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Public Hospital Care Efficiency in the State of Rio Grande do Sul

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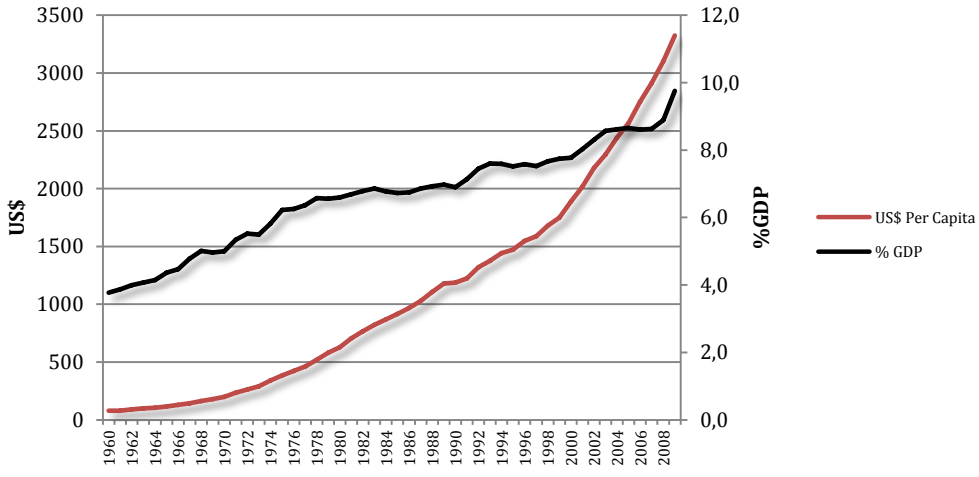
Introduction

The World Health Organization defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”.

Although there are several other variables that determine a healthy life, such as nutrition, environment, and socioeconomic conditions, health care dominates the economic and political landscape in countries over the world due to its importance in the economy. Actually, most of the nations have experienced rapid increases in health care spending’s over the past 50 years, which makes the attention to the subject quite predictable.

Figure 1 tracks the average share of GDP and the per capita expenditure in health among the OECD countries since 1960. It makes unmistakable that the health care sector is a large and fast growing portion of the global economy. Indeed, in average, these countries increased their share in GDP by 157% over the last five decades, achieving an amount of 9.8%.

Figure 1 - Average OECD Health Expenditures, 1960-2009



Source: OECD Health Data 2012, OECD

Medici (Piola & Vianna, 2002) explains this increase in expenditure by six main causes:

a. Access expansion: Derivate by governmental programs aiming to include more people in health systems and provide broader range of treatments;

b. Aging population: The decline of fertility and mortality rates in these countries promoted more expensive health care services. Studies found that health care for elderly populations could cost 90% more compared to other age groups;

c. Technology: Different from the other sectors, gains in technology applied to health care don't substitutes labour for capital. On the contrary, new diagnostics and improved service quality demands more skilled human resources, leading to enhanced costs;

d. Socioeconomic factors: The demand for health care became more inelastic, as a consequence of the increasing level of information available. In this context, as the income level grows, so does the demand;

e. Epidemiologic profile: the structure of diseases migrated from infectious, which demands preventive care, to chronic, which demands more complex and expensive treatments;

f. Growing role of insurance: Built to protect consumers and providers from risk and uncertainty, the insurance tends to increase the costs of medical care, as the US experience is showing with the malpractice protections.

The author poses that the combination of these factors with others, external to the health sector, promotes the medical prices to grow above the overall inflation.

United States is a notable example of it. With a market-oriented system, the country can be considered as an outlier when referred to health expenditures. In their article “Is the American health care uniquely inefficient?” Garber and Skinner (2008) pointed out, among others, the intensive use of high technology and high-cost care as a reason for United States extremely high spending compared to most of other developed countries, with equivalent (and sometimes worse) health indicators.

As a developing country, classified by the World Bank as in the middle upper income group, Brazil is still facing the challenge of expanding the access to health care and improving its quality to the lower income population. Since the implementation of the National Health Care System in 1988, the country has been increasingly improving the health services and reducing inequalities between regions.

The World Health Organization Statistics publication in 2013 shows the evolution of key indicators of health and health coverage in Brazil, for the last two decades:

Table 1 – Evolution Brazil`s Health Indicators

Health Indicator	1990	2011
Life Expectancy at Birth (years)	67	74
Infant Mortality Rate (per 1000)	49	14
Birth Attended by Skilled Personnel	-	99%
Antenatal (At least 4 visits)	-	90%

Source: World Health Organization Statistics 2013

In fact, if compared to other countries on the same range of per capita income, Brazil has better indicators, although it’s still far from high-income group averages:

Table 2 – Compared Health Indicators by Level of Income

	Life Expectancy at Birth	Infant Mortality Rate (per 1000)	Birth Attended by Skilled Personnel	Antenatal (At least 4 visits)
Brazil	74	14	99	90
Middle Low Income	66	46	60	53
Middle Upper Income	74	16	97	80
High Income	80	5	99	96

Source: World Health Organization Statistics 2013

Different from developed countries governments that are engaged in cost constraints measures, Brazil focus is to provide enough financing support to expand coverage and increase quality of health care. Indeed, the per capita income growth and the efforts to improve the system are reflected in the expenditure. Again comparing to its income group, the country spent significantly more both in terms of GDP share or per capita expenditure in 2010.

Table 3 – Compared Health Expenditure by Level of Income

	Total Expenditure in Health % GDP	Total Expenditure in Health Per Capita (PPP)	Government Expenditure Per Capita (PPP)
Brazil	9	1009	474
Middle Low Income	4.3	152	55
Middle Upper Income	6	598	332
High Income	12.4	4612	2850

Source: World Health Organization Statistics 2013

Mirroring the high-income countries experience and the development of their health care systems, there is a strong internal confidence in increasing investments as the main approach to improve

population health. The debate frequently addresses three universal health care systems as models: the French, UK and Canadian systems.

Table 4 shows the evolution of expenditure levels in these three countries for the last decade. It is added the average of South America and Chile`s (the only south American country in the high income group) expenditures to the table.

Table 4 – Compared Health Expenditure

	% GPD			US$ Per Capita (PPP)		
	2000	**2010**	**% Increase**	**2000**	**2010**	**% Increase**
Canada	8.8	11.4	19%	2519	4433	71%
UK	7	9.6	19%	1835	3433	88%
France	10.1	11.7	12%	2546	3997	56%
South America Average*	7.3	6.9	-3%	468	720	66%
Chile	7.7	7.4	-2%	735	1191	57%
Brazil	**7.2**	**9**	**25%**	**503**	**921**	**83%**

* Except European territories
Source: World Health Organization Statistics 2013

Data indicates that like these developed countries with universal access to health care, and unlike South American nations, the total health expenditure in Brazil is rising as a share of GDP. This tendency can be observed both in private (income effect) and government expenditure. On the other hand, it is also important to note the relevant gap to the selected references.

Medici (2011) places that universalism in developing countries must be constructed on scientific basis, in an incremental mode that doesn't harm stability and the development process, and respect the

nation`s culture. The level of expenditure in health by a country is a matter of choices, and each strategy suits specifically for its needs.

But even if it's perfect, the allocation strategy can't guarantee improvements in population health by itself. In order to reach people`s lives, it is vital to get the best value for the money invested buy having an efficient management of resources.

Marinho, Cardoso and Almeida (2012) employed the stochastic frontier method to assess the efficiency of the Brazilian health care system in comparison to OECD countries. Defining life expectancy at birth and infant survival rate as proxies for output and the per capita health expenditure as input, they concluded that Brazil`s health care system is efficient in relation to others of the sample, mainly because of the relatively low level of input.

According to the authors, the developed countries relative inefficiency would be reflecting the diminishing marginal benefits of increasing medical care. They suggested that the augment of investments would improve the effectiveness of the system in Brazil.

It's worthy to mention that there is an incremental cost closing to the end of life. So, given that life expectancy in developing countries is higher than in Brazil, the economic efficiency model should be adjusted.

When addressing the medical care efficiency the hospitals play a large role. With higher costs than preventive and primary care, the secondary and tertiary health care provided by hospitals has higher costs and therefore represents a vast share of the medical care expenditures. In Brazil, approximately 70% of health care disbursement is to hospital services.

Souza, Nishijima and Rocha (2007) modelled and evaluated the hospital sector of the State of São Paulo Municipalities defining the survival hospital rate as output. Applying the stochastic frontier method, the authors found high rates and great dispersion between inefficiency scores among these municipalities.

Marinho (2003) also found great dispersion in the State of Rio de Janeiro municipalities. The author employed the data envelopment analysis method to evaluate efficiency, defining per capita inpatients and outpatients treated as outputs and hospital infrastructure and financing indicators as proxies for inputs.

La Forgia and Couttolenc (2009) developed a qualitative analysis of the Brazilian hospital system. They pointed to the challenges of improving performance for public hospital care and suggested measures to overcome it. The authors cite the need for coordinated policies and actions to provide accountability, financial incentives and assessment of quality and efficiency of the services.

Indeed, the starting point to enhance efficiency is the assessment, from where the information for decision-making process is derived, helping both the worst and the best performers to make improvements. The information is also fundamental feedback for regulation authorities in order to adjust incentives and constraints of the system.

This paper intends to evaluate the efficiency of the hospital care sector of another state in Brazil, the State of Rio Grande do Sul. To do so, it addresses the hospitals as decision-making units and the relations between its outputs and inputs, deriving inefficiency scores by data envelopment analysis methodology application.

The data was collected from the site of Brazilian National Health System (DATASUS) and the finance system of the State (FPE), both for the year of 2012, available for the general public.

Health economics and financing

To take advantage of health care or hospital efficiency assessment it's important to understand the financial and managerial incentives and constraints of this industry. Study of the supply, demand and prices behaviour is an important pillar that supports a good policy-making process.

Many observers claim that economics is irrelevant to the study of health. The complaint suggests a model of health care in which health is considered to be primarily a technical issue of medical science, better left to experts. But with the increasing relevance of health care to the global economy, it's not surprising that health economics has become a specific discipline.

Arrow (1963) analysed the behaviour of medical care industry and concluded that the competitive model is an incomplete description of the reality. The uncertainty and risk involved in the sector forces non market relationships and promotes the creation of social institutions in which the usual assumptions of the market are contradicted.

Grossman (1972) defined health as a durable good, or a type of investment. In his model, a flow of services is produced from the stock of health, which is consumed continuously over a lifetime. Everyone is endowed with a certain stock of health at the beginning of a time period. The stock depreciates over time with age and may be augmented by medical care (investment). For the author, the production of health is a mathematical function of personal lifestyle, socioeconomic conditions, technology, environment and medical care.

The large role of non-profit organizations motivated the development of many utility maximization models to explain hospitals

and physicians behaviour. For Joseph Newhouse (1970) the non-profit hospitals manage to set a combination of quantity and quality that maximizes the preferences of the managers within a budget constraint. The hospital`s pursue for prestigious would lead to a socially inefficient production technologies or output qualities.

Mark Pauly and Michael Redisch (1973) proposed a model in which the non-profit hospital is a “physicians cooperative”, assuming the physicians control the hospitals operation. In the model, the hospital seeks to maximize the net revenue per physician.

Harris (1977) described hospitals as two separate firms interacting: the trustees administrator group that serves as suppliers of inputs and the physician staff that serves as demanders. One of the conclusions of his analysis is that regulation to limit hospital costs must establish incentives and constraints not only on administrators but also for physicians.

According to Folland, Goodman and Stano (2006) some distinctive features of economics analysis are identified in health sector. The scarcity of societal resources, the rational decision making by players, the benefits of marginal analysis and utility of models for prediction in some extent are among them.

Some key differences in health economics are somehow, even if it’s implicit, enclosed in all analysis in this sector. The main characteristics and its consequences in player’s behaviour must be well understood:

a. Uncertainty: The uncertainty about illness, the treatment or even if the medical prescription will produce the desired result turns costs very difficult to predict and creates great demand for insurance. As mentioned before, the uncertainty promotes

creation of non-profit institutions and increases government intervention.

b. Asymmetric knowledge: The consumer has few or no information about the quality or need for the service he is buying. The difficulties to know which hospital, physician or treatment best fits, leads the patient to the so called doctor-patient relationship, in which the supplier becomes the only one responsible to set the demand. This feature gives the physicians relatively great market power and makes regulation more complex.

c. Prevalence of non-profit: As a consequence of the uncertainty, the non-profit institutions tend to be oriented by political or humanitarian incentives, rather than cost-effectiveness.

d. Third part coverage: The large role of insurance, by governments, social institutions or private companies, and incomplete information, isolate the consumers from the prices and costs of care.

These four main characteristics and others make health care different, if not unique, and particularly complex to be set as an efficient system. Indeed, depending on the structure of the market and regulation rules, the combination of these aspects might result in explosive costs, both caused by demand (quantity) or prices. Without a good system of incentives and monitoring it's likely to have an arrangement within all players oriented to maximize quantity, quality and income of workers, and no cost-effectiveness incentives.

There`s another important market phenomenon related to the natural race for insurance in the sector called adverse selection. It means that demand for insurance is directly correlated to the individual risk, in other words, healthier people buy less than the sick, which

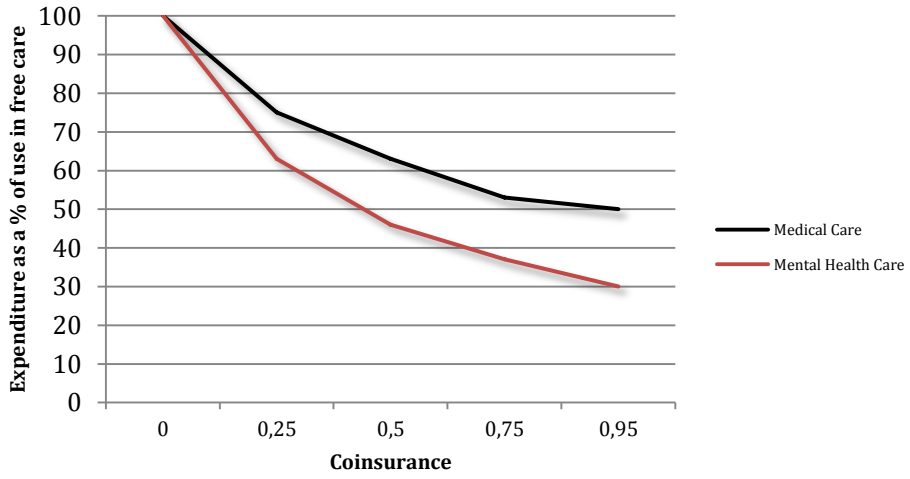
pushes up the costs. This is one of the reasons why any managed competition care system, in which the insurance are provided by the private sector, needs to compel young individuals to have insurance plan.

The challenge for policy makers of health care systems is to provide the right incentives to have an efficient system that constrains costs without impacts on the population health.

Although demand for health care can be considered as inelastic, empirical studies have shown evidences that it depends on variables as out-of-pocket prices, income, socioeconomic condition and state of health.

The RAND Health Insurance Experiment, 1974-1982, demonstrated that the level of coinsurance is a determinant variable to medical care demand. It was observed a variation of 50% in expenditure from individuals who received free services to the ones paying 95% of coinsurance.

Figure 2 - RAND Experiment 1974-1982



Source: Folland, Goodman and Stano (2006)

Some of the possible financial constraints on demand are:

a) Coinsurance: The individual pays a percentage of the costs of medical services. It aims to increase consumer's perception of costs and limit unnecessary treatments or high prices. An inadequate level could also inhibit necessary treatments, specially in low income populations;

b) Co-payment: The individual pays fixed values for services. It is often applied up until certain number of procedures or visits considered as excessive;

c) Indemnity: The consumer is insured with free medical care until certain limit of expenditure, from which the costs are out-of-pocket;

d) Deductible: The insured pays his medical care expenses up to a limit, from which the insurance takes over.

Insurers apply many financial methods in order to contain excessive demand. Most of them are different combinations of the cited above.

Gruber (2006) analysed the RAND experiment and other empirical evidences of the relation between out-of-pocket prices and the demand for health care. The author concluded that coinsurance rates with out-of-pocket limits could significantly reduce health care without sacrificing health. Exception made to risk group populations.

But financial methods cannot always be applied, especially in those countries where health care is a social right granted by the government. In these cases, managerial measures are taken to prevent the unnecessary treatments. The most effective is

gatekeeping, in which the individual must visit a referred general practioner that should prescribe only the needed care.

Social insurances frequently have low income or risk group's populations as targets, which lead to less financial and more managerial constraints for excess demand. It requests attention on monitoring measures and tends to create waiting lists, observed in many universal care systems around the world.

The main players on the supply side are the physicians, due to their strong relation to the patients they turn out to be the main responsible for setting the level of services. There are basically four different systems of physician payment:

a) Fee for service: Encourages productivity and eliminates payroll charges. It requests strong control systems and regulation based on prices. Evidences shows it tends to increase the quantity of services provided, especially the ones with more value-added.

b) DRG – Diagnostic Related Group: The payment is fixed according to the diagnostic code, so that a cost constraint is established. It tends to promote treatments with less quantity of procedures. As the fee for service system, it requests strong control and monitoring systems against frauds.

c) Salary: The physician is paid by the number of hours worked, which tends to eliminate incentives for price or quantity distortions, but increases incentives for corporatism.

d) Capitation: More effective and more applied on primary care. The physician is responsible for the health of the population in its area and receives a fixed payment for it. It tends to

increase the diagnosis exams and need discrimination of payment according to the local population profile.

Medici (Piola & Vianna, 2002) points to the three main tendencies on public health systems financing, in order to reconcile management autonomy, coverage, quality and cost containment:

a) Management contract: Other than have public establishments, the government contract services and negotiates goals with contractors (agents) which are autonomous and rewarded when having good performance. This is the main mode of hospital care financing in the State of Rio Grande do Sul and most of the states in Brazil.

b) Global budget: Public establishments are endowed with fix annual budget based on efficiency parameters. This is a solution applied by England to contain costs in the hospital care sector.

c) Managed competition: The government regulates the private sector to provide integral medical care, by establishing minimal standards for plans and prohibiting discriminations due to pre-existing conditions. Each individual has to apply for a plan and may have subsidy. The system is applied in Netherlands and it’s the purpose of the current health care reform in United States.

The DEA methodology

Data Envelopment Analysis (DEA) is one of the methods of performance measurement that supports the type of information we are seeking. It was initially developed as a method for assessing the comparative efficiencies of organizational units such as the branches of a bank, schools, hospital departments or restaurants.

It employs linear programing to compare the relation of outputs and inputs performed by decision-making units (DMU) and calculate relative scores of efficiency. The key feature that makes the units comparable is that they perform the same function in terms of the kinds of resource they use and the types of output they produce.

Initiated by Charnes and Rhodes in 1978 in their seminal paper Charnes et al. (1978), the use of DEA to assess performance have advanced at an explosive pace. La Forgia and Couttolenc (2009) extended the concepts to evaluate hospitals and define standards of technical efficiency to hospital management.

According to Guerra (2011) several works applied DEA to evaluate efficiency in hospitals. The author underlines Marinho and Façanha (2001), Marinho (2001a; 2001b; 2001c), Calvo (2002), Register and Brunning (1987), Grosskopf and Valdmanis (1987), Finkler and Wirtschafter (1993), Burgess Jr. and Wilson (1996), Ersoy et al. (1997), Dalmau-Matarrodona and Puig-Junoy (1998), Tambour and Zethraeus (1998), Webster, Kennedy and Johson (1998), McKillop et al. (1999), Valdmanis (1992), Ozcan, Luke and Haksever (1992) and Ozcan and Luke (1993).

For the purpose of this work, the main advantages of the model compared to others are: i) it permits the analysis of multiple inputs and

outputs, fundamental issue for hospital analysis; ii) indicates differences in the allocation of resources between efficient and inefficient units; iii) don't need a specific production function to relate outputs and inputs.

Among the limitations it's worthy to mention: i) it measures the relative efficiency, not the absolute number; ii) the results are specific for the selected sample, and therefore subjected to data collection problems.

There are other two key concerns on this evaluation, in order to have reliable results: the choice of the DMU`s, in a way that the assumption that they perform the same outputs using the same kind of resources holds; and the selection of variables as proxies to inputs and outputs, so that the scores are truly a measure of technical efficiency. These issues are addressed in the next section.

A variety types of DEA models were developed, differing on the way it treats returns of scale, orientation to inputs or outputs and relation between efficiency and input excesses and output shortfalls.

The analysis of inputs and outputs of the selected hospitals led us to choose the CCR – I model, considering constant returns of scale and treating the slacks separately. The model orientation is to minimize inputs keeping outputs at least the same level, since that the demand for services is given to the decision making units.

According to Cooper, Seiford and Tone (2000), the computational scheme for solving linear programs for the CCR-I model for each DMU is the following:

(DLP_0)

Phase I objective min θ

Phase II objective $\min -eS^- - eS^+$

Subject to $\theta x_0 = X\lambda + S^-$

$y_0 = Y\lambda - S^+$

$\theta, \lambda, S^-, S^+ \geq 0$

Where:

(DLP_0) = Dual Linear Programing for DMU zero;

θ = objective value (ratio efficiency score);

S^- = Input Slack

S^+ = Output Slack

e = vector of ones

x_0, y_0 = input and output vector zero

X, Y = matrices of inputs and outputs

λ = semipositive vector

The software utilized to develop calculations is the OSDEA-GUI, an open source available on Internet for free download.

Rio Grande do Sul Hospital Care Evaluation

The public hospital care in Rio Grande do Sul is provided mostly by non-profit institutions, contracted by the state or local governments within federal rules. There are 257 non-profit and 38 public institutions providing public hospital care.

Among the 257 non-profit hospitals, 224 are contracted by the State level, which gives the state government great responsibility on regulation for quality and efficiency of services.

The contracts respect standard frameworks stated by the National Health Department and its terms should be renewed once a year, when annual supply of services and desired health indicators goals are revised. The payments are made according to services provided and goals achievements.

The supply is limited by a global financial ceiling and the payments follow a mix of fee-for-service and service-related case rates (which has similarities to DRG), with prices set by the Federal Government and health commissions. Each contract has a set of quality target indicators associated to a percentage of the payment, which should be monitored by commissions with state, hospital and local community representatives.

The system gives to the hospitals autonomy to arrange its means and accomplish the established objectives, in contrast to the rigid rules that the State is submitted when providing the services directly. In other hand, minimal standards of coverage and quality are established and the cost is limited, encouraging improvements in efficiency.

It means that most of the hospital care system is aligned to one of the world main tendencies in public health financing: the management

contract. The design of the system covers aspects of autonomy, coverage, quality standards and cost containment.

As any price ceiling, it's expected that the global financial ceiling and the services prices setting cause shortages, which are somehow observed in universal health care systems around the world. The extent of ceiling and the counterbalancing coverage incentives established in contracts must be well designed and monitored in order to minimize the problem. Financial constraint measures in demand side aren't legal in Brazil.

The State of Rio Grande do Sul still haven't implemented the system as it's designed to work. Two main factors harmed the establishment of the complete set of incentives and constraints for a good and efficient hospital care:

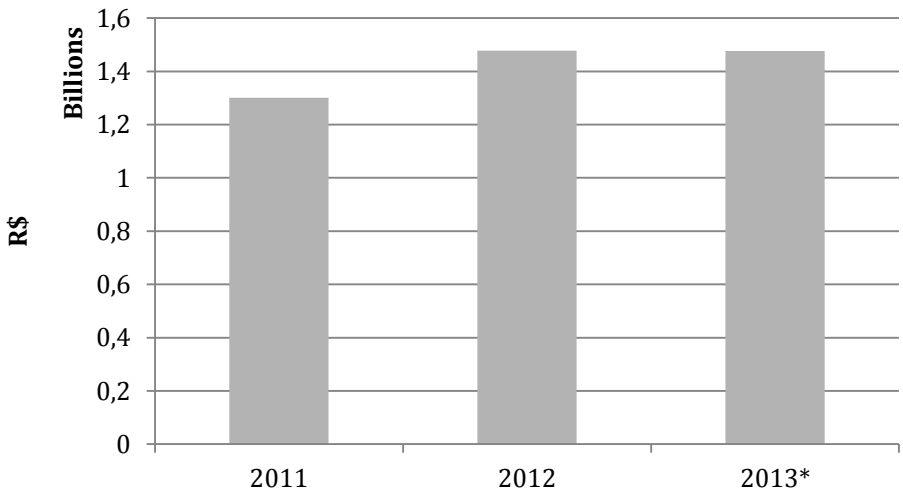
a) Instability in financing rules and amount levels: Budget restrictions prevented the State to set adequate levels of global financing and fair prices for several kinds of services. It promoted the creation of financial incentives over time and compensations to hospitals losses externals to the meritocratic logic;

b) Lack of opportune information to control the contracts performance: Set supply, monitor services provided and quality goals and pay monthly more than 200 hospitals according to its performance requires a whole set of information that was not available on time. Until 2012, the contracts were paid by the global value, disregarding the hospitals achievements.

The financial issue is being addressed by the Sate. In fact, the expenditure on hospital care is already the largest among the operational expenditures in the State budget, reaching R$ 1,4 Billions in 2012 (approximately US$ 640 millions). Federal transfers are also

included, since the state government has the responsibility to manage these resources.

Figure 3- Hospital Payments by the State



* Until October
Source: FPE

Objectively evaluate efficiency may be a difficult task. Even when addressing the theme strictly in terms of the relation between inputs and outputs, disregarding quality standards, the results should always be examined carefully. Wrong assumptions in the selection of the variables and clusters can easily lead to precipitate conclusions, reason why the limitations of the analysis must be completely clear.

One sensitive assumption of any efficiency-evaluating model is the selection of inputs and outputs. For this study, we considered as outputs the number of individuals treated, represented by the indicators **inpatients-day and outpatients-day**. The information is obtained by dividing the total inpatient's permanency and outpatient's visits by 365 days.

The selection of these indicators as outputs leads to a pure productivity evaluation. It's important to clarify that the most efficient

hospitals in the model could have, for example, high rates of hospital mortality, since we didn't include this variable as output.

On the other hand, the simplification isolates factors that are not in the hospital decision range and makes the results more reliable. As mentioned before, effectiveness indicators like mortality and life expectancy depend mainly on variables that are external to the hospital care.

As inputs, we should select variables representing all the factors of production. We assumed that **number of beds and payment received** are the capital factors, and **hours-work of physicians** is the labour factor. Consistent data for hours-work of non-physician weren't available.

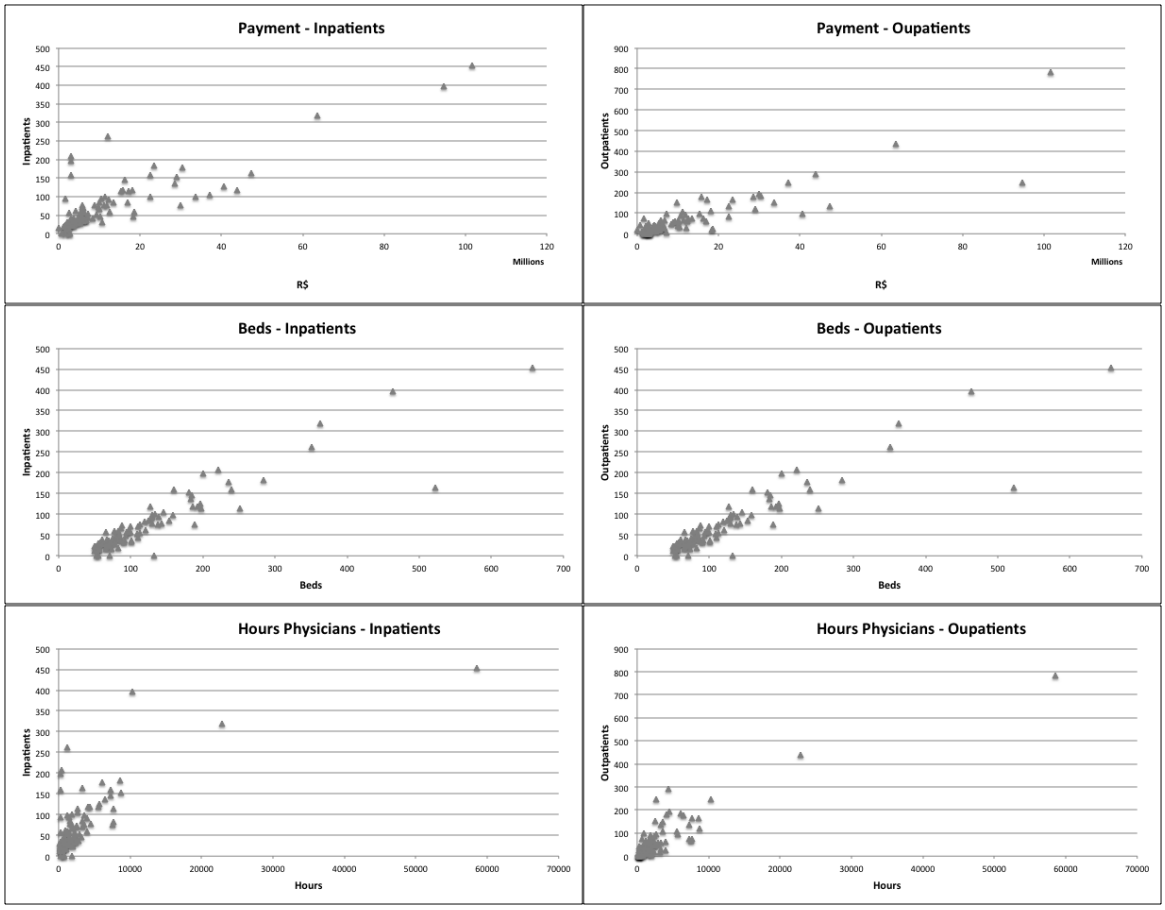
All collected data is referred to the entire fiscal year of 2012, in order to have current data and eliminate seasonal effects.

The 100 largest hospitals represent 54% of the State total hospital expenditure, approximately R$ 700 millions in 2012. If the payments made by local governments are included, this amount increases to more than R$ 1 billion.

In average, these hospitals received R$ 11 millions in the period, applied 2770 hours-work of physicians per month (approximately 16 full time doctors) and 118 beds to attend 70 inpatients and 63 outpatients per day.

But the average is not an accurate representation of the hospitals behaviour, mainly because of the dispersion.

Figure 4 – Outputs-Inputs Relations: 100 largest hospitals



Source: DATASUS and FPE

Figure 4 shows the scatter diagram of all single output-input relations. A tendency line is clearly observed when relating outputs to beds and payments, but the same can't be inferred for the hours-work of physician. The dispersion between hospitals outputs-inputs relations suggests that there might be inefficiencies.

Here we must address the second sensitive assumption in order to compare efficiencies: the hospitals compared must apply the same inputs to produce the same outputs. That assumption can't be made with the database of the 100 largest hospitals.

Among these establishments, there are hospitals providing several different levels of treatments complexity, different case mixes that certainly affect their outputs-inputs relationships. Situations where the analyses can reach a perfect solution for this problem are rare, and this restriction must be taken in consideration when results are explored.

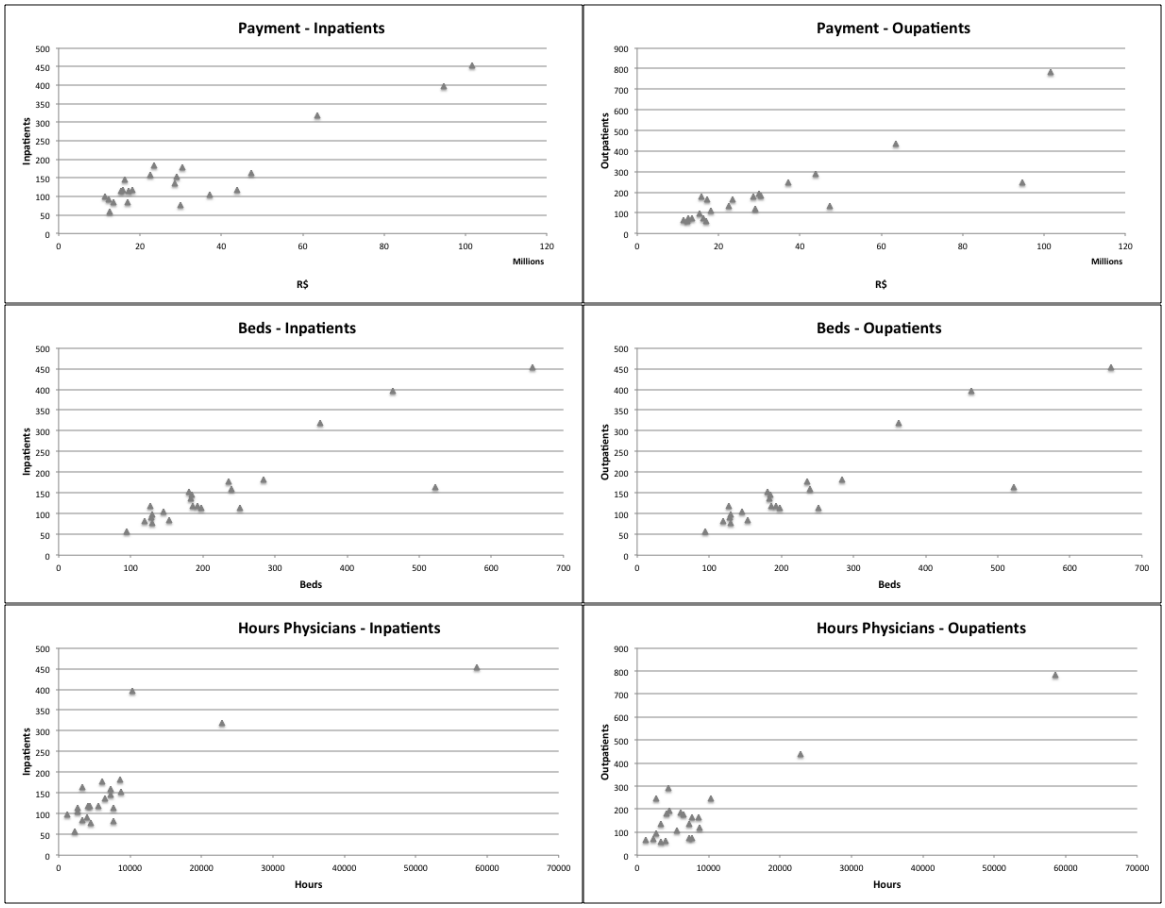
In order to mitigate the heterogeneity, we selected a cluster of hospitals with more comparable outputs. Although still not perfect, the clusterization permits to reach reasonably results. For the cluster, we selected among the largest general hospitals in terms of government annual expenditure, the ones providing both medium and several number of different high complexity treatments, with intensive care units available.

We reached a cluster of 22 general hospitals that received more than R$ 700 millions in 2012 considering local and State government payments. The share of the State is R$ 330 millions, 22% of the state hospital care expenditure. From this point we assumed the sample is homogeneous in terms of inputs and outputs, differing only by scale and efficiency.

Figure 5 repeats the scatter diagram to the selected hospitals. The shape doesn't differ much from the Figure 4, although the sample can be considered more standardized. By the analysis of this graph the returns to scale is assumed to be constant.

Applying the multiple input-output DEA model, the relative efficiency scores can be compared and gains possibilities can be identified.

Figure 5– Outputs-Inputs Relations: Selected Hospitals



Source: DATASUS

Results

Model Details:

Model Type	CCR_I
Model Orientation	INPUT_ORIENTED
Model Efficiency Type	TECH
Model RTS	Constant Returns of Scale
Model Description	The Charnes Cooper and Rhodes Model called CCR

Variables

Name	**Orientation**	**Type**
BEDs (SUS)	INPUT	STANDARD
HH Docs	INPUT	STANDARD
Payments	INPUT	STANDARD
Outpatients	OUTPUT	STANDARD
Inpatients	OUTPUT	STANDARD

Cluster criteria:

General hospital;
Medium complexity services provided;
High complexity services provided (high complexity cardiology, nephrology or neurology);
More than 10 types of accreditations;
Surgeries provided;
Intensive care units provided;
Top 50 in government payments.

Software:

OSDEA-GUI, available for free download at http://www.opensourcedea.org.

Table 5 - Row Data

DMU Name	Beds	Hours Physicians	Payment (R$)	Inpatient	Outpatient
IRMANDADE SANTA CASA POA	657	58507	101,607,510	454	785
ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	522	3316	47,359,104	164	136
ASSOCIACAO HOSPITALAR BENEFICENTE SAO VICENTE DE PAULO	464	10305	94,585,709	397	246
UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	362	22860	63,589,662	319	438
HOSPITAL UNIVERSITARIO AESC (ULBRA)	284	8578	23,498,154	184	164
SANTA CASA DE CARIDADE DE URUGUAIANA	252	2637	15,223,074	114	96
SANTA CASA DE MISERICÓRDIA DE PELOTAS	240	7339	22,437,566	159	136
FUCS - HOSP GERAL DE CAXIAS DO SUL	236	6071	30,368,196	179	184
ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	198	7675	17,212,523	114	164
SOCIEDADE DR BARTHOLOMEU TACCHINI	193	5548	18,151,715	118	109
ASSOCIACAO HOSPITAL DE CARIDADE IJUI	186	4415	43,791,698	118	290
SPAC UCPEL HOSPITAL UNIVERSITÁRIO HOSP UNIVERS MEC MPAS	185	7318	16,219,048	147	73
HOSPITAL DA CIDADE DE PASSO FUNDO	183	6529	28,553,353	136	178
PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	181	8716	28,966,653	152	120
ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	153	3257	16,895,591	84	59
FUNDACAO HOSPITALAR SANTA TEREZINHA DE ERECHIM	145	2605	37,242,709	105	248
SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	130	4523	29,887,376	78	194
ASSOCIACAO DAS DAMAS DE CARIDADE	130	1254	11,507,433	99	66
HOSPITAL DE CARIDADE E BENEFICÊNCIA	129	4006	12,321,189	92	62
SOCIEDADE EDUCAÇÃO E CARIDADE HOSPITAL DOM JOÃO BECKER	127	4150	15,843,682	118	181
HOSPITAL SANTA CRUZ	119	7706	13,584,745	84	74
SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	94	2200	12,490,129	58	72
TOTAL	**5170**	**189515**	**701,336,819**	**3473**	**4075**

Source: DATASUS, FPE

Table 6 - Objective Value – Ratio Efficiency

DMU		Objective Value
1	IRMANDADE SANTA CASA POA	0.80
2	ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	0.68
3	ASSOCIACAO HOSPITALAR BENEFICENTE SAO VICENTE DE PAULO	1.00
4	UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	0.95
5	HOSPITAL UNIVERSITARIO AESC (ULBRA)	0.94
6	SANTA CASA DE CARIDADE DE URUGUAIANA	0.90
7	SANTA CASA DE MISERICÓRDIA DE PELOTAS	0.84
8	FUCS - HOSP GERAL DE CAXIAS DO SUL	0.86
9	ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	0.87
10	SOCIEDADE DR BARTHOLOMEU TACCHINI	0.78
11	ASSOCIACAO HOSPITAL DE CARIDADE IJUI	0.94
12	SPAC UCPEL HOSPITAL UNIVERSITÁRIO HOSP UNIVERS MEC MPAS	1.00
13	HOSPITAL DA CIDADE DE PASSO FUNDO	0.80
14	PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	0.90
15	ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	0.65
16	FUNDACAO HOSPITALAR SANTA TEREZINHA DE ERECHIM	1.00
17	SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	0.90
18	ASSOCIACAO DAS DAMAS DE CARIDADE	1.00
19	HOSPITAL DE CARIDADE E BENEFICÊNCIA	0.88
20	SOCIEDADE EDUCAÇÃO E CARIDADE HOSPITAL DOM JOÃO BECKER	1.00
21	HOSPITAL SANTA CRUZ	0.79
22	SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	0.72

Figure 6 - Ratio Efficiency Scores

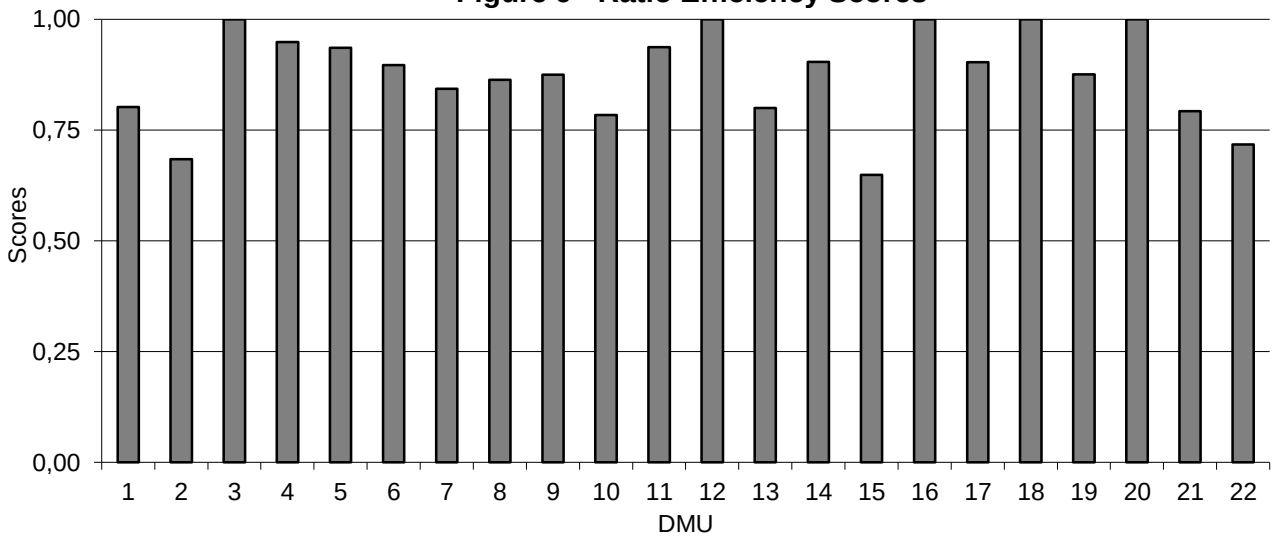


Table 7 - Overall Efficiency: Ratio Efficiency + Slacks Analysis

DMU Name	Location	Nature	Objective Value	Slack Beds	Slack Hours Physicians	Slack Payments (R$)
IRMANDADE SANTA CASA POA	PORTO ALEGRE	Non-Profit	0.80	0	31461	0
ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	RIO GRANDE	Non-Profit	0.68	141	0	9,582,684
ASSOCIACAO HOSPITALAR BENEFICENTE SAO VICENTE DE PAULO	PASSO FUNDO	Non-Profit	1.00	0	0	0
UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	PORTO ALEGRE	Non-Profit	0.95	0	10462	17,478,492
HOSPITAL UNIVERSITARIO AESC (ULBRA)	CANOAS	Non-Profit	0.94	47	0	0
SANTA CASA DE CARIDADE DE URUGUAIANA	URUGUAIANA	Non-Profit	0.90	83	0	0
SANTA CASA DE MISERICÓRDIA DE PELOTAS	PELOTAS	Non-Profit	0.84	10	0	0
FUCS - HOSP GERAL DE CAXIAS DO SUL	CAXIAS DO SUL	Non-Profit	0.86	0	0	0
ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	CANOAS	Non-Profit	0.87	49	2551	0
SOCIEDADE DR BARTHOLOMEU TACCHINI	BENTO GONCALVES	Non-Profit	0.78	10	0	0
ASSOCIACAO HOSPITAL DE CARIDADE IJUI	IJUI	Non-Profit	0.94	0	590	0
SPAC UCPEL HOSPITAL UNIVERSITÁRIO HOSP UNIVERS MEC MPAS	PELOTAS	Non-Profit	1.00	0	0	0
HOSPITAL DA CIDADE DE PASSO FUNDO	PASSO FUNDO	Non-Profit	0.80	0	439	4,577,936
PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	CAXIAS DO SUL	Non-Profit	0.90	0	2532	5,772,118
ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	SANTO ANGELO	Non-Profit	0.65	0	0	0
FUNDACAO HOSPITALAR SANTA TEREZINHA DE ERECHIM	ERECHIM	Public	1.00	0	0	0
SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	LAJEADO	Non-Profit	0.90	0	1623	0
ASSOCIACAO DAS DAMAS DE CARIDADE	CRUZ ALTA	Non-Profit	1.00	0	0	0
HOSPITAL DE CARIDADE E BENEFICÊNCIA	CACHOEIRA DO SUL	Non-Profit	0.88	0	0	0
SOCIEDADE EDUCAÇÃO E CARIDADE HOSPITAL DOM JOÃO BECKER	GRAVATAI	Non-Profit	1.00	0	0	0
HOSPITAL SANTA CRUZ	SANTA CRUZ DO SUL	Non-Profit	0.79	0	2840	0
SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	SANTA ROSA	Non-Profit	0.72	0	0	1,384,975

Table 8 – Projections

DMU Name	Beds	Hours Physicians	Payment (R$)
IRMANDADE SANTA CASA POA	527	15464	81,492,733
ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	216	2268	22,813,808
ASSOCIACAO HOSPITALAR BENEFICENTE SAO VICENTE DE PAULO	464	10305	94,585,709
UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	343	11219	42,831,649
HOSPITAL UNIVERSITARIO AESC (ULBRA)	219	8025	21,983,544
SANTA CASA DE CARIDADE DE URUGUAIANA	143	2363	13,644,004
SANTA CASA DE MISERICÓRDIA DE PELOTAS	192	6186	18,911,999
FUCS - HOSP GERAL DE CAXIAS DO SUL	204	5239	26,205,654
ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	125	4162	15,055,921
SOCIEDADE DR BARTHOLOMEU TACCHINI	142	4349	14,228,810
ASSOCIACAO HOSPITAL DE CARIDADE IJUI	174	3546	41,028,784
SPAC UCPEL HOSPITAL UNIVERSITÁRIO HOSP UNIVERS MEC MPAS	185	7318	16,219,048
HOSPITAL DA CIDADE DE PASSO FUNDO	146	4783	18,260,515
PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	164	5346	20,408,811
ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	99	2113	10,959,992
FUNDACAO HOSPITALAR SANTA TEREZINHA DE ERECHIM	145	2605	37,242,709
SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	117	2462	26,995,302
ASSOCIACAO DAS DAMAS DE CARIDADE	130	1254	11,507,433
HOSPITAL DE CARIDADE E BENEFICÊNCIA	113	3508	10,788,608
SOCIEDADE EDUCAÇÃO E CARIDADE HOSPITAL DOM JOÃO BECKER	127	4150	15,843,682
HOSPITAL SANTA CRUZ	94	3267	10,766,056
SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	67	1578	7,573,271
TOTAL	**4138**	**111510**	**579,348,040**
POTENTIAL GAIN: %(ROW DATA – PROJECTION)	**-20%**	**-41%**	**-17%**

Table 9 – Potential Gains

DMU Name	% Beds	% HP	% R$
IRMANDADE SANTA CASA POA	20%	74%	20%
ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	59%	32%	52%
UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	5%	51%	33%
HOSPITAL UNIVERSITARIO AESC (ULBRA)	23%	6%	6%
SANTA CASA DE CARIDADE DE URUGUAIANA	43%	10%	10%
SANTA CASA DE MISERICÓRDIA DE PELOTAS	20%	16%	16%
FUCS - HOSP GERAL DE CAXIAS DO SUL	14%	14%	14%
ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	37%	46%	13%
SOCIEDADE DR BARTHOLOMEU TACCHINI	27%	22%	22%
ASSOCIACAO HOSPITAL DE CARIDADE IJUI	6%	20%	6%
HOSPITAL DA CIDADE DE PASSO FUNDO	20%	27%	36%
PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	10%	39%	30%
ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	35%	35%	35%
SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	10%	46%	10%
HOSPITAL DE CARIDADE E BENEFICÊNCIA	12%	12%	12%
HOSPITAL SANTA CRUZ	21%	58%	21%
SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	28%	28%	39%

Table 10 – Objective Value vs Institutional Mortality

DMU Name	Objective Value	Institutional Mortality
IRMANDADE SANTA CASA POA	0.80	0.9%
ASSOCIACAO DE CARIDADE SANTA CASA DO RIO GRANDE	0.68	0.7%
ASSOCIACAO HOSPITALAR BENEFICENTE SAO VICENTE DE PAULO	1.00	0.0%
UNIAO BRASILEIRA EDUCAÇÃO E ASSISTÊNCIA HOSP SÃO LUCAS PUC	0.95	4.7%
HOSPITAL UNIVERSITARIO AESC (ULBRA)	0.94	2.2%
SANTA CASA DE CARIDADE DE URUGUAIANA	0.90	3.1%
SANTA CASA DE MISERICÓRDIA DE PELOTAS	0.84	3.7%
FUCS - HOSP GERAL DE CAXIAS DO SUL	0.86	0.5%
ASSOCIAÇÃO BENEFICENTE CANOAS HOSPITAL N SRA DAS GRAÇAS	0.87	1.3%
SOCIEDADE DR BARTHOLOMEU TACCHINI	0.78	0.9%
ASSOCIACAO HOSPITAL DE CARIDADE IJUI	0.94	3.4%
SPAC UCPEL HOSPITAL UNIVERSITÁRIO HOSP UNIVERS MEC MPAS	1.00	4.2%
HOSPITAL DA CIDADE DE PASSO FUNDO	0.80	1.0%
PIO SODAL DAMAS CARIDADE MANTENEDORA HOSP N S DE POMPÉIA	0.90	0.5%
ASSOCIACAO HOSPITAL DE CARIDADE DE SANTO ANGELO	0.65	6.4%
FUNDACAO HOSPITALAR SANTA TEREZINHA DE ERECHIM	1.00	1.3%
SOCIEDADE BENEFICENCIA E CARIDADE DE LAJEADO	0.90	0.0%
ASSOCIACAO DAS DAMAS DE CARIDADE	1.00	0.0%
HOSPITAL DE CARIDADE E BENEFICÊNCIA	0.88	0.0%
SOCIEDADE EDUCAÇÃO E CARIDADE HOSPITAL DOM JOÃO BECKER	1.00	3.1%
HOSPITAL SANTA CRUZ	0.79	2.0%
SOCIEDADE HOSPITAL DE CARIDADE SANTA ROSA - VIDA E SAÚDE	0.72	3.3%

Source: DATASUS

Data Analysis

The ratio efficiency scores indicates the potential reductions in all inputs, at the same proportion, in a way that the outputs of DMU`s are at least maintained at the same level. As mentioned before, the grade isn't an absolute value, but a comparison of behaviours of all DMU`s in the sample.

The results showed in Table 6 point to relatively homogeneous and high efficiency scores among the hospitals, with 16 DMUs presenting scores equal or above 0,8 and only 2 below 0,7. The low dispersion among scores suggests that the resources are being well applied.

Correlations between efficiency and scale, geographical region or nature of establishments were not observed, although it is recommended experiments with higher number of DMUs to definitive conclusions about it.

The slacks in inputs mean how much it can be reduced after the ratio score is applied. It represents the excess of a particular input for a given DMU, indicating the weakness to be overcome in order to achieve the efficient level.

Applying the ratio efficiency scores to all inputs and then subtracting the slacks projects the DMUs to the efficiency frontier. Due to model limitations, this is an ideal state that can't be achieved in the real world. But even if the exact values for these potential gains are not completely known, the relative order of magnitudes are good hints to find potential gains.

The projections showed in table 8 indicate potential gains in all three inputs, with considerably more space for reduction of hour-work of physicians. The table indicates that in a perfect situation, where all

DMUs perform with the exactly same efficiency, would be possible to reduce 41% of physician labour (approximately 440 full time doctors) and treat the same number of individuals.

Table 9 points to the potential percentage gains for each input of DMUs and highlights the ones above 30%. It means that these resources aren't applied efficiently according to the benchmarks. Investigation of the causes of these distortions is recommended.

It is also desirable to find out if there's correlation between the efficiency scores and quality. Since the model don't internalize this dimension, it could be possible to have most of the efficient hospitals concerned only about maximize quantity of individuals treated and neglecting the excellence of the services. That could be an unfair advantage.

Table 10 shows the percentage of institutional mortality (mortality after 48 hours in the hospital) for each DMU. Although the absolute quality can't be objectively assessed, this ratio is frequently used as proxy for it. If the assumption holds, the lack of correlation means that there`s no losses in quality as the efficiency increases.

Final Considerations

The study explored the great magnitude of health care in the global economy. The fast growing expenditure is a concern for most of developed countries, in which basic health standards are already achieved, and cost constraints measures are in the centre of the agenda.

It was demonstrated that Brazil is following the trail left in the past by the developed world and increasing its expenditure. The expansion is due to an income effect and increasing public financing, aiming to expand access and quality of its health care system. The rise of the public expenditure in health is viewed as one of the main strategies to improve population`s health conditions.

The expansion of health care systems must be gradual and in a scientific mode, in order to protect the development process. The income effect and the associated variables can be more determinant of health conditions than medical care, especially in low income levels.

An important remark is also made about the financing expanding strategy, which is the central issue of this work: losses in efficiency are expected when increasing resources, but measures are needed in order to minimize it. Could Brazil take a shortcut in the developed world path and improve its system effectiveness in an efficient way?

To do so, there are important aspects of health economics to be considered. The characteristics of the sector can easily lead to explosive costs, and need to be perfectly understood and well addressed by the regulation system. The complexity is even higher when the system is universal, granted by the government, since there are restrictions for financial demand constraints.

The largest players on medical care expenditure are the hospitals. Utility maximization models suggest non-profit hospitals tend to be more oriented to increase perception of quality and quantity of services instead of cost constraints. It becomes especially important to policy makers if considered that 70% of health care expenditure in Brazil is due to hospital services.

On the State of Rio Grande do Sul, the hospital care expenditure represents a large share of the total operational government expenditure and follow an increasing tendency. There are about 300 hospitals providing public services, most of them non-profit institutions contracted by the state.

The hospital care system design follows one of the world main tendencies to conceal coverage, autonomy, quality and cost constraints. But the incomplete implementation harms the establishment of the set of incentives and constraints for a good and efficient hospital care system.

We applied the DEA method to compare the efficiency of 22 hospitals, which received more than R$ 700 millions by local and State government. The model considered beds, hours of physician labour and payments received as inputs, and inpatients-day and outpatients as outputs.

The results shown relatively low dispersion and good levels between ratio efficiency scores, which led to the conclusion that most of these hospitals are quite efficient. It is pointed though several potential gains in efficiency, especially in hours-work of physicians utilization.

Even with limitations of the model taken in consideration, it’s fairly correct to say that the strategy of increasing financing tend to be turned into access expansion by a reasonable proportion.

In other hand, the system tends to lose efficiency as the financing grows. As a consequence, the complete implementation of the designed incentives and constraints becomes more vital, in order to prevent waste of the scarce resources and make difference in people's lives.

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