448	0.6637***
Model 6	199	0.7069749	0.1297229	0.333037	0.935676	0.5606***
Model 7	200	0.7471827	0.1208079	0.3751675	0.945289	0.6686***
Model 8	199	0.7212512	0.1289889	0.3379224	0.9347335	0.5626***

Table 4 displays the efficiency scores by region and by year for model 1. The mean efficiency score decreases in all regions between 2013 and 2015, though at different rates. The decrease in mean efficiency is the highest in Khuvsgul with a drop of -19.71% between 2013 and 2015. Thereby, Khuvsgul ranks as the most efficient region in 2013 but as the second least efficient in 2015. The lowest decrease in mean efficiency is observed in Bulgan (-5.08%). Consequently, Bulgan is the second most efficient region in 2015 while being the least efficient in 2013. Between 2013 and 2014, mean efficiency increases in Bulgan and Sukhbaatar, decreases in Khuvsgul and Zavkhan and remains stable in Arkhangai.

Table 4: Efficiency scores by region and year

	2013-2015		2013		2014		2015		2013-2015 variation
	Mean score	Ranking	Mean score	Ranking	Mean score	Ranking	Mean score	Ranking	
Arkhangai	0.6662246	4	0.6947109	3	0.6934461	5	0.6105169	3	-12.12%
Bulgan	0.6737065	3	0.6695225	5	0.7157627	3	0.6355126	2	-5.08%
Khuvsgul	0.6870264	2	0.75905	1	0.7095282	4	0.6094476	4	-19.71%
Sukhbaatar	0.6588835	5	0.6845962	4	0.717495	2	0.5745593	5	-16.07%
Zavkhan	0.7101955	1	0.7524139	2	0.7385126	1	0.6441042	1	-14.39%

4.2. Factors having an impact on efficiency

Table 5 presents the results of the truncated regressions using bias-adjusted DEA scores. We first present the results for the main model (model 1) and then discuss the heterogeneity of results by models.

Looking at model 1, we find a negative and significant correlation between the poverty headcount and the efficiency score. This result is confirmed by the use of two alternative measures of poverty; the poverty gap index and the poverty severity index (results not shown). Results of the regression analysis for model 1 show a positive and significant association between the dependency ratio and the efficiency of SHCs. Then, the presence of more children and elders in its catchment population enhances the efficiency of a SHC. The size of the soum population is also positively correlated with the efficiency score. This indicates that the low efficiency exhibited by some SHCs is related to the small demand for medical care they face in sparsely populated areas. On the contrary, we find no correlation between the area of the soum and the efficiency of SHCs once controlled for the population size. The share of the soum population living in ger is positively correlated with the efficiency of SHCs. This implies that SHCs facing more nomadic populations exhibit better efficiency. The proximity of SHCs to the aimag general hospital does not impact their efficiency. Moreover, we find no significant correlation between the share of doctors in medical staff and the efficiency of SHCs.

The sign and significance of correlations are unchanged for several variables whatever the model considered. This is the case for the poverty headcount, the share of the catchment population living in ger, the distance to the intersoum hospital and the size of the population (except in model 4). On the contrary, the dependency ratio loses statistical significance when preventive visits are replaced by the number of controlled pregnant women and the number of diabetes/hypertension tests. The area of the soum is positively correlated with SHCs' efficiency only in models where bed days are used instead of inpatients. Finally, the share of doctors in medical staff is negatively correlated with SHCs' efficiency in models 3, 5 and 7 while it is not significant in other models.

Table 5: Results of truncated regression analyses

	Bias-adjusted DEA score							
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Poverty headcount	-0.00327**	-0.00531***	-0.00430***	-0.00538***	-0.00336***	-0.00286**	-0.00445***	-0.00369**
	(0.00132)	(0.00142)	(0.00132)	(0.00141)	(0.00125)	(0.00146)	(0.00138)	(0.00145)
Dependency ratio	0.00808***	0.00470**	0.00768***	0.00456**	0.000144	-0.00375*	0.000467	-0.00338
	(0.00197)	(0.00206)	(0.00196)	(0.00210)	(0.00201)	(0.00216)	(0.00204)	(0.00228)
Living in ger (%)	0.00169***	0.00218***	0.00197***	0.00247***	0.00127***	0.00141***	0.00160***	0.00184***
	(0.000468)	(0.000503)	(0.000462)	(0.000514)	(0.000460)	(0.000520)	(0.000490)	(0.000534)
Population	0.0000152**	0.0000132*	0.0000166***	0.0000109	0.0000662***	0.0000624***	0.0000635***	0.0000628***
	(0.00000619)	(0.00000695)	(0.00000614)	(0.00000678)	(0.00000677)	(0.00000746)	(0.00000667)	(0.00000773)
Area (km^2)	-0.00000203	0.00000910***	-0.00000154	0.0000115***	0.000000899	0.00000695**	0.000000246	0.00000721**
	(0.00000283)	(0.00000327)	(0.00000281)	(0.00000347)	(0.00000292)	(0.00000353)	(0.00000313)	(0.00000356)
Distance general hospital	-0.0000194	0.00000962	-0.0000517	-0.0000138	-0.0000768	-0.0000798	-0.0000414	0.0000176
	(0.000106)	(0.000116)	(0.000105)	(0.000117)	(0.000113)	(0.000129)	(0.000114)	(0.000126)
Doctors (% medical staff)	-0.00125	-0.0000812	-0.00160*	-0.000503	-0.00289***	-0.00178	-0.00281***	-0.00164
	(0.000898)	(0.000967)	(0.000890)	(0.00100)	(0.000934)	(0.00109)	(0.000965)	(0.00106)
Year = 2014	0.0400**	0.00284	0.0417**	0.00418	0.0258	-0.0141	0.0221	-0.0258
	(0.0198)	(0.0217)	(0.0197)	(0.0213)	(0.0196)	(0.0222)	(0.0207)	(0.0222)
Year = 2015	-0.0702***	-0.115***	-0.0741***	-0.123***	-0.0327*	-0.0720***	-0.0385**	-0.0804***
	(0.0181)	(0.0203)	(0.0180)	(0.0206)	(0.0183)	(0.0196)	(0.0194)	(0.0208)
Constant	0.269***	0.423***	0.337***	0.448***	0.626***	0.764***	0.657***	0.747***
	(0.101)	(0.107)	(0.0999)	(0.112)	(0.0985)	(0.110)	(0.100)	(0.111)
N	221	220	221	220	200	199	200	199

Standard errors in parentheses ; * p<0.10, ** p<0.05, *** p<0.01

5. Discussion

We study the efficiency of SHCs which provide primary health care for rural populations in Mongolia. Between 2013 and 2015, SHCs of our sample exhibit a low mean efficiency (0.682) indicating that health care production could, in average, be increased by 46.67% without an increase in inputs. Our results point to a decrease in efficiency of SHCs over time, in particular between 2014 and 2015, and to a heterogeneity of SHCs' efficiency across regions.

Our results show that demand-side factors impact SHCs' efficiency. First, the size of the soum population affects positively the efficiency of SHCs because SHCs located in more populated areas face a higher demand that spurs their activity. This result is in line with those found for rural primary health centers in Chile (Ramírez-Valdivia et al., 2011) or Burkina Faso (Marschall and Flessa, 2009), where more population in the catchment area is associated with better efficiency. However, this result diverges from those of San Sebastian and Lemma (2010) or Audibert et al. (2013). The former find no association between the sub district's population and the efficiency of rural health posts in Ethiopia while the latter find no correlation between the population density and the efficiency of township hospitals in China. A logical policy implication of this result would be - taking careful consideration of the characteristics of the local context - to reduce the resources of SHCs which face a too low demand. Indeed, our analyses indicate that most SHCs could achieve similar activity levels with reduced resources, therefore not affecting equity of access to health care between rural and urban populations.

Facing poorer populations tend to lessen SHCs' efficiency, most likely because OOP health expenditures or transportation costs induce health care renouncements among low-income populations. This result supports the findings of Dorjdagva et al. (2017), who point to pro-rich inequalities in the use of inpatient services in SHCs. This is also in line with results of Audibert et al. (2013), who find a negative correlation between rural income and township hospitals' efficiency in China. Then, providing free outpatient drugs in SHCs, even for those not covered by the SHI, could increase SHCs' activity and efficiency. Besides ensuring free primary health care, access to care of poor populations and SHCs' efficiency could benefit from the creation of better and low cost transportation infrastructures in the long-run or - which would be more feasible considering the huge surface of Mongolia - to benefit from transport costs partially subsidized by the SHI.

SHCs' efficiency is positively associated with the share of the soum population living in ger. Despite a more difficult access to health facilities, people living in ger experience harsher living conditions that may deteriorate their health states and lead them to demand more medical care than sedentary inhabitants. This could explain why SHCs facing more nomadic inhabitants achieve better efficiency. The age structure of the catchment population also impacts SHCs' efficiency. We find that SHCs facing more children and seniors exhibit higher efficiency, likely because these population categories consume more preventive and curative health care than middle-age adults (Gan-Yadam et al., 2013). However, the opposite result is found by Ramírez-Valdivia et al. (2011) in

Chile where the shares of the population under 6 and over 65 are negatively associated with the efficiency of primary health care practices in rural municipalities.

Our results also point to the lack of association between SHCs' efficiency and the distance to the aimag general hospital. Thus, the activity and efficiency of SHCs are not affected by the proximity of a higher referral level heath facility. This indicates that the self-referral of patients to the aimag general hospitals is not a major issue for the rural health system in Mongolia. Two previous studies, conducted in Ethiopia (San Sebastian and Lemma, 2010) and China (Audibert et al., 2013), also find no association between primary health facilities' efficiency and their distance to the closest higher level health center.

SHCs' efficiency is positively correlated with the area of the soum only when considering the number of bed days instead of the number of inpatients. To understand this result, we ran additional regression analyses[3]. Controlling for soum attributes and population characteristics, we find that the soum area is positively and significantly correlated with both the number of bed days and the mean length of stay. However, this variable is not associated with the number of inpatients. This result might indicate that patients living further from the SHC benefit from longer inpatient stay.

With the exception of model 1, the share of doctors in medical staff is negatively correlated with SHCs' efficiency when considering inpatients rather than bed days. Further regression analyses[4] show that the share of doctors is positively correlated with the number of bed days and the mean length of stay, but not associated with the number of inpatients. Then, the negative association between the share of doctors and efficiency, when considering the number of inpatients as an output, might be linked to longer inpatient stays decided by doctors compared to nurses. These longer inpatient stays might be associated with higher quality of care and fewer revisits.

Our study is not without limitations. Data have been collected at the SHC level and we could only gather complete and reliable data for SHCs of 5 out of 20 Mongolian rural regions. Then, our results regarding the determinants of SHCs' efficiency cannot be generalized to the entire country as the partial data (or lack of data) for the SHCs of other regions did not make it possible to integrate them into the analysis. Moreover, the analyses made in this study to highlight the factors that contribute to explain the differences in SHCs' efficiency were conditional on available data relevant for the purpose of this study. That is, there are several potential explanatory fields - which can be important from the point of view of the regulation of the health system - that could not be taken into consideration. This is the case of the role of financial incentives which are complementary to remunerations and whose effect on efficiency, positive or negative, is a priori indeterminate. Further studies should integrate such variables in order to provide more guidance to the Mongolian health authorities from a policy-oriented perspective. Despite these limitations, our study can provide useful information for policy makers and constitutes the first attempt to measure

[3] Available from the authors upon request.
[4] Idem.

health care facilities' efficiency and efficiency determinants in central Asian post-soviet health systems. Our results are likely to be of interest for other countries that transitioned from the Semashko health system after the fall of the Soviet Union but that are still heavily relying on inpatient and specialized care, especially those sharing geographic characteristics with Mongolia such as the low population density in rural areas.

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