Technical Efficiency in the Production of Aggregate Regional Health Outcomes in Italy

Claudio Pinto, Ph.D. in Economics of Public Sector, University of Salerno

Abstract—**The World Health Organization report 2000 consider improving health the main objective of the health systems. The report introduce a framework for assessing health system performance, and assert that the different degrees of efficiency with which health systems organize and finance themselves, and react to the needs of their populations, explain much of the widening gap in death rates between the rich and poor, in countries and between countries, around the world. In Italy the responsibility of manage, organize and finance health care system, is of the Regions. The different degree of efficiency between Italian health regional system, in the achieving the objective of the maintenance of the health status of their population, is therefore, for us, important as much as at country level. Here, we use data envelopment analysis to measure relative technical efficiency between health care regional system in Italy. Assuming different technology specification, we found a substantial high level of technical efficiency in the production of aggregate health outcomes for it. An average the 0.98160 is the degree of technical efficiency in constant return of scale, and 0.98869 is in the variable return to scale technology. The bias correct efficiency score, on average, are 0.9581 and 0.9739 respectively. The efficiency to scale is in mean 0.9929.**

***Index Terms*—health, public healthcare, optimized production technology.**

I. Introduction

THIS paper deal with measurement of public sector performance. The debate on the economic performance in public sector is very crucial when public sector offer fundamental service such as health, transportation, instruction, justice among others. The measurement of economic performance in the public sector is also an important issue for researcher and policy maker [20]. The magnitude of public or private provision has a direct impact on the wellbeing and is vital for the economic development and growth. In this paper measurement of performance issue is considered as the relative economic efficiency for publicly financed regional health care systems in Italy. Many studies have treated the topics [1,8,9,14,15], while other studies has outline the limits of the use of the non-parametric estimates frontier for the measurement of performance and relative limits in the policy indication [17,18]. In Italy most of the Regions deal with the problem of the reduction of health expenditure without reduce the supply of the minimum level of the health services (*Livelli Essenziali di Assistenza-LEA*). The efficient use of the resources is a key point to pursuit this objective. Applying data envelopment analysis (DEA) to 20 Italian healthcare regional systems, we deal with how much efficiently regional health care system use their resources in the production of the aggregate health outcomes. The paper is structured as follow: a brief literature is showed to review similar papers; the characteristic of provision of care and financing of health system is stated in section II, while data envelopment analysis is showed in section III. Results and conclusions are in section IV and V respectively.

A Brief Literature Review

Previous researches have been interested, in a lot of cases, at cross-country comparison of efficiency for health outcomes production.

Retzlaff et al [15] analyzes technical efficiency, using data envelopment analysis, in the production of aggregate health outcomes using Organization for Economic Co-operation and Development (OECD) health data. They compare 27 of the 29 OECD countries. The outputs of their model are infant mortality and life expectancy at birth, input variables are selected referring models of the determinants of health: (1) the social environment and population characteristics of a country; (2) the lifestyles, attitudes, and behaviors of the population; and (3) available medical care services and health expenditures. Social

Acceptance for review 18 February 2013
Claudio Pinto, is Ph.D. at University of Salerno, via Ponte Don Melillo, 84084, Fisciano (SA), Italy (email:clpinto@unisa.it)

environment variables of a country can change over time, they are beyond the short-term discretionary control of policy makers, and therefore, may not appear to be inputs of health production. However, these exogenously fixed variables are important to include in the analysis because they affect health outcomes. Lifestyle factors include dietary choices, exercise, and physical activity. In addition to the social environment, they model access to medical care and physician services, as well as the share of GDP allocated to health care, as inputs to the production of health. The authors use practicing physicians per 1000 population and inpatient beds per 1000 population as medical inputs that represent access to health care in their model. They also include Magnetic Resonance Imager (MRI) units per one million population as a medical input to acknowledge the growth and importance of healthcare technology. In their work they estimates two DEA model, as input and output orientation. Both models were run individually for each of the two outputs and for both input and output orientations. In the discussion they affirm that the results have at least two important policy implications. The first is which path to the frontier offers greater potential improvement for technically inefficient countries, via either input reduction or output enhancement. The second is which output provides the greater improvement potential for a given country. For output improvement they show that the technically inefficient OECD countries on average can reduce infant mortality by 14.5% without using more resources, but they can increase life expectancy only slightly, by 2.1%, without increasing resource use. Therefore, efforts to reduce infant mortality appear to have more potential as a public health goal for the inefficient OECD countries as a whole than attempts to expand life expectancy. For input reduction their results suggest that the technically inefficient OECD countries on average can reduce inputs by 14.0% without raising the level of infant mortality. Alternatively they can reduce inputs by 21.0% without reducing life expectancy. On average, there is more inefficiency in input use in regard to life expectancy than infant mortality. Thus, for technically inefficient countries, additional resources will have greater impact if directed toward reducing infant mortality than to increasing life expectancy.

Afonso and Aubyn [1] estimates efficiency in the health and education sectors for a sample OECD country implementing DEA and Free Disposal Hull (FDH). They pose attention on measure of quantity input in health care sector such as doctors, nurses, hospitals beds, and use health results such as infant survival rates such outputs and life expectancy of DEA model. Efficiency results in health, in the FDH technology, show eleven of 24 country are efficient. These are Canada, Denmark, France, Japan, Korea, Norway, Portugal, Spain, Sweden and United Kingdom and Unites States. Denmark, Japan, Norway, Portugal, and Unites States are efficient by default, as they do not dominate any other country. Whereas remaining efficient country dominate other producer.

Puig-Junoy [14] using input DEA model estimate technical efficiency for OECD countries, decomposing technical efficiency in pure technical efficiency and scale efficiency. The output variables choice are variation of female and male life expectancy, whereas physicians, non-physicians personnel per 1000 inhabitant, number of beds per inhabitant are choice as input variables, together at tobacco and alcohol consumption per capita are life style proxies. As non-discretionary variables they choice proportion of individual under 65, as proxy for age. Additional weigh constraints DEA model is considered. The variables under weigh constraints are physicians, non-physicians personnel, and the output variables. Results from constrained DEA model show an average overall technical efficiency of 0.594 in the 1960s, 0.678 in the 1970s and 0.720 in the 1980s. Pure technical efficiency score show a lower level of relative efficiency. In constrained DEA model in the decade considered six out 21 countries are operating on the frontier (Austria, Greece, Italy, Japan, Portugal and United Kingdom). The inefficient countries use about 39% more inputs per units of health stocks than efficient countries. In the second stage the variables used are human capital, private financing, gatekeepers. The second stage results suggest that human capital is significantly and negatively related to efficiency, overall and pure. Technical efficiency in health production decreases with an increase in the proportion of health expenditure financed privately. An important part of the variation of the health production efficiency remained unexplained, this suggest that other variables not included in the analysis are important.

Grosskopf et al [9] estimates the Malmquist productivity index at 143 countries in the 1997. They have 66 middle-income countries (including upper and lower middle income), 48 low-income countries or LDCs and 28 developed countries based on the World Bank's country classifications. They begin with a simple health sector model, and then move to models which include other socioeconomic factors. In the first model, they focus on the health sector and measure health sector output as a vector of variables including life expectancy at birth and the reciprocal of the under-five mortality rate, which were the most frequently reported health outcomes proxies available in the 1997 data set. The inputs to the health sector are private and public health expenditures as a percentage of per capita GDP. The later model augment outputs to include per capita GDP (model 2a). The health sector inputs are again the share of GDP spent on private and public health expenditure, but they also introduce broader economic inputs namely gross capital formation per capita and the per capita labour force. The last set of models augments these to include a measure of human capital as input, i.e. the enrollment rate in primary education (model 2b). other models are specified as they indicate in the table reported here.

	Model 1	Model 2a	Model 2b	Model 3a	Model 3b
Outputs					
Life exp.	x	X	x	X	x
(Infant mortality)$^{-1}$	x	X			x
GDP/pop.		X	x	X	x
Inputs					
% Public health exp.	x	X	x	X	x
% Pvte health exp.	x	X	x	X	x
Labour/pop.		X	x	X	x
Cap./pop.		X	x	X	x
Primary enroll. rate				X	x

For the simple health care sector model with life expectancy and infant survival rate as outputs, the average quantity index are highest for developed country and lowest for middle income countries. When they augment the model to include per capita GDP as an output and add labour, capital and education variables as input, developed countries have the highest index and less developed countries the lowest.

Gupta et al [8] assesses the efficiency of government expenditure on education and health in 37 countries in Africa in 1984–1995, both in relation to each other and compared with countries in Asia and the Western Hemisphere using a FDH analysis. As input they uses per capita education and health spending by the government in purchasing power parity (PPP). Health output is measures by life expectancy, infant mortality, and immunizations against measles and diphtheria–pertussis–tetanus (DPT) and educational attainment by primary school enrollment, secondary school enrollment, and adult illiteracy. Data on educational attainment, health output, and public spending on education and health are available for 37 African countries, and for pooled data of 85 countries in Africa, Asia, and the Western Hemisphere. In the initial analysis of the efficiency of government spending, the level of spending in relation is compared separately with each output indicator. For the health sector, over time, the productivity of health spending in Africa has generally increased. Analyzing the efficiency of government spending separately for each output indicator does not give a definitive answer to the question which countries spend their public resources relatively efficiently, as this would require taking into account all indicators of output. For health spending, Ethiopia, Tanzania, and Zimbabwe —with an average annual spending of 2.1% of GDP in the last time period (1990–1995) —perform relatively well in two time periods, whereas the ranking and input efficiency scores for Malawi, Mali, Mauritania, Mozambique, and Niger—with an average annual spending of 1.8% of GDP—are lower. Finally, the relative efficiency of health spending improved between periods 1 (1984–1989) and 2 (1990–1995) in Madagascar and Mali. In their conclusion they affirm that governments in the African countries are less efficient in the provision of health and education services than the countries in Asia and the Western Hemisphere. The results suggest that the inefficiencies observed in Africa are unrelated to the level of private spending.

Other studies have used parametric approach in the OECD countries camparison [5] or single States [12] , other authors used spatial econometric for exploring regional differences in the health production in Germany [6]. Halkos et al [10] consider the efficiency difference of public health services in Greeek prefectures. Hollingsworth and Wildman [11] consider the performance of the health-care around the world re-estimating a parametric and non-parametric model with WHO health data.

Finally such authors [17] outline the limits of the analysis deriving to the model building in the nonparametric approach to policy indications.

II. Italian's health care system: provision of care and financing

Primary care is provided by General Practice (GP), pediatricians, and independent physicians and self-employed and those working on contracts given by the government are compensated with a capitation fee with reference to the figure of adults for GP and children for pediatricians, listed in their own list [13]. GP and pediatricians are gatekeepers for accesses to secondary care. They put in writing pharmaceutical prescription and pay visits to patients when and if necessary, in addition to vaccinating patients [13]. People are free to choose any physicians they have a preference, provided that the physician they choose had not reached the allowed maximum patients. In 1999 primary health care was significantly reformed, emphasizing group practice, initiating economic incentives for GP and encouraging integration between primary care physicians and district services such as health education, social care, environmental health and home care. Ambulatory care are provided with specialist ambulatory services, such as curative activities and visits and diagnostic, so are provided either by ASL or by accredited privative and public facilities that have ASL have agreements and contracts. These services are listed in formularize that varying across Regions. Secondary inpatient care is provided by public, accredited private and private hospitals, the last often non-for-profit organizations. The distribution in 2008 was 641 (54.4%) public hospitals and 541(45.6%) private accredited, in particular 67% of public hospital are directly managed hospitals, 12% hospital enterprise, 21% other. Trends are decreasing due to reductions and consolidations. The most directly managed hospitals are in Lazio (52), Sicilia (46), Campania (39), Calabria (32), Toscana (32), fewest in Valle-D'Aosta (1), Lombardia (2). The most private accredited are in Lombardia (71), fewest in Basilicata (2). Patient's can choose free services i.e. to get treatment from the structures in their ASL or another provider in ASL that is in the same region or not. The introduction of DRG payment method and fiscal liability of the regions necessitated the crucial question of mobility. People living in Northern Italy choose own or nearby region, southern people tend to move in other region, often in Northern Italy (mainly Lombardia and Emilia Romagna). Care financing change during 1990, when reforms to contribute create a federalism asset for Italy. The movement through fiscal federalism started in1997 with abolition of social insurance contributions and introduce a regionally collected system of tax financing. New roles define to redistribute resources to regions so as to make certain that there is adequate level of care for all residents. Now the main resource of financing for SSN is a combination of national and regional taxes. In 1997 decree legislative 446 introduced two new type of regional tax; firstly, the IRAP, that is a regional corporation tax levied on the companies added value and the public sector employees salaries and secondly, additional IRPEF. Decree legislative 56/2000 further pushed the funding system along fiscal federalism, in fact regional financing has come from: 1) Region receive 90% of IRAP revenue, 2) the regional share of IRPEF is 0.9%, with possibilities for Regions to modify from 0.9% to 1.4%, 3) a defined quantity of the petrol excise tax and 4) revenues from motor vehicle tax and other tax. In other the 56/2000 stated that a fix proportion of national VAT revenue would be used to establish National Solidarity Fund, to be used to reallocate funds to the regions not capable of raise adequate resources to provided basic package. Regions can choose how to allocate resources between; firstly, public health service in living and working environments; secondly, around 50 percent of health care to the community, around 45 percent of health care in hospitals. The percentage may be modulated at regional level according to the targets of regional planning. additionally they may decide how to apportion resources to the ASL; most region s transfer found to the ASL based on capitation. Another source of financing is out-of-the pocket payment. There are two form of out-of the pocket payment: first is a fee for diagnostic measures, pharmaceuticals and appointments specialist visits, second is direct fees by users to pay for private services of health care and over-the-counter (OTC) drugs. Recently any discrete legislative in actuation of law 42/2009 have introduced standard cost and needs standard such criteria of financing in health [13].

III. Data Envelopment Analysis

Data envelopment analysis is a mathematical founded technique used to performance evaluation of organizational activity. The DEA methodology using a linear programming technique estimate an "efficient frontier" and use a distance function approach to derive the measure of efficiency. Here, each health care regional system is considered such as an producer with his activity plan (x_i,y_i), for i=1.....n, where $x_i \epsilon R^p$ is an input/resources regional vector and $y_i \epsilon R^q$ is a output regional vector. The DEA-VRS input oriented model is estimates for derive radial relative efficiency (or Farrel technical efficiency). The outputs of model are the health outcomes, rate of mortality and life expectation at 0 year for men and women, while the inputs are health care resources measured in quantity (hospital beds, employees in NHS, technical instruments in public and private institute and extra hospital, ambulatory and laboratory, nigh-keeper physicians, GP and pediatricians). The following program is solved, as envelopment form:

$$\min_{\lambda,\theta} \theta$$

$$s.t.$$

$$X\lambda_i \leq \theta x_{io}$$

$$Y\lambda_i \geq y_{io}$$

$$\sum_{i=1}^{n} \lambda_i = 1$$

Where X and Y are respectively the input and output matrix, (x_{io}, y_{io}) is the plan under evaluation, θ is the measure of input efficiency and ʎ is a scalar. The optimal solution of program (1) above are (ʎ*,θ*). If θ*=1 the regional healthcare system under evaluation is fully efficient. If θ*<1 the regional health care system under evaluation is inefficient, and (Xʎ ,Yʎ) outperform $(\theta x_{io}, y_{io})$. In other word when the healthcare regional system under valuation have an θ*<1 can reduce proportionally his input vector maintaining his objective in term of output (here assumed as maintain the same health status of his served population, measured by health outcomes indicators) relatively other healthcare regional system on the frontier.

IV. Results

In this section we show the efficiency results for each healthcare regional system. The DEA input model estimates, uses as inputs rate of beds, ordinary and day hospitals, rate of employees in the national health care (NHS), equipment (i.e. tomography, magnetic resonances) per capita (this variables is not in the data base but derived by author, using regional population), rate of general practices and pediatricians, rate of ambulatory and laboratory. Whereas the outputs are life expectancy at 65 year, for male and female, and infant rate of mortality, The choice of inputs and outputs is in accordance with the literature selected [i.e. 11,8]. The data used refer year

TABLE I

FARREL EFFICIENCY SCORE

YEAR 2005

Regione	VRS				CRS			
	Eff. Score	B.C. Eff.score	low limits	high limits	Eff. Score	B.C. Eff.score	low limits	high limits
Piemonte	1.0000	0.9893	0.9705	0.9995	1.0000	0.9844	0.9640	0.9990
Valle d'Aosta	1.0000	0.9820	0.9309	0.9994	1.0000	0.9710	0.9034	0.9991
Lombardia	1.0000	0.9831	0.9306	0.9997	1.0000	0.9711	0.9064	0.9989
Trentino A.A.	1.0000	0.9829	0.9309	0.9994	1.0000	0.9694	0.9028	0.9988
Veneto	1.0000	0.9830	0.9335	0.9995	1.0000	0.9705	0.9024	0.9989
Friuli V.G.	1.0000	0.9831	0.9316	0.9996	1.0000	0.9711	0.9199	0.9988
Liguria	0.9268	0.9188	0.8996	0.9264	0.9266	0.9116	0.8867	0.9258
Emilia Romagna	1.0000	0.9827	0.9323	0.9996	1.0000	0.9735	0.9278	0.9991
Toscana	0.9753	0.9676	0.9562	0.9748	0.9099	0.8959	0.8752	0.9089
Umbria	1.0000	0.9840	0.9399	0.9995	1.0000	0.9734	0.9273	0.9990
Marche	1.0000	0.9826	0.9304	0.9995	1.0000	0.9722	0.9213	0.9989
Lazio	0.9426	0.9347	0.9132	0.9423	0.9299	0.9147	0.8845	0.9289
Abruzzo	1.0000	0.9852	0.9502	0.9995	1.0000	0.9814	0.9579	0.9988
Molise	1.0000	0.9828	0.9322	0.9996	0.9885	0.9724	0.9403	0.9874
Campania	1.0000	0.9825	0.9314	0.9996	1.0000	0.9707	0.9018	0.9991
Puglia	1.0000	0.9830	0.9311	0.9996	1.0000	0.9703	0.9018	0.9989
Basilicata	1.0000	0.9827	0.9334	0.9997	1.0000	0.9713	0.9019	0.9990
Calabria	1.0000	0.9829	0.9312	0.9995	1.0000	0.9702	0.9032	0.9990
Sicilia	1.0000	0.9831	0.9349	0.9996	0.9982	0.9823	0.9448	0.9976
Sardegna	0.9293	0.9220	0.9087	0.9289	0.8789	0.8652	0.8390	0.8779

2005 and are published in the Health For All (HFA) database. The assumption on the technology are constant return of scale (CRS) and variable return of scale (VRS). For each model a bootstrap technique is used to derive bias correct Farrel input efficiency score and confidence of interval [13]. For the results see Table I. In the CRS model the regional health care system full efficient are 14, while in the VRS model we have 16 full efficient regional healthcare systems. In mean we have not substantial differences between CRS (mean of efficiency score is 0.98160) and VRS (mean= 0.98869) model specification. The Wilcoxon rank sum test suggest we cannot reject the hypothesis of the substantial differences in the mean between the two scores efficiency distributions (p-value=0.44). The standard deviation of the CRS model is 0.03731, while in the VRS model the standard deviation is 0.02482. A two sample Kolmogorov-Smirnov test reveals that the score of the two models to come from the same distribution. This can suggest that we can use indifferently CRS or VRS model. The minimum efficiency score in the CRS model is 0.8789 (this minimum level refer at the Sardegna that can save 12,11% of all input resources and have the same health outcomes results). In the VRS model the minimum level of efficiency score is 0.9268 and refer at the Liguria. The minimum correct bias efficiency score in the CRS model is 0.8652 (Sardegna) and 0.9188 (Liguria) in the VRS model, confirming the same rank for Sardegna and Liguria in both model. While the mean of correct bias efficiency score is 0.9739 in the VRS model and 0.9581 in the CRS model. The standard deviation are 0.02152 in the VRS model and 0.0329 in the CRS model. For this results see Table II, where are reported for each DEA model specification, mean, standard deviation and minimum of efficiency, for bias correct efficiency score and for the simple score. In mean the health system is scale inefficient (Scale Efficiency-SE=CRS/VRS=0.9816/0.9886=0.9929). The potential gains of efficiency, deriving to the scale efficiency, increase if we consider the bias correct efficiency score (SE*=0.9581/0.9739=0.9838). The mean level of scale efficiency result is influenced of the presence of small and great regional health care system (i.e. Valle D'Aosta, Molise, Abruzzo, Basilicata). Generally small productive units show increasing return to scale and great unit show decreasing return to scale. But the concept of small and great is a relative concept. Here, we use average health care regional dimension as comparative entity (see TABLE III).

TABLE II

MEAN, MIN AND STANDARD DEVIATION

	Model			
	VRS		CRS	
	effciency	bias correct efficiency	effciency	Bias correct efficiency
mean	0,9886	0,9739	0,9816	0,9581
standard deviation	0,0248	0,0215	0,0373	0,0329
min	0,9267	0,9188	0,8789	0,8652

Health care system as Valle D'Aosta, compared with the mean of Beds (13055.45), Personnel of NHS (32385.95), Equipment (892.4) and Physicians (3400.65), see TABLE III, show a very small dimension. The same happen for many regional health care system (Trentino A.A., Friuli V.G., Liguria, Umbria ,Marche, Molise, Basilicata, Calabria, Sardegna). While, Lombardia, Piemonte, Veneto, Emilia Romagna, Toscana, Lazio, Campania, Puglia e Sicilia, compared with average health care systems, are relatively greater. For better consider the difference in the regional inhabitant, we have used as variables the rate of variables. For example, in the beds variables, we have used the number of beds per 1000 inhabitant.

TABLE III
MEAN AND STANDARD DEVIATION OF VARIABLES
(THE DIMESION OF REGIONAL HEALTH CARE SYSTEM)

	Variables			
	Beds	Personnel of NHS	Equipment	Physicinas
Piemonte	19058	55848	1401	4374
Valle d'Aosta	473	1889	45	131
Lombardia	42319	92251	2942	8965
Trentino A.A	4802	14927	361	898
Veneto	20081	57232	1095	4831
Friuli V.G.	4995	16125	375	1269
Liguria	7749	21621	547	1723
Emilia Romagna	20484	54110	1103	4495
Toscana	15455	47636	1041	4297
Umbria	3228	10776	380	1124
Marche	6648	17701	568	1737
Lazio	29876	50176	2002	6001
Abruzzo	6090	15326	397	1779
Molise	1870	3925	135	524
Campania	22035	54842	993	6942
Puglia	16037	35052	1313	4925
Basilicata	2198	6516	195	1017
Calabria	8814	22846	589	3137
Sicilia	21032	48016	1806	7047
Sardegna	7865	20904	560	2797
Mean	13055.45	32385.95	892.4000	3400.650
Sd	10839.53	23862.84	728.4868	2514.825

FIGURE I

HISTOGRAM OF EFFICIENCY SCORE

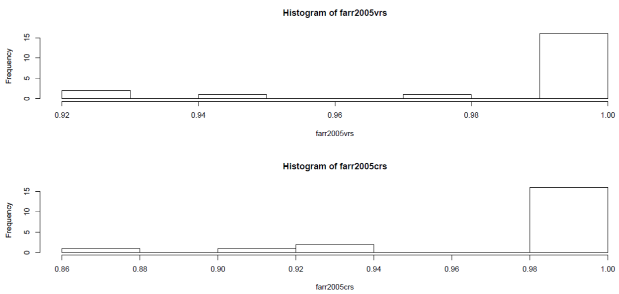


FIGURE II

BOX PLOT OF EFFICIENCY SCORE

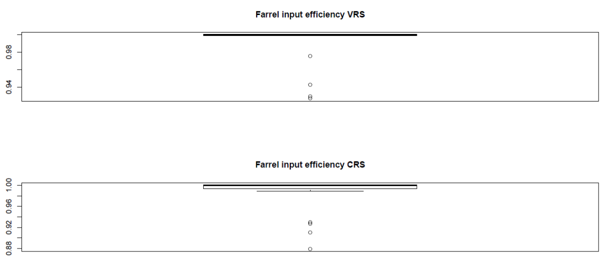


FIGURE III

HISTOGRAM OF BIAS CORRECT EFFICIENCY SCORE

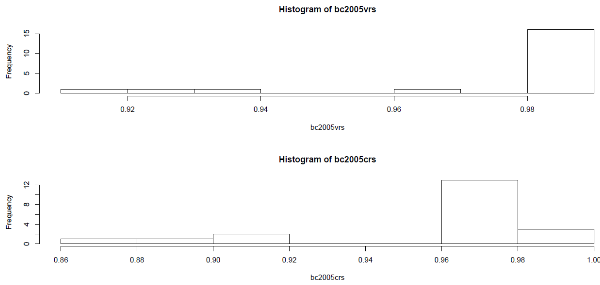
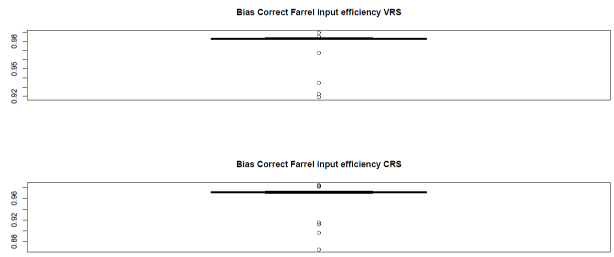


FIGURE IV

BOX PLOT OF BIAS CORRECT EFFICIENCY SCORE



The histogram of the efficiency score in Figure I show the empirical distribution of the efficiency score for CRS and VRS-DEA model. Do not seems there are greater differences between them. This is confirmed to Kolmogorov-Smirnov test as above affirmed. Some differences exist between the boxplot for non-correct efficiency score (see FIGURE II) and bias correct efficiency score (see FIGURE IV). In both boxplot the point outside the box would reveal the existence of outliers, specially for CRS bias correct efficiency score (see FIGURE IV). The empirical distribution in the FIGURE III, reveals same little differences compared with histogram in FIGURE I. This can be attributed a the sensitivity analysis done with bootstrap approach.

V. Conclusion

In this paper we have used DEA input model to discover potential gains in the production of aggregate health outcomes in the regional health care systems. The input orientation is our choice because of the question posed in the paper are: 1) the health system can be spending inefficient but technically efficient, how technically inefficient are is therefore a crucial point to relate it at the spending inefficiency; 2) to pursuit the objective of guarantee minimum level of services using efficiently the resources. In general we can conclude that the healthcare regional systems are not more technically inefficient. So eventually great inefficiency in the health expenditure should be attributed at other circumstances. However the major potential saving are in Sardegna, about of the 12,1 % in the CRS model and 7 % in the CRS model. Any regional healthcare system are technically efficient (i.e. Campania, Piemonte, Sicilia) despite they present health deficit. The data envelopment analysis seem confirm the possibilities according to one productivity entity, such as an health care system, as we consider here, with unbalanced financial budget, can be technical efficient. These evidence, suggest to investigate more and more the problem of the financial unbalanced of the health care system and the technical efficiency conditions. However it is necessary, to be awareness of the limits of the technique [14]. The correct production model is not a simply selection. For example here we have considered life expectation indicators as output in the DEA model, but more indicators are available. In other, the data envelopment analysis are data driving, so different results are possible. Later, in the literature on efficiency analysis, other factor can influence the efficiency of the production process, this is deal with in different ways, for example with two stage econometric analysis.

References

[1] Afonso, A. & St. Aubyn, M. (2005). “Non-parametric Approaches to Education and Health Efficiency in OECD Countries,” *Journal of Applied Economics*. 8, (November): 227-246

[2] Babazono, A. & Hillman, A.L. (1994). "A comparison of international health outcome and health care spending: " *Journal of Technology Assessment Health Care*. 10(3): 376-381

[3] Cooper W.W., Seiford, L. M. & Tone, K., "*Data envelopment analysis. A Comprehensive Text with Models, Applications, References and DEA-Solver Software*." New York: Springer,2007.

[4] Dash, U., Vaishnavi, S. D. & Muraleedharan, V. R. (2008). "Technical efficiency in the use of Health Care Resources: A Case Study of Tamil Nadu" *Indian Economic Review*. 43, (1): 69-82

[5] Evans, D.B., Tandon, A., Murray, C.J.L., & Lauer, J.A. (2001). "The Comparative Efficiency of National Health Systems in Producing Health: An Analysis of 191 Countries*", GPE Discussion Paper Series*: No. 29. World Health Organization: Geneva

[6] Felder, S. & Tauchmann, H. (2009). Regional Differences in the Efficiency of Health Production: An Artefact of Spatial Dependence? *Ruhr Economic Paper*. No.112

[7] France, G. Taroni, F., & Donatini, A. (2005),"The Italian health care system", *Health Economics*. 14 (Suppl 1): S187-202

[8] Gupta, S., Verhoeven M, . (2001). “The efficiency of government expenditure Experiences from Africa”, *Journal of Policy Modeling*. 23: 433– 467.

[9] Grosskopf, S., Self, S., Zaim, O. (2006). “Estimating the efficiency of the system of healthcare financing in achieving better health”, *Applied Economic*s. 38(13): 1477- 1488

[10] Halkos, G.E. & Tzeremes, N.G. (2010). "A conditional non parametric analysis for measuring the efficiency of regional public healthcare delivery: An application to Greek prefecture", *Health Policy*. 103(1):73-82

[11] Hollingsworth, B and Wildman, J. (2003). "The efficiency of health production: re-estimating the WHO panel data using parametric and non-parametric approaches to provide additional information". *Health Economics*. 12 (6): 493-504

[12] Kathuria et alt (2005),"Inter-state disparities in health outcomes in rural india: an analysis using stochastic production frontier approach", Development policy review. 23 (2): 145-163

[13] Lo Scalzo A, Donatini A, Orzella L, Cicchetti A, Profi li S, Maresso A. Italy: Health system review. *Health Systems in Transition*, 2009; 11(6)1-216

[14] Puig-Junoy, J. (1998). "Measuring Health Production Performance in the OECD", *Applied Economic Letters*. 5: 255 – 259

[15] Retzlaff D, Chang CF, Rubin RM (2004), “Technical efficiency in the use of the health care resources:a comparison of OECD countries“, *Health Policy,* 69 (1):55-72

[16] Simar, L, Wilson ,PW (1998), “Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models”, *Management Science* , 44:49–61

[17] Smith, P.C., Street, A.(2005),“Measuring the efficiency of publics services: the limits of analysis. *Journal of the Royal Statistical Society,* 168:401-417

[18] Spinks, J., Hollingsworth, B. (2009), “Cross-country comparison of technical efficiency of health production: a demonstration of pitfalls“ *Applied Economics*, 41:4,417-427.

[19] Tediosi, F. Gabriele, S. & Longo, F. (2009). "Governing decentralization in health care under tough budget constraint: What can we learn from the Italian experience?", *Health Policy*. 90, (2): 303-312

[20] “Health Systems: Improving Performace“, World Health Organization, Geneva, Switzerland, Rep 2000.

[21] Worthington, A. C. (2004). "Frontier Efficiency Measurement in Healthcare: A Review of Empirical Techniques and Selected Applications", *Medical Care Research and Review.* 61(2):135-70

Claudio Pinto is Ph.D., in Economics of Public Sector at University of Salerno. His research interests are efficiency analysis, policy indications with benchmarking approach. In particular his works have interested health sector.