Efficiency in Saving Infant Lives: the Influence of Water and Sanitation Coverage

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Abstract: In this paper, we aim to assess the relationship between water and sanitation coverage and saved infant lives. Our hypothesis is that extended coverage implies measurable results in terms of reduced infant mortality. Moreover, we suspect that with the same resources, ceteris paribus, different countries can achieve better or worst results depending on the efficiency which the resources are used. We explore the policy consequences, simulating the effects that improvements in efficiency can yield in terms of the reduction in child mortality. Our approach is first to explore with a database of Latin American countries the "production function" of survivor infants on 1,000 births. Once we identify the causal relationship with an econometric model, we estimate a production frontier with Data Envelopment Analysis in order to determine the best performers: countries which can do better with the same "inputs". Finally, we simulate the consequence of catching up to the frontier in each country. The impressive quantitative results are interesting for policy concerns, since efficiency is reconciled with equity (in the sense that the winners of the coverage increases and the health improvements are the poorer).

1. Introduction

Water and sanitation coverage have a direct incidence on infectious diseases. The World Health Organization has estimated than approximately 80% of all illness affecting less developed countries are attributable, in part, to proper water supply and adequate sanitation means (WHO, 2003). Polluted water is one of the main causes of diarrhea diseases, an important mortality factor in babies and younger children, responsible of the loss of thousand of workdays in adults, and generator of impressive expenses in medical care. Contaminated rivers and underground waters represent a direct threat to health when they are used for drinking, personal hygiene, laundry wash, crop irrigation or cooking. Coastal pollution can provoke direct illness and the contamination of sea products. The inefficient drainage of rain water in urban places could be the direct cause of the reproduction of mosquitoes and other infectious disease vectors.

According to UNICEF (2005) some of the more common diseases related with the insufficient or nil access to water and sanitation (and for that reason, avoidable with extended coverage) are: diarrhea (4 billion cases yearly in the whole world, with 1.8 million deaths attributable to this illness every year, 90 percent of them being children under five years old. The repetition of episodes yields more vulnerability to malnutrition and other diseases), cholera (a bacteria disease, it causes repeated diarrhea episodes and can derive in death), typhoid fever (with 12 million cases yearly), intestinal parasites (affecting 10 percent of the population in less developed countries, can cause malnutrition, anemia and lags in children growth), malaria (with between 300 to 500 million cases yearly, and a million children deceases), schistosomiasis (a parasite infection originated by contact with polluted water, with 200 million infected, 10 percent of whom exhibit severe consequences), trachoma (6 million people suffer blindness as a consequence, affecting mainly women and being children specially vulnerable to this disease).

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Not all illness impacts the same in all regions. Rural areas are generally more exposed and the relationship is direct between exposure and the length to a safe source of water. Distance to supply also impacts on the quantity of water people can consume. According to the WHO, the minimum consumption to minimize health hazards is 55 liters/inhabitant/day (5 liters being drinking water, 25 for sanitation services, 15 for hygiene and 10 for food preparation (Ferro et al., 2009).

UNICEF (2009) has estimated that almost 900 million people do not have access to safe sources of water, being the lowest coverage rates located in the Sub-Saharan African Region (even when the greatest quantity of people without access live in Asia). In sanitation, the estimate is of 2,500 million people without access to improved sanitation facilities. The definition of "improved" is quite lax, including for example latrines. In Latin America there are 150 thousand deaths yearly attributable to water diseases, 85 percent in children fewer than five years, the majority derived from diarrheas. At the world level, the infant mortality was, on average, 72 deaths for each 1000 births in 2006. The average in developed countries was 6, in developing countries 79 and in the Latin American and the Caribbean region 27.

In this paper, we aim to assess the relationship between water and sanitation coverage and saved children lives. We have a policy concern, which is if better resource utilization can be reflected in better results in infant mortality. Infant mortality recognizes a priori a set of possible causes. We focus on the role of water and sanitation coverage since is a rough measure of access to potable water and sanitation facilities. Our hypothesis is that extended coverage implies measurable results in terms of reduced infant mortality. Moreover, we suspect that with the same resources, ceteris paribus, different countries can achieve better or worst results depending on the efficiency which the resources are used. We explore the policy consequences, simulating the effects that improvements in efficiency can yield in terms of the reduction in child mortality.

Efficiency in organizations started to be measured since the seminal paper of Farrell (1957), who calls technical efficiency the achievement of the more possible amount of output from a given set of inputs. There are two different families of techniques to measure comparative performance: non parametric frontiers (computed by means of mathematical programming), known as Data Envelopment Analysis (DEA), and parametric methods (deterministic and stochastic frontiers), estimated by econometric methods. Coelli et al (1998) is a good reference of the issue.

The frontier analysis estimates either a production or a cost frontier. A production function is a relationship between outputs and inputs, where the more efficient units produce more with the same inputs. A cost function is a relationship between costs and the output and input prices which the firm faces in the market. The more efficient unit, in this case, is the one which achieves lower costs for a given output. To each relationship are normally added "environmental" variables, to recognize the differences between units which can be attributed to external factors.

Our approach is first to explore with a database of Latin American countries the "production function" of survivor infants on 1,000 births. The survivors we conjecture are consequence of water and sanitation coverage, medic infrastructure, and level of development of the country. Once we identify the causal relationship with an econometric model, we estimate a production frontier with Data Envelopment Analysis in order to determine the best performers: countries which can do better with the same "inputs". Finally, we simulate the consequence of catching up to the frontier in each country. The results are interesting, since efficiency is reconciled with equity (in the sense that the winners of the coverage increases and the health improvements are the poorer).

After this introduction, the section 2 refers to the database and the methodology, section 3 presents the estimates, section 4 discuss the results and section 5 summarize the conclusions.

2. Database and methodology

2.1 Database

We develop a database for 20 Latin American countries, composed by water and sanitation, health and economic indicators, for 2006. Our database contains also demographics statistics which are useful for the study.

Our intention is to generate, in the first step, a “production function” where the “outputs” are saved infants lives. Our departure point is infant mortality statistics. We have two possible variables to explore, which is infant mortality under five years old, on one hand, and total infant mortality, on the other hand. These variables are normally expressed as deceased infants on one thousand of births. In the Figure 1 we can see the data, where each observation is a country of the sample. We construct the inverse variable, one thousand minus deceases such an “output” indicator. Its interpretation is straightforward: survivor infants on every one thousand births. There are two variables to test, one related with the infants which were not deceased under five years old, and the other on all the universe of infants.

At low ages, the sensitivity to water related deceases increases, therefore, the variable LIVE5 (survivor infants under five years old) is particularly attractive to this case.

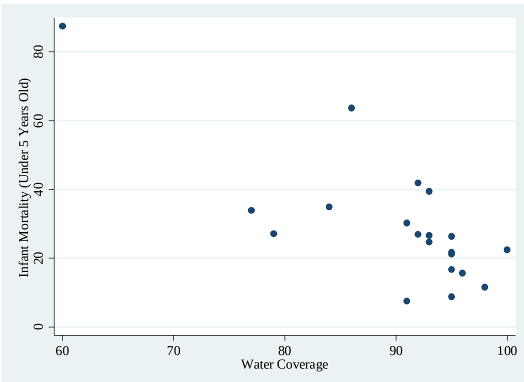
The “outputs” denoted by LIVE5 and LIVET (total survivor infants) –that is saved lives- are “produced” by potable water coverage, sanitation access, and other health “inputs”, such as beds in hospitals and physicians. We use those four variables as indicators of the inputs to “produce” survivor infants. Also, we control by two other variables, one of them, strictly economical: the per capita GDP. It is an indicator of production, and we expect, ceteris paribus, better results in countries with higher per capita GDP level. We include also, another variable, which is an indicator of “modernity” and development: the percentage of urban population. In developed countries, the great majority of the population lives in urban places.

Two caveats are important with respect to the inputs water and sanitation coverage, and two additional comments are relevant with respect to the “controls”. In the econometric jargon it denotes the “environmental” variables, in the sense of external factors which influences the phenomena under study, but not under control of the authorities which decide policies.

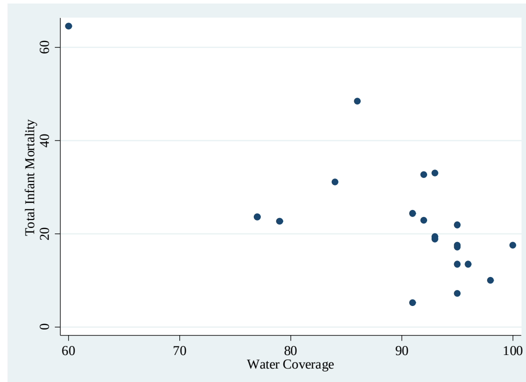
The coverage measures are aggregate and not totally satisfactory, since they include a wide variety of possibilities. For example, a sanitation network or a more precarious solution such a latrine is included there. The same, the quality of the service is not indicated by the coverage. Intermittences are common in some places, and it is usual to have eight or twelve hours a day of water supply in some countries. Even worst, in many places, the water supplied is not ever apt to human consumption.

Figure 1: Infant Mortality (Under Five Years Old and Total) versus Water and Sanitation Coverage

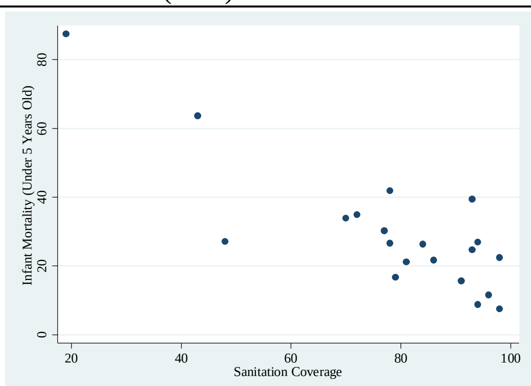
Infant Mortality (Under 5) and Water Coverage in Latin America (2006)



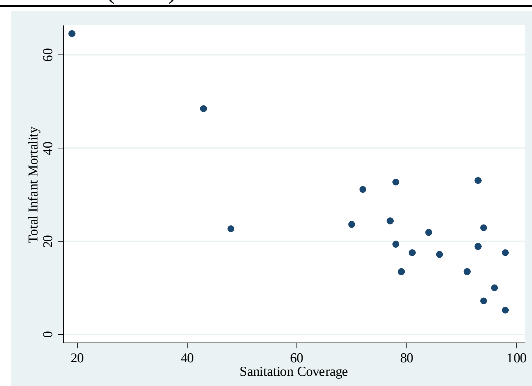
Total Infant Mortality and Water Coverage in Latin America (2006)



Infant Mortality (Under 5) and Sanitation Coverage in Latin America (2006)



Total Infant Mortality and Sanitation Coverage in Latin America (2006)



With respect to per capita GDP and the percent of urban population, in some sense they intend to proxy the quality of the services. It is reasonable to suppose that urban services are of better quality than rural ones, and it is also expected that higher per capita GDP proxies better quality of public services. But, the per capita GDP is an average, a central tendency measure, more useful when the dispersion of the variable is not high. Latin America is one of the more unequal places in the world, measured by the Gini Coefficient, so the per capita GDP has to be use with care as a measure of level of life (and health, a priori positively correlated with per capita GDP). Also, the urban population, taken as a progress measure, in the case of Latin American has to be managed with care. The urbanization process was rapid and disordered in some countries of the region, and huge poor neighborhoods developed in the periphery of the urban zones. It is also true that the relatively high rural population which remains in Latin America presents bad economic and social indicators in the region.

The Table 1 presents the definition of the variables we use, a brief explanation and the unit measure which applies. In Appendix we present the database in use in Table A1 and the Table A2 shows the correlation matrix of the variables.

Table 1: Definition of the variables in use

Variable	**Name**	**Explanation**
MO5	Infant Mortality Under Five Years Old	Deceased Infants Under Five Years Old on 1,000 Births
LIVE5	Infant Survivors Under Five Years Old	Not Deceased Infants Under Five Years Old on 1,000 Births
MOT	Total Infant Mortality	Deceased Infants on 1,000 Births
LIVET	Total Infant Survivors	Not Deceased Infants on 1,000 Births
GDP_PC	Gross Domestic Product per capita	Denominated in American Dollars
WA_COV	Water Coverage	In percent of total population
SA_COV	Sanitation Coverage	In percent of total population
BEDS	Beds in hospitals	On 1,000 inhabitants
PHYSICIANS	Physicians	On 10,000 inhabitants
URBAN	Urban population	On percent of total population

Source: Own elaboration on UNICEF and World Health Organization (OMS, 2008, 2009 and 2010).

The correlation matrix confirms some presumptions on the variables. First, both output variables exhibit a 0.99 correlation. We decide to use LIVE5 since the worst consequences of water infectious diseases impact on children under five years old. Second, the correlation between both output variables and the inputs we choose to test are positive. Saved lives are in line with water and sanitation coverage, beds and physicians, per capita GDP and urbanization. The greatest correlations between output and inputs are in the range of 0.7 and 0.8 in water and sanitation coverage. Beds and physicians show a positive correlation with the outputs in the range of 0.5 and 0.56. GDP per capita is correlated with a value of 0.66 with the output measures, and urbanization rate is positively correlated at a 0.56 value with the latter.

Water and sanitation coverage exhibit a correlation of 0.86 between themselves. We chose water coverage since we judged more confident the water coverage data. The series on sanitation seems to be very “generous” with the countries included, since the variable has a lax definition to our taste. We cannot include both variables in the production function, because a problem of linear correlation between the variables. The same problem appears with the variables BEDS and PHYSICIANS, which have a high correlation of 0.87. We finally chose the latter in the estimates we performed. Finally, the per capita GDP and the urbanization rate present a high correlation of 0.77. We chose the former.

The Table 2 presents the descriptive statistics of the variables. The mean of LIVE5 is 970 (that is, a rate of 30 deceased infants on 1,000 births), with a standard deviation of 18 (three times the average in developed countries). The difference between the minimum and the maximum is 80. Water coverage has a mean of 90 and sanitation coverage has 78. The number of physicians on 10,000 inhabitants is almost 18, but the standard deviation here is impressive: 13; the same high dispersion happens in beds on 1,000 inhabitants. The urban population, finally, averages 70 percent of the population. We have data of 20 countries in 2006 for all the variables.

Table 2: Descriptive Statistic of the Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
live5	20	970.555	18.69761	912.6	992.5
livet	20	976.745	13.89686	935.5	994.8
wa_cov	20	90	9.188093	60	100
sa_cov	20	78.6	20.6025	19	98
beds	20	1.816	1.340331	.52	6.2
physicians	20	17.68	13.78705	2.5	63.4
gdp_pc	20	7552	3528.809	1056	13460
urban	20	.701	.1464276	.46	.92

2.2 Methodology

We developed a two stage methodology in order to achieve responses to the questions we placed at the beginning of this paper. First, we estimate by Ordinary Least Squares the "production function" of survivor infants. The econometric approach has the advantage of allow us to correctly identify the causal relationships between the variables, and to determine the degree of confidence of the estimates.

In a second stage, once identified inputs and outputs, we estimate efficiency frontiers in the "production" of survivor infants by means of Data Envelopment Analysis (DEA) to account for the best performers in the region. Once we do the former, we look after some simulations which permit us determine the possibilities of achieving better results.

2.2.1 Econometrics

Our task here is to discover the technology of "production" of survivor infants. The econometric approach was useful to discard variables (LIVET was discarded as output, and BEDS and URBAN were also replaced by PHYSICIANS and GDP_PC). We estimate models including WA_COV and SA_COV as alternative. Although the latter gives better statistic results, the former is more confident in our understanding, and finally we prefer to continue to the second stage of our methodology with WA_COV. Normally, WA_COV encompasses SA_COV; the opposite is not true, but there are some exceptions.

The models we estimate are numbered from 1 to 6:

LIVE5 = f(WA_COV)   (Model 1)

LIVE5 = f(WA_COV, PHYSICIANS) (Model 2)

LIVE5 = f(WA_COV, PHYSICIANS, GDP_PC) (Model 3).

The Models 4 to 6 are the same, but they exchange WA_COV by SA_COV.

The Model 1 is intended to explain the output strictly in terms of water coverage. It explains 55 percent of the variance of the output. The Model 2 adds a second input, PHYSICIANS, and the explanative power of the model goes up to 67 percent. Finally, the Model 3 controls by economic development, approximated by GDP_PC. The adjust R^2 goes up to 71%. The variables are all significant at least at 10%. The estimated coefficients exhibit a reasonable conduct: the absolute value of the coefficient of WA_COV (and of SA_COV) decreases when new variables are added to the analysis. It is also higher when we consider WA_COV instead of SA_COV. The model 3 is the one we chose to estimate the frontier by means of DEA.

Table 3: Econometric models

Variable	Model 1	Model 2	Model 3
LIVE5 (dependent)			
WA_COV	1.5533*	1.3442*	0.9450**
PHYSICIANS		0.5102**	0.5227*
GDP_PC			0.0015***
CONSTANT	830.7576*	840.5484*	864.5971*
# observations	20	20	20
F Statistic	25.13	21.18	16.97
Prob>F	0.0001	0.0000	0.0000
R Squared	0.5826	0.7136	0.7609
Adjusted R Squared	0.5594	0.6799	0.7161
Variable	**Model 4**	**Model 5**	**Model 6**
LIVE5 (dependent)			
SA_COV	0.7570*	0.6607*	0.4932*
PHYSICIANS		0.3591***	0.4010**
GDP_PC			0.0014***
CONSTANT	911.0510*	912.2705*	913.3690*
# observations	20	20	20
F Statistic	41.18	26.16	21.93
Prob>F	0.0000	0.0000	0.0000
R Squared	0.6958	0.7547	0.8044
Adjusted R Squared	0.6790	0.7259	0.7677

* = significant at 1%, ** = significant at 5%, *** = significant at 10%

The unexplained part of the model could recognize several explanations, and we are dealing for that reason with an upper bound for “inefficiency”. In poorer countries, for example, the role of international aid could explain not so bad results which are not captured by the data.

2.2.2 DEA (Data Envelopment Analysis)

It compares the technical efficiency of a decision unit with a hypothetical one which uses inputs in the same proportion efficiently. The virtual decision unit to use as a comparator is built as the weighted mean of the efficient decision units, counting with the inputs the unit under study uses. Using linear programming, an envelopment of the more efficient combinations of inputs and outputs is built, yielding cost or production frontiers. The efficiency measure is a relative one: calls for the best performers in the sample. The method is widely used for benchmarking.

There are some estimation possibilities, such as measures which are input oriented or output oriented, and it is possible to assume constant returns to scale (CRS) or variable returns to scale (VRS). CRS implies that if all inputs are doubled, outputs are also doubled. VRS can yield more than an output duplication (increasing returns to scale) or less than an output duplication (decreasing returns to scale) since all the inputs are doubled. The output oriented models maximize output subject to fixed amounts of inputs, instead of that input oriented models minimize the use of inputs to produce a given output.

Under this methodology, firms are considered as efficient if it does not exist other decision unit (or combination of them) which produces more (with the same inputs) or is capable to use less inputs (for the same output). In some context, one measure is better than the other: some firms can vary easily its production; other has more discretion on the inputs. It depends on the context.

DEA does not specify a particular shape or a functional form for the efficient frontier: it just connects linear segments joining decision units with the higher productivity (ratios between output and inputs), or the lower unit costs (ratios between total costs and outputs). Units on the frontier are considered efficient, and units below the production frontier (above the cost frontier) are considered inefficient, and its inefficiency measure is the distance between the performance of the unit under study and the frontier.

The problem of input oriented linear programming CRS is formulated as:

$Min_{\theta,\lambda}\ \theta,$

$S.T. \quad -Y_i + Y^*\lambda \geq 0,$

$\theta^*x_i - X^*\lambda \geq 0,$

$\lambda^*Z = z_j,$

$\lambda \geq 0,$

The problem of output oriented linear programming CRS has the form:

$Max_{\theta,\lambda}\ \theta,$

$S.T. \quad -\theta Y_i + Y^*\lambda \geq 0,$

$x_i - X^*\lambda \geq 0,$

$\lambda^*Z = z_j,$

$\lambda \geq 0,$

The estimate of the input oriented linear programming VRS solves:

$Min_{\theta,\lambda}\ \theta,$

$S.T. \quad -Y_i + Y^*\lambda \geq 0,$

$\theta^*x_i - X^*\lambda \geq 0,$

$\lambda^*Z = z_j,$

$\lambda = 1,$

Finally the output oriented linear programming VRS is:

$Max_{\theta,\lambda}\ \theta,$

$S.T. \quad -\theta Y_i + Y^*\lambda \geq 0,$

$x_i - X^*\lambda \geq 0,$

$\lambda^*Z = z_j,$

$\lambda = 1$,

Where Y is the matrix of the outputs of the units in the simple, X is a matrix which shows the inputs in use for each unit of the database; Z is a matrix which contains all environmental variables of each unit; x_i, y_i and z_i are the vectors observed of each unit in particular, and finally, λ is a vector of intensity parameters which allow the convex combination of the inputs and outputs observed to built the envelopment surface. The former problems have to be solved N times according to the number of units in the sample. The environmental variables in the models are considered as neutral not discretionary variables, over that the units has not control. The method yields different values of θ for each unit between 0 and 1. If the unit achieves 1, it is considered efficient (in the frontier), otherwise it is inefficient, and it can improve its score with a better use of its inputs (moving towards the frontier). In our context, units are countries.

3. Estimates

We estimate three alternative models for the production frontier. All of them have in common the definition of the output, which is LIVE5. We use one or two measures of coverage (WA_COV, SA_COV or WA_COV and SA_COV), one measure for another input to save lives (PHYSICIANS), and an environmental variable to control for the level of development of the country (GDP_PC). Our frontier models depart from the Model 3 and the Model 6 of the precedent section, and we also put together WA_COV and SA_COV in a third frontier. We call the DEA estimates respectively as M1 (includes WA_COV), M2 (comprises SA_COV) and M3 (both).

We chose an output oriented CCR model to explain the survivor infants, considering resources as exogenous. The results are interpreted as the number of additional survivors (or saved lives) attributable to a better management of the resources, at the level of the best performers in the sample.

Survivors could be placed in three groups: one is a biological survival rate, which would take place even without any intervention (a floor, which we can see in countries poorer than those of the sample); the second is a rate not explained by our model (recall that the R^2 in Model 3 is 0.67 and in Model 6 is 0.76: we are not explaining one fourth to one third of the survival rate); and the third is the rate which we can explain. Our goal is a ceiling, achievable by better management. Because our departure point is that we can explain at least two thirds of the variance of the variable, we subtract the constant obtained in our econometric Model 3 (865 survivors on 1,000 births).

The efficiency levels are presented in the Table 4.

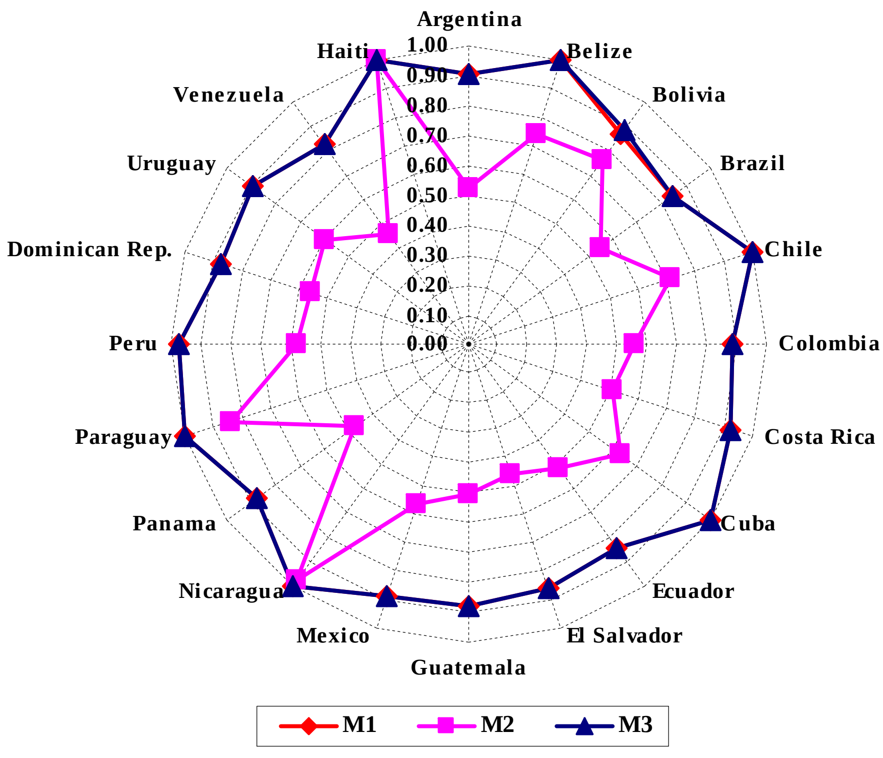
Table 4: Efficiency levels

Country	M1	M2	M3
Argentina	0.90	0.52	0.90
Belize	1.00	0.74	1.00
Bolivia	0.87	0.76	0.89
Brazil	0.85	0.54	0.85
Chile	1.00	0.71	1.00

Colombia	0.89	0.56	0.89
Costa Rica	0.93	0.51	0.93
Cuba	1.00	0.63	1.00
Ecuador	0.85	0.52	0.85
El Salvador	0.86	0.46	0.86
Guatemala	0.88	0.50	0.88
Mexico	0.89	0.56	0.89
Nicaragua	1.00	0.98	1.00
Panama	0.88	0.47	0.88
Paraguay	1.00	0.84	1.00
Peru	0.98	0.58	0.98
Dominican Republic	0.87	0.56	0.87
Uruguay	0.90	0.60	0.90
Venezuela	0.83	0.46	0.83
Haiti	1.00	1.00	1.00
Source: Own Elaboration			

The Figure 2 provides a visual comparison of the precedent results. The models M1 and M3, in fact seems overlapped, that is because SA_COV is encompassed by WA_COV. M2 instead, distorts importantly the results, in our presumption, due to the sanitation coverage measure.

Figure 2: A visual comparison of the efficiency scores



4. Discussion of the Results

The countries which yield on the frontier are Belize, Chile, Cuba, Nicaragua and Haiti. Chile is one of the richest countries in the sample. Cuba is a particular case, since its health infrastructure is out of range with respect to its GDP_PC. For example, the country has one and a half the physician rate than the figure for Argentina whose GDP_PC is almost three times the Cuban. With respect to the poorer well performed countries (Nicaragua and Haiti), the result shows that the problem is more a question of absolute level of resources than that of its management. Even when they have fewer survivors on 1,000 inhabitants (discounting the constant unexplained by our econometric model), their LIVE5 is achieved from very scarce relative levels of water and sanitation coverage and physicians.[4]

The relative efficiency scores can be translated in additional survivors (or saved lives). Basically, the idea is to adjust the LIVE5 rate assuming that each country could achieve the efficiency improvement to the level of the best performers in the sample, catching up the frontier. The Table 5 shows those results. For each country, the second column presents the 2006 levels of LIVE5, the third column replicates the fourth one of the Table 4 (Score according the model M3), the fourth column shows the additional saved lives on 1,000 inhabitants, and the last column displays the percentage gain in survivors because of the levels we can explain in our model.

Table 5: Lives saved with the match up to the efficiency frontier

Country	Survivor infants on 1,000 births (LIVE5)	Efficiency store according to M3	Saved lives on 1,000 births (additional survivors for improvements in efficiency)	Potential survivorship rate in percentage
Argentina	984.3	0.90	9.5	11%
Belize	978.3	1.00	0.0	0%
Bolivia	936.3	0.89	5.3	13%
Brazil	969.7	0.85	13.5	18%
Chile	991.2	1.00	0.0	0%
Colombia	973.4	0.89	10.2	13%
Costa Rica	988.4	0.93	7.4	8%
Cuba	992.5	1.00	0.0	0%
Ecuador	973.6	0.85	14.2	18%
El Salvador	973.1	0.86	12.7	16%
Guatemala	958.1	0.88	8.6	14%
Mexico	978.8	0.89	10.4	12%
Nicaragua	972.9	1.00	0.0	0%
Panama	975.3	0.88	10.8	14%
Paraguay	960.6	1.00	0.0	0%
Peru	966.1	0.98	1.8	3%

[4] Nevertheless, it is important to point to a technical problem referred to the use of the constant of the econometric model. We performed simulations considering higher unexplained survivor levels. When it increases, the efficiency scores for Haiti and Bolivia (in a lower proportion) lower. For example, for Haiti a for a constant set at 895 survivors, the efficiency score falls to 0.89; if we consider a constant of 900, the efficiency falls to 0.69, and considering 905, the score remains at 0.45. See the figure A1 in the Appendix.

Dominican Republic	965.1	0.87	10.4	15%
Uruguay	983.3	0.90	9.6	11%
Venezuela	977.5	0.83	17.5	21%
Haiti	912.6	1.00	0.0	0%
Average	**970.6**	**0.92**	**7.1**	**9%**

A better management of the resources currently disposable for sanitation and health can generate around 7.1 additional lives on 1,000 births on average in Latin America. The best results can be achieved by Venezuela and Ecuador (17.5 and 14.5 saved lives on 1,000 births, respectively). For the countries already in the frontier we do not expect any improvement, nevertheless we know that the regional frontier is below its ceiling, since currently this is 994 on 1,000 births in the developed countries.

5. Conclusions

Our goal is to assess firstly a measure of the relationship between water and sanitation coverage and infant mortality, using a database for Latin America. Second, with a "production function" of saved lives which explains at least two thirds of the phenomena, we estimate a "production frontier" using DEA to detect the best performers. The results of an output oriented CCR model to explain the survivor infants, considering resources as exogenous are interpreted as the number of additional survivors (or saved lives) attributable to a better management of the resources.

The catching up of the frontier (that is, a better management of the current resources in the worst performers to the levels of the best performers) can achieve an impressive result: on average the region can save 7 lives on 1,000 births. The current level is 29.4 deceases on 1,000 births (with peaks in Haiti and Bolivia), with the best practices of the region, it can be reduced to 22.3. The more important gains can be achieved in Venezuela and Ecuador. Seeing the results in another way, the lives saved are more than the average infant mortality in the developed world. A third point of view, the current infant mortality can be reduced on 24% just adopting the best practices of the region, with the resources today available.

We know about the problems related with the quality of the information. If a better use of the resources can reduce the infant mortality, the coordination of efforts to a better diagnosis and to share experience and knowledge within the region is highly desirable. In this sense, future and deeper research in the issue can help the policy design and implementation.

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Appendix

Table A1: Database in use, 2006

Country	GDP_PC	POP_TO	URBAN	MO5	MOT	WA_COV	SA_COV	BEDS	PHYSICIANS
Argentina	11997	39104	0,92	15,70	13,50	96	91	4,10	32,10
Belize	6536	287	0,51	21,70	17,20	95	86	1,30	8,10
Bolivia	3980	9353	0,65	63,70	48,40	86	43	1,10	4,90
Brazil	9026	188157	0,85	30,30	24,40	91	77	2,40	17,00
Chile	13004	16466	0,88	8,80	7,20	95	94	2,30	9,30
Colombia	7832	43703	0,74	26,60	19,40	93	78	1,00	12,70
Costa Rica	9952	4395	0,62	11,60	10,00	98	96	1,30	18,00
Cuba	4500	11200	0,76	7,50	5,20	91	98	6,20	63,40
Dominican Republic	6979	9673	0,66	34,90	31,10	84	72	2,00	20,00
Ecuador	7146	13202	0,64	26,40	21,90	95	84	1,00	15,40
El Salvador	6092	6082	0,62	26,90	22,90	92	94	0,90	20,10
Guatemala	4312	13028	0,48	41,90	32,70	92	78	0,70	9,70
Haiti	1056	9563	0,46	87,40	64,50	60	19	0,52	2,50
Mexico	13460	106410	0,77	21,20	17,50	95	81	1,60	14,00
Nicaragua	2445	5524	0,56	27,10	22,70	79	48	1,00	16,40
Panama	10114	3287	0,72	24,70	18,90	93	93	2,20	13,80
Paraguay	4118	6014	0,59	39,40	33,00	93	93	1,30	6,00
Peru	6947	28175	0,75	33,90	23,60	77	70	1,20	11,50
Uruguay	10431	3329	0,92	16,70	13,50	95	79	2,90	38,70
Venezuela	11113	27190	0,92	22,50	17,50	100	98	1,30	20,00

Table A2: Correlation Matrix Between the Variables

	live5	livet	wa_cov	sa_cov	beds	physic~s	gdp_pc	urban
live5	1.0000							
livet	0.9938	1.0000						
wa_cov	0.7633	0.7397	1.0000					
sa_cov	0.8342	0.8189	0.8655	1.0000				
beds	0.5156	0.5294	0.2573	0.3994	1.0000			
physicians	0.5566	0.5652	0.2730	0.4007	0.8753	1.0000		
gdp_pc	0.6587	0.6624	0.6647	0.6083	0.2536	0.1521	1.0000	
urban	0.5553	0.5744	0.4683	0.4468	0.5395	0.4626	0.7709	1.0000

Figure A1: Simulations on the constant and its incidence on the efficiency score