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Social Protection and Health Division

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TECHNICAL NOTE Nº
IDB-TN-1582

November 2018

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Inter-American Development Bank

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library
Moreno-Serra, Rodrigo.
Levels and determinants of health system efficiency in Latin America and the Caribbean / Rodrigo Moreno-Serra, Misael Anaya Montes, Peter C. Smith.
p. cm. — (IDB Technical Note ; 1582)
Includes bibliographic references.
1. Health services administration-Latin America-Evaluation. 2. Medical care-Latin America-Evaluation. 3. Public health-Latin America-Evaluation. I. Anaya Montes, Misael. II. Smith, Peter C. III. Inter-American Development Bank. Social Protection and Health Division. IV. Title. V. Series.
IDB-TN-1582

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Levels and Determinants of Health System Efficiency in Latin America and the Caribbean

Rodrigo Moreno-Serra[1], Misael Anaya Montes[1], Peter C. Smith[2]

Abstract

This technical note reports on the results of a study that seeks to identify the levels of efficiency and their possible determinants across Latin American and Caribbean (LAC) health systems, as well as to provide insights into the quantitative influence of these potential determinants on observed levels of health system efficiency in the region. The study uses state-of-the-art developments in data envelopment analysis (DEA) as the cornerstone method to analyze the links between efficiency in the achievement of health system objectives and certain system characteristics at the country level. DEA methods are applied to examine the efficiency with which the health systems of LAC countries translate existing resources into a given level of performance, measured by a number of alternative health system outputs. Key findings are that there is substantial room for efficiency improvements in the health system of most LAC countries. Empirical results also suggest that greater health system efficiency in LAC could be stimulated by improvements in the quality of health institutions. The most compelling evidence found in that respect refers to the correlation between institutional factors and efficiency in the provision of access to health services. The study pinpoints a few experiences in some efficient health systems in LAC and elsewhere that may offer useful insights to LAC countries currently considering planning and organization reforms to improve their spending performance. This includes broad areas linked to the operation of medium-term expenditure frameworks, provider reimbursement and expansions in primary care, among others. Unfortunately, the general absence of reliable quantitative evidence about the efficiency consequences of many system reforms implemented in LAC restricts what can be learnt from these experiences by other countries of the region.

JEL codes: H51, I18.

Keywords: health system efficiency, health care spending, Data Envelope Analysis, Latin America and the Caribbean

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Executive summary

Background. Most Latin America and Caribbean (LAC) countries have achieved great improvements in population health and well-being since the early 2000s. Average life expectancy has been rising significantly for example, while under-five mortality rates have been consistently reduced. Health systems have likely represented a crucial driver of this progress through a widening of access to necessary health services for citizens, as indicated by improvements in service utilization measures. However, health inequities persist among and within countries. In LAC, as in other regions of the world, countries vary significantly in terms of the population health indicators achieved for similar amounts of resources devoted to health, with some countries in the region exhibiting far better progress than others judged by average improvements in key indicators. In many instances health improvements have occurred favoring certain population groups at a disproportionate rate.

The mixed health results achieved by LAC countries individually have taken place in a general context of increasing pressure on health budgets. Identifying the countries that do better than others in translating health resources into better outcomes, as well as understanding the reasons for these differences in performance, represent essential steps to the development of policies that ensure sustained progress towards universal health coverage (UHC) and health for all.

Objectives, methods and data. Our study seeks to identify the levels of efficiency and their possible determinants across LAC health systems, as well as to provide insights into the quantitative influence of these potential determinants on observed levels of health system efficiency in the region. We use state-of-the-art developments in data envelopment analysis (DEA) as the cornerstone method to analyze the links between efficiency in the achievement of health system objectives and certain system characteristics at the country level. For each country, DEA looks for all other countries that achieve the same (or better) health outputs at lowest use of inputs. Conversely, it can be used to search for the other countries that use the same (or lower) inputs and achieve the highest level of outputs. We apply DEA methods to examine the efficiency with which the health systems of LAC countries translate existing resources into a given level of performance, measured by a number of alternative health system outputs.

For the first part of this study, we have assembled a database with annual information for 27 LAC countries: 26 Inter-American Development (IDB) members plus Cuba. A second part of the analyses extends the sample to include the group of OECD economies as well as selected middle-income countries (MICs) from other regions, so as to benchmark the efficiency performance of LAC countries, leading to a total of 71 countries in this enlarged sample. Aggregate data for all these countries have been collected from international, publicly available sources, including information from the World Bank World Development Indicators, the WHO Global Health Observatory repository, OECD and IDB sources.

We measure efficiency performance using seven main health system outputs: three health outcomes (*life expectancy at birth*, *under-five mortality rate* and *disability-adjusted life years lost for all causes*); two indicators of access to services (*skilled birth attendance* and *DPT immunization rates*); and two indicators of equity of access to services (*ratio poorest/richest wealth quintiles of births attended by skilled health staff* and *ratio rural/urban of births attended by skilled health staff*). In additional estimations, we examine two further output measures: *life expectancy at age 60* and the *pooled spending share of total health financing* (proxy for financial protection). Output indicators are used as five-year averages (2011-2015) in the estimations. Taken together, our analyses explore a broad range of indicators in key areas of the health system.

The fundamental input required to achieve improvements in access to care and population health status is spending on health services. Thus, our analysis assesses the extent to which countries differ in the success with which their health expenditures achieve a given level of performance. Our main input indicator is *pooled prepaid health expenditure per capita* (public spending on health plus voluntary health insurance payments) at PPP constant international dollars. This spending aggregate refers to funds paid by citizens before the need for medical care through sources such as taxation, social health insurance contributions and voluntary insurance plans. This is our main chosen input because, in principle, the consequent access to care and health improvements can arise regardless of who makes the prepayment. We also explore *public health expenditure per capita* and *total health expenditure per capita* as alternative input measures. Input indicators are used as lagged five-year averages (2006-2010) to account for the fact that increases in health expenditures in one year may take some time to be translated into improvements to the health system and better health conditions. Finally, by including indicators of *GDP per capita* and the *share of population aged 65 and above* (as well as *smoking prevalence* in alternative estimations) as additional DEA inputs, our analysis acknowledges that a country's ability to maximize the impact of a given level of financial resources on access to care and health outcomes may be affected by its levels of economic, social and institutional development – i.e. constraints that may be completely external to the health system.

This study goes one step further than much of the available literature to assess what factors act as the main possible determinants, and to what extent, for some countries to be able to translate a given level of health financing into better performance on access and health outputs than that achieved by other countries. Through robust regression techniques, in the main analyses we examine associations between measured levels of health system efficiency and policy choices related to: the organization of healthcare financing and delivery (*out-of-pocket health expenditure share of total health expenditure* and *hospital beds per 1,000 people*); quality of governance (*indices for six governance sub-dimensions*, in addition to an *average governance index*); and the quality of health system institutions (survey-based indices for *medium-term sectoral vision for the health system in line with the government plan*; *results-based management in the production of goods and services*; and *sectoral*

information systems; plus an *average health system institutional quality index*). We undertake these analyses for both the LAC-only and enlarged samples of countries, although in the latter case issues around data comparability for the health system institutional quality measures impose a limit to the conclusions.

Key results and implications for policy. The first main message from our analyses is that there is substantial room for efficiency improvements in the health system of most LAC countries. The potential gains that LAC countries could make by approaching the estimated efficiency frontier for population health outcomes and provision of access to services, while keeping their current health budget, are typically large. For example, at current spending levels, LAC countries could improve life expectancy at birth up to about 4 years on average if they followed best practices. Despite relatively good efficiency performance for under-five mortality and life expectancy at age 60, LAC health systems perform especially poorly compared to the OECD and other MICs regarding the provision of equitable access to services for their levels of health spending.

Within the LAC region, Chile, Costa Rica, Cuba, Jamaica and Uruguay are consistent efficiency frontrunners across our numerous estimations and robustness checks. The lack of comparable countries for Haiti in some DEA estimations (in terms of its uniquely low health spending level within the LAC group) means that the country reaches the efficiency frontier in some analyses, although the country's measured efficiency performance becomes low when comparisons include MICs with similar health spending levels. Consistent underperformers in health system efficiency across our several analyses include Bolivia, Guatemala, Panama, Peru and Suriname. There are, of course, countries that perform much better for specific groups of outputs (e.g. health outcomes) than others (e.g. equity of access to care).

Another message from our study is that efforts to increase health system efficiency could be focused in a few key policy areas that, we find, are linked to cross-country efficiency variations in LAC, including general governance aspects. The relationship between better governance and higher system efficiency is apparent when comparing LAC countries among themselves (where governance is linked mainly to efficiency in the provision of wider and equitable access to services) and, even more strongly, when LAC countries are contrasted to their OECD and MIC counterparts (with governance quality also associated directly with efficiency in generating better population health). In general, countries with the most efficient health systems score highly in aspects such as government effectiveness, transparency and citizens' participation in policymaking, and regulatory quality.

Our empirical results also suggest that greater health system efficiency in LAC could be stimulated by improvements in the quality of health institutions. The most compelling evidence we find in that respect refers to the correlation between institutional factors and efficiency in the provision of access to health services. Countries with 'better' health system institutions – mainly in the sense of having (1) a medium-term sectoral vision aligned with the

overall government strategy, and (2) results-based management of health service provision – tend to be also those providing wider access to needed healthcare services, for a given level of health expenditure. Our study pinpoints a few experiences in some efficient health systems in LAC and elsewhere that may offer useful insights to LAC countries currently considering planning and organization reforms to improve their spending performance. This includes broad areas linked to the operation of medium-term expenditure frameworks, provider reimbursement and expansions in primary care, among others. Unfortunately, the general absence of reliable quantitative evidence about the efficiency consequences of many system reforms implemented in LAC restricts what can be learnt from these experiences by other countries of the region.

Although the large potential efficiency gains in LAC health systems should be actively sought by policymakers, both as a matter of public sector accountability and as a crucial step in the progress of less efficient countries towards UHC, our results highlight some cautionary notes for health policy. A key finding is that even the highest health spenders in the LAC region are not necessarily close to achieving the levels of outcomes typically found, for example, among OECD countries, and reductions in current health expenditure levels – a key input to enhance the quantity and quality of health services – would likely be counterproductive for health development. We find that there is very limited scope for health expenditure savings in most LAC countries deemed 'inefficient' without harming health outputs, as opposed to the potentially huge gains in system outputs that the same countries could achieve by using existing resources more efficiently. Therefore, a crucial policy implication for health system efficiency is that LAC countries should seek ways to improve the health outcomes and coverage indicators achieved for their current levels of resources, rather than seek to reduce their health expenditure levels – which are already low compared to typical spending figures among OECD countries, for instance.

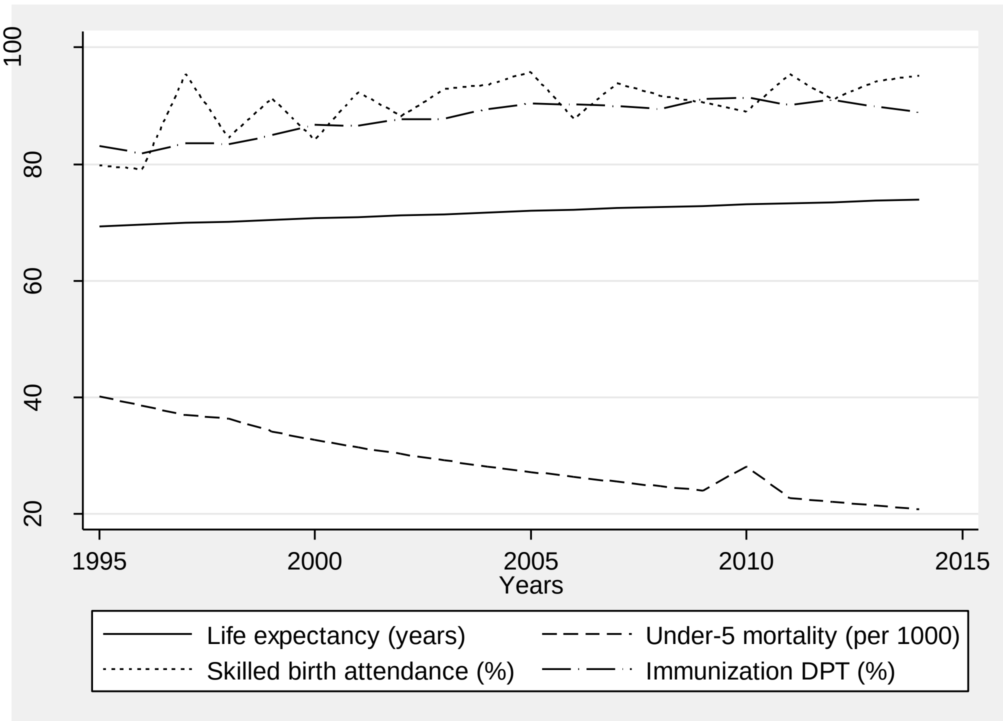
Section 1 Introduction

1.1 Background and motivation

During most of the 2000s, the majority of Latin America and Caribbean (LAC) economies experienced sustained growth and improvements in social indicators, as shown among others by the evolution of real GDP growth and poverty reduction data (World Bank 2017). Yet this trend has stalled in many countries of the region since the onset of the global financial crisis in 2008. And despite recent progress, social inequalities remain pervasive in the region, with World Bank data on Gini indices placing 10 LAC countries among the 15 most unequal in terms of income distribution (World Bank 2017).

The situation in the health sector closely resembles the panorama described above. As a general rule, LAC countries have achieved great improvements in health and well-being. Average life expectancy has been rising significantly for example, while under-five mortality rates have been consistently reduced (Figure 1). Health systems have likely represented a crucial driver of this progress through a widening of access to necessary health services for citizens. Service utilization measures commonly used as proxies for access to needed services, such as coverage of skilled birth attendance and immunization rates, have improved continuously during the 2000s (Figure 1).

Figure 1: Selected health outcomes and coverage indicators in LAC (1995-2014)



Much of this health progress has been spurred within the wider context of the global push for universal health coverage (UHC). Yet progress towards UHC entails not only aggregate

improvements in service access and health outcomes; at the center of this health agenda is also the drive to address unmet needs and health inequities (WHO 2010). A massive 125 million people in the LAC region still lack access to basic health services (PAHO 2016). Health inequities persist among and within countries, with some countries in the region exhibiting far better progress than others judged by average improvements in key indicators, and in many instances health improvements have occurred favoring certain population groups at a disproportionate rate. Haitians are expected to live 62 years on average, as compared to 79 years for Costa Ricans, and while under-five mortality is as low as 5.5 per 1,000 live births in Cuba, this figure reaches 39.4 per 1,000 live births in Guyana. Maternal mortality in rural areas in Bolivia is twice as high as in more urban areas, a pattern emulated by many other LAC countries (World Bank 2017; PAHO 2016; Etienne 2013).

The mixed health results achieved by LAC countries individually have taken place in a general context of increasing pressure on health budgets. Although the share of public spending directed to the health sector in LAC countries has increased by as much as 41% between 2000-2012 on average, cost pressures arising from technological advances and changes to the demographic and epidemiological profiles mean that health expenditures will likely continue to grow at rates above economic growth in some countries of the region (de la Maisonneuve and Oliveira Martins 2013). In such a scenario, increased efficiency in the use of existing resources becomes an immediate target for health policy action in order to help reduce cost pressures in the health system, while still making progress towards UHC goals and better population health.

In LAC, as in other regions of the world, countries vary significantly in terms of the population health indicators achieved for similar amounts of resources devoted to health (see next sections). Identifying the countries that do better than others in translating health resources into better outcomes, as well as understanding the reasons for these differences in performance, represent essential steps to the development of policies that ensure sustained progress towards UHC and health for all. This is an even more pressing need in the challenging economic context currently faced by many LAC countries, constraining public expenditures and public spending on health in particular.

1.2 Our study and this report

Our study seeks to identify the levels of efficiency and their possible determinants across LAC health systems, as well as to provide insights into the quantitative influence of these potential determinants on observed levels of health system efficiency in the region. The main methodology adopted for the investigation of efficiency levels is Data Envelopment Analysis, applied to country-level annual data.

This report presents a selected literature review and the methodological framework to underpin the efficiency analyses, discusses data sources and collection issues, and presents our analytical results about comparative levels of efficiency among LAC countries and their

possible determinants. The main analyses presented here are subject to a battery of robustness checks, and results from relevant extensions of the main analyses are also discussed. This report also presents the results of analyses that compare the levels of health system efficiency in LAC countries with those of OECD countries and selected emerging economies. The report concludes with a discussion of implications for regional health policy and the main limitations of the study.

Section 2 Health system efficiency

2.1 The measurement of health system efficiency

When comparing the performance of health systems, it is common for commentators to refer to these systems as being more or less 'efficient', or more or less 'productive', based on measures of health-related inputs and outputs. Often efficiency and productivity are presented as inherently linked ideas in practice, with the latter referring to the extent to which the resources used by the health system are used 'efficiently' in the pursuit of its goals (Smith et al. 2013).

An immediate question that arises is what the goals of a health system ought to be. There is a fair degree of consensus that the fundamental goal of health systems is to improve the health of the population (WHO 2010). Further key objectives pursued by national governments and international organizations include, among others, good performance on access to needed health services and 'responsiveness' to individual needs and preferences of patients; as well as equity in access, health outcomes and health payments (Smith et al. 2013). Population health has traditionally been measured using broad indicators such as standardized mortality rates, life expectancy and disability-adjusted life years (DALYs) (cf. e.g. Moreno-Serra and Smith 2014; Moreno-Serra et al. 2016). Metrics have also been developed to assess attainment in the other system goals mentioned, while indicators of overall and sectoral health expenditures have been commonly employed as summary measures of the resources – or inputs – consumed to achieve a given level of performance around set objectives.

A further challenge for health system efficiency comparisons is that 'inefficiency' is intrinsically difficult to measure, as it represents the shortfall in performance from what could in principle be achieved – the latter usually an unobserved concept that is open to challenge. The most common approach to inferring inefficiency has been to construct an estimate of the 'health production frontier' (or its analogue, the cost function) on the basis of the observed performance among exemplar units of observation, in this case health systems (Jacobs et al. 2006). The reasoning behind this approach is that, even though we cannot know 'true' potential with absolute certainty, we can observe best practice and its change over time, as well as performance among health systems operating below observed best practice. This was the principle underlying the World Health Report 2000 and most of the subsequent efforts to assess health system performance (WHO 2000). The report of its Scientific Peer Review Group lays out the several challenges associated with such an undertaking (Anand et al. 2002).

The above reasoning leads naturally to the association of 'efficient' performance with operation on a best-practice frontier, and thus any 'inefficient' performance with operation on the wrong side of that frontier. For practical analyses, the construction of the frontier and the positioning of units of observation with respect to the latter become an empirical matter. Two approaches have dominated the productivity literature: econometric methods, pre-

eminently various forms of statistical methods such as panel data models and stochastic frontier analysis, and the descriptive methods known as Data Envelopment Analysis (DEA). Although these methods approach the task in radically different fashions, they have the common intention of using the observed behavior of all units to infer the maximum feasible level of attainment (the production function), and offering estimates of the extent to which each individual unit falls short of that optimum.

2.2 Available evidence on the efficiency of health systems

There is now a good amount of evidence available about the relative levels of efficiency in the health sector of high-income countries, produced using alternative variations of the analytic approaches mentioned above (Cylus et al. 2016).

In its review of the recent literature, Medeiros and Schwierz (2015) conclude that there is evidence of widespread inefficiencies in the health sector of several OECD countries that help explain their differences in health attainment. These inefficiencies relate to aspects including sub-optimal provision of hospital care, imbalances around physical and human resources relative to health needs, inadequate access to health prevention and promotion activities, and institutional factors such as deficient data collection, insufficient use of health technology assessment in decision-making and weak governance of the health system, among others. From their own DEA work, Medeiros and Schwierz find that life expectancy at birth could be increased by around 2.3% on average (or 1.8 years) if inefficient countries moved from their current position to the efficiency frontier. The worst performers in terms of health system efficiency were identified as the Czech Republic, Lithuania and Slovakia, while Belgium, Cyprus, Spain, France, Italy, Sweden and the Netherlands performed consistently well in the DEA models used.

Despite the importance and timeliness of the topic, there is very little accumulated evidence on the degree and determinants of health system efficiency in the LAC region as a whole, with the exception of ad-hoc analyses of specific sectors in a few particular countries. Much of this work has focused on the primary care sector, where DEA and other techniques have been used to study efficiency at the micro and meso levels of care provision. For example, wide variations in technical efficiency concerning the levels of provision of various services across primary care facilities have been identified in rural Guatemala (relative to the number of health workers as input; Hernandez and San Sebastian 2014), Lima-Peru (relative to personnel and other expenditure categories; Ligarda and Ñaccha 2006), Chilean municipalities (relative to general expenditures in primary care; Ramirez-Valdivia et al. 2011), Bucaramanga-Colombia (relative to general expenditures in primary care; Ruiz-Rodriguez et al. 2016), Nuevo Leon-Mexico (focused on diabetes care and work-hours allocated to such care; Salinas-Martinez et al. 2009) and small Brazilian municipalities (relative to general expenditures in primary care by the public sector; Varela et al. 2010).

Rigorous studies measuring and comparing efficiency levels specifically across the health systems of LAC countries are conspicuous by their absence. A few studies have attempted to measure health system efficiency using samples that include all world countries with available data, focusing often on comparisons of average efficiency across regions. Herrera and Pang (2005) apply DEA and other methods to estimate public expenditure efficiency in the health and education sectors, using a sample of 140 developing countries for the period 1996-2002. The authors use alternative measures of life expectancy and immunization coverage as output indicators in the health analyses. Although there is variation in efficiency performance depending on whether single or multiple inputs and outputs are considered, results for LAC countries usually indicate Chile, Costa Rica and Trinidad and Tobago as the most efficient systems in the region, while Argentina and Barbados are explicitly mentioned as least efficient in some analyses. Grigoli and Kapsoli (2013) also examine public expenditure efficiency with respect to health-adjusted life expectancy on a sample of 80 developing countries, but use stochastic frontier modelling with data for a longer period (2001-2010). The authors find that African countries have the highest levels of inefficiency (i.e. largest potential gains in life expectancy for current spending levels), while LAC countries have generally smaller potential gains for current spending, ranging from 4.7 years in Barbados to only 1.2 years in Haiti (most efficient).

Gonzalez et al. (2010) employ DEA and other methods on a broader sample of 165 developed and developing economies observed in 2004. Their goal was to compare health system efficiency across clusters of countries grouped according to income levels, using healthy life expectancy and DALYs as system outputs, and public spending on health as the input indicator. According to the efficiency scores reported in the study, Chile and Costa Rica once again appear as leaders on efficiency performance in LAC. Jowett et al. (2016) also use DEA to compare low- and middle-income country performance on UHC progress indicators for service coverage and financial protection, with respect to a country's public spending on health per capita. The authors measure performance using five service coverage indicators (e.g. DPT3 immunization, skilled attendance at birth), and one measure of financial protection (public expenditure on health as percentage of total health expenditure). Their results point to high levels of variation across countries in terms of UHC performance, particularly at low levels of public spending where some countries achieve a performance less than half of others with similar levels of spending. However, even at higher levels of public spending there are large differences in how much financial protection countries achieve for greater public spending on health. These results suggest, once again, that there is significant room for advances in key health indicators in many countries through health system efficiency improvements, within the already existing pool of resources for the sector.

As with the other previous studies, although the dataset analyzed by Jowett et al. (2016) does include some LAC countries, the disaggregated analyses focus mostly on the poorest countries of Africa and Asia. Only two LAC countries are mentioned explicitly. The first is Cuba, who is among the six most efficient countries judged by UHC indicators achieved vis-à-vis the level

of public spending on health. The second country is Haiti, which in some analyses is also among the best performers. A closer look to the data used by Jowett et al. reveals that the main likely driver behind Haiti's high DEA efficiency scores is the country's very low level of public spending on health (10.81 dollars per capita), which is seen in a 'favorable' efficiency light by the mechanics of DEA, despite Haiti's generally poor UHC indicators (e.g. population coverage below 50% for three services and less than 10% share of public spending over total health spending). Although DEA represents one of the most useful and flexible approaches to measure and compare efficiency, this issue highlights the need to understand its limitations and further scrutinize the results obtained – as with any other analytical methods used.[2] We return to this point in the next section and for the discussion of our results.

Our study fills some important gaps in the aforementioned literature, as explained in the next sections. There is little policy-relevant guidance that can be derived from the current cross-country literature about which specific actions countries can take (that is, factors under more direct policy control) to improve health system efficiency. Even when previous studies have examined factors correlated with efficiency performance, such factors are usually proxied through indicators that are too broad, and/or have very limited direct relationship with the functioning of the health system, to be of useful guidance for policymakers (e.g. urbanization, income distribution). Moreover, although efficiency analyses have examined expenditure efficiency relative to some important health indicators (e.g. life expectancy measures), they have usually ignored other key outputs of the health system, particularly those related to equity of access to services – a fundamental component of the UHC agenda (WHO 2010). Our study contributes to the knowledge base in the above areas by performing head-to-head comparisons of health system efficiency specifically among *all* LAC countries, and also by benchmarking the results for LAC against other emerging and developed economies.

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[2] It is noteworthy that Haiti is found to be the most efficient health system in LAC according to the results from Grigoli and Kapsoli (2013), obtained using stochastic frontier analysis. This indicates the need to scrutinize further the results and limitations of any efficiency analytic technique, not just DEA of course.

Section 3 Methodology and data

3.1 Data envelopment analysis (DEA)

The problems associated with using statistical models to infer health system efficiency have been exhaustively documented (cf. e.g. Anand et al. 2002). In general, they do not appear to offer much help in tackling questions underlying health system efficiency primarily because they require specification of a functional form, i.e. the specific relationship between inputs and health outputs. These models also require prior evidence about the main determinant factors driving variations in health outputs – in other words, what factors could be considered as relevant inputs. It is rarely the case in health system studies for the cause-and-effect links between inputs and outcomes to be unequivocally known. This leads to much subjectivity in the choice of relationship patterns among explanatory variables (e.g. additive or multiplicative, linear or non-linear), and between them and the independent variable(s) of interest. In the absence of clear natural experiments where exogenous events lead to differential changes in system inputs across countries, it is often difficult to ascertain whether a systematic relationship found between (say) health expenditures, other system inputs and population outcomes is due to a genuine causal relationship or, instead, to an incorrectly specified functional form.

Our study uses DEA as the cornerstone method to analyze the links between efficiency in the achievement of health system objectives and certain system characteristics at the country level. DEA is based on the economic principles of cost and production functions, but uses estimation techniques based on linear programing models (Jacobs et al. 2006). It searches for the units that 'envelope' all other units on the basis of a composite estimate of efficiency. For each unit, DEA looks for all other units that achieve the same (or better) outputs at lowest use of inputs. Conversely, it can be used to search for the other units that use the same (or lower) inputs and achieve the highest level of outputs. For each unit – a country and its health system in our case – the ratio of actual to 'optimal' performance (or best practice) is referred to as inefficiency. The economic foundations of DEA and general guidance to how its results should be interpreted are detailed in Annex B.

Compared to statistical methods, DEA has some attractive features. It requires none of the restrictive assumptions required to undertake regression methods. It can handle multiple inputs and multiple outputs simultaneously, and it requires none of the stringent model testing that is required of statistical techniques. And if the interest lies in multiple criteria (i.e. outputs) to assess the performance of units, something desirable from a health system perspective, DEA does not require the analyst to pre-define weights for these criteria – yet the method is flexible enough to accommodate alternative weighting schemes in the analysis if desired.

Some caveats of DEA must be noted, however, because they influence the interpretation of results obtained and the implied policy conclusions. Although data on multiple inputs may be

included in the analyses, DEA studies need to be parsimonious in the selection of inputs. For health system efficiency analyses, this means focusing ideally on a small set of indicators that represent the main system and environmental factors potentially influencing health system outcomes. The main reason for this procedure derives from an intrinsic limitation of DEA models. The inclusion of more constraints offers units (countries) more potential 'excuses' for lower levels of performance, which in turn implies that an increasing number of units are likely to lie on the 'best practice' frontier. In our context this would reduce the capacity to discriminate among countries and their health systems. This may be appropriate, but requires careful scrutiny. The construction of efficiency frontiers using DEA may also be more sensitive to the presence of outliers than statistical models, in the sense that a unit employing very low levels of inputs (compared to all other units) may be considered efficient despite 'poor' relative performance on outputs. As detailed in the next sections, our study examines a range of modelling perspectives in order to identify the sensitivity of judgments to different technical choices, including alternative sets of inputs and treatment of outliers.

Our study applies the DEA methods described above to examine the efficiency with which the health systems of LAC countries translate existing resources into a given level of performance. As detailed in the next sub-section, performance is measured through health outcomes and access to care indicators, whereas the main input in our models is health spending per capita. The analyses herein use the 'output orientation' specification throughout, with variable returns to scale. This indicates the extent to which a better performance on indicators of access to care and health outcomes could be obtained while still maintaining the same level of health expenditures. In simple terms, our approach identifies those LAC countries that achieve the best performance on output indicators for their level of health spending per capita, comparing other countries in relation to these 'best performing' countries. A country that is among the 'best performing' on access and health outputs given its current level of spending will receive a score of 100%; another country with a score of say 0.75 is then considered to be achieving progress at a level 75% of that in the 'best performing' country.

3.2 Data

Data limitations for LAC countries restrict the richness of information that can be used to assess health system efficiency, compared to the information available for most OECD countries for instance. As detailed in the document *Data Collection Progress Summary* submitted previously to the IDB, this study has started by assessing the trade-offs between data availability for LAC countries, quality and fitness for purpose, for the information contained in major international, publicly available sources. These include, among others, the World Bank World Development Indicators (WDI) and EdStats, the WHO Global Health Observatory repository and UNICEF databases.

We have assembled a database with annual information for 27 countries (26 IDB members plus Cuba). The indicators used in our main DEA estimations, extensions and sensitivity

analyses, as well as their sources and five-year average values for the relevant periods, are described in the sections below and in Table A 1 and Table A 2 in Annex A.[3]

3.2.1 Output indicators

Since there is general agreement that the ultimate goal of a health system should be to improve the health of patients and the general public, we measure performance primarily with regard to broad indicators of population health status, in line with the SDG3 health goals (UN 2016), along with key measures of progress towards UHC (service coverage indicators) agreed in the joint UHC monitoring framework (WHO and World Bank 2015). Also in line with both the SDG and UHC agendas, we acknowledge the relevance of assessing health system performance from the perspective of equity in access to necessary care. Therefore, for the main DEA estimations we examine data on:

(i) Health outcomes: **life expectancy at birth** (years); **under-five mortality rate** (per 1,000 live births); and **disability-adjusted life years lost** (DALYs, all causes, age-standardized, per 100,000 population);
(ii) Access to services: **skilled birth attendance** (percentage of deliveries); and **DPT immunization rate** (percentage of children aged 12-23 months);
(iii) Equity of access to services: **ratio poorest/richest wealth quintiles of births attended by skilled health staff**; **ratio rural/urban of births attended by skilled health staff**.

Life expectancy is a broad measure of population health and is widely available at the country level, although it may be influenced by many environmental factors beyond the control of the health system. Thus we also examine under-five mortality rates, which are considered good proxies for general population health status and tend to exhibit a sizeable component of deaths amenable to health system actions in low- and middle-income settings (UN 2016). The use of DALYs serves as a good complement to the two previous outcomes in that it provides an assessment of both years lost to premature *mortality* and years lost due to *morbidity* in a health system. Life expectancy and mortality data are available on an annual basis for all 27 countries up to years 2014 and 2015 (respectively), while DALY data are available for year 2012 only.

We proxy general access to the health system through rates of utilization of services that should be provided to entire population groups: skilled birth attendance and DPT vaccination. Together, these two proxies provide a good panorama of the conditions of access to the broader basket of services provided in a health system (WHO 2008). Data on skilled birth attendance are typically available for between 10-15 different countries for a given year up to 2014, while annual DPT immunization rates are available for all countries up to year 2015.

[3] The time period for which we have been able to collect the relevant country information varies by indicator, but most of the annual information spans the period 1995-2015.

In this study we move beyond average access patterns and investigate differences in access to the health system according to socio-economic conditions. For this we analyze data on the ratio of births attended by skilled health staff between the poorest and richest wealth quintiles, as well as the ratio of births attended by skilled staff between rural and urban populations. These data present some challenges: even after joining comparable information from various sources such as WHO, UNICEF and the World Bank, and considering the latest country data available between 1996-2015, we end up with usable data for a smaller sample of countries than for the other DEA outputs (19 countries for the poorest/richest ratio and 21 countries for the rural/urban ratio). In spite of these data limitations, we believe that an examination of equity of access conditions for most LAC countries, based on a key service such as skilled birth attendance, widens and strengthens our analyses by gathering evidence on the highly relevant issue of health-related inequities in the region.[4]

The DEA methodology requires that output variables are measured in a way to indicate that 'more is better'. Thus in the estimations we use the inverse of the under-five mortality rate and DALYs lost. Furthermore, for output indicators we use five-year averages (2011-2015) in the DEA estimations, instead of their most recent values (except for DALYs and the equity of access measures, due to the data limitations mentioned above). This is basically for two important reasons. First, using five-year averages allows us to explore data on specific indicators (e.g. skilled birth attendance) for more LAC countries than using just the latest data. Second, the averaging procedure reduces the influence of extreme values (outliers) observed for countries due to, for example, one-off epidemiological or economic shocks and/or data measurement errors.[5]

3.2.2 Input indicators

The fundamental input required to achieve improvements in access to care and population health status is spending on health services. These funds are deployed with varying levels of efficiency to provide access to needed health services by the population and secure better health outcomes. Our analysis assesses the extent to which countries differ in the success with which their health funds achieve a given level of performance.

Because among LAC countries health expenditures vary greatly in its mix of public and private expenditures, an analytical decision must be made on the specific spending aggregate to be examined as the main input of interest. Our study starts by using **pooled prepaid health expenditure per capita** (public spending on health plus voluntary health insurance payments)

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[4] Data for other indicators, such as antenatal care coverage, were explored by the research team but their use would imply a larger loss of LAC countries for the analyses due to missing information.

[5] A case in point is Haiti, for which the reported under-five mortality rate jumps from 81.2 (2009) to 208.8 (2010) and back to 77.2 (2011). The 2010 outlier point for Haiti shifts the average under-five mortality in LAC upwards for that particular year (see Figure 1). Since we use 2011-15 averaged values for outputs, the outlying value in 2010 does not affect our estimation results. But even if we had included the mortality figure for 2010 in our analyses, the five-year averaging procedure would have reduced the influence of such outlier.

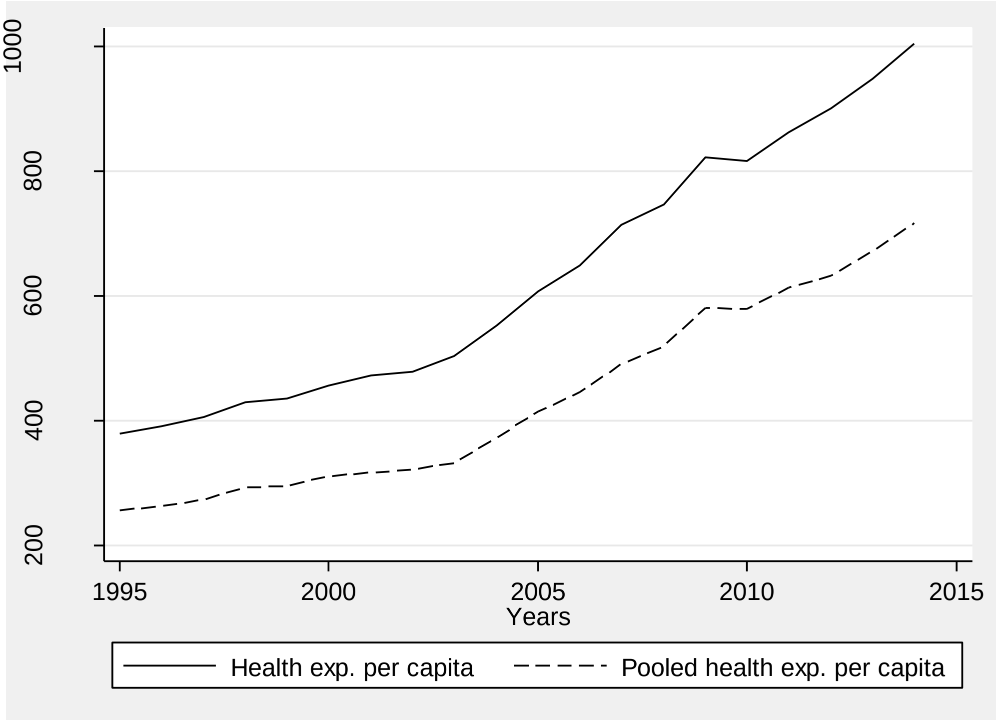
at PPP constant international dollars. This spending aggregate refers to funds paid by citizens before the need for medical care through sources such as taxation, social health insurance contributions and voluntary insurance plans. The causal influence of such pooled funds for improvements in access and population health has been established at the cross-country level (Moreno-Serra and Smith 2012; 2014). Within the wider context of push for UHC and progress around SDGs, pooled health financing indicates the prepaid resources that a nation is directly devoting to financial risk protection and effective access in the health sector, as opposed to out-of-pocket (OOP) health payments made directly to providers at the point of service use. We choose not to use just publicly pooled financing (i.e. public or government expenditures on health) because in principle the consequent access and health improvements can arise regardless of who makes the prepayment.

As alternative specifications, our study also explores using **total health expenditure per capita** (i.e. public plus private) or **public health expenditure per capita** at PPP constant international dollars instead as the main input in the DEA model. These results are presented as model extensions later in this report.[6]

Data on health expenditures are available annually for all 27 LAC countries up to year 2014. As it can be seen in Figure 2, both total and pooled health expenditure have been rising significantly in the LAC region since 1995, reaching averages of above 1,000 and 700 US dollars (constant 2011 international, PPP adjusted) in 2014, respectively. Yet countries differ substantially on the rates at which health spending increased over the period. For instance, while both total and pooled health expenditure rose in real terms by around 11% in Cuba, the same expenditure indicators increased by just about 2% in Venezuela. And although the average spending increase in the region was accompanied by average improvements in health attainment and access to care as mentioned above, the degree to which individual countries have improved health outputs varies considerably as well, with high spenders not necessarily being the best performers. In terms of pooled health expenditures, for example, Chile and Brazil spend similar amounts but the former country records a much higher life expectancy and significantly lower under-five mortality (Figure 3). A similar picture emerges if we examine total or public health expenditure per capita instead.

Figure 2: Total and pooled health expenditures per capita in LAC (1995-2014)

[6] All the health spending indicators refer to expenditures by financing agent, not financing source. So for example public health expenditure (main component of our measure of pooled health expenditure) consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds. Total health expenditure is the sum of public and private health expenditure.



We use five-year averages of our health expenditure measures in the DEA for the reasons discussed in the previous sub-section. Unlike outputs, however, we measure inputs as 2006-2010 averages. This responds to intuitive reasoning and empirical evidence about time lags in the causal chain between health spending, changes in service access and quality, and improvements in health outcomes at the country level. Investments in the health system in one year may not translate into improvements in access to care, efficiency performance and outcomes in the same year, due for instance to logistical constraints in reaching target populations or reorganizing service delivery and improving care quality (cf. Moreno-Serra and Smith 2012). Indeed, empirical studies have shown that increases in healthcare spending and utilization, as well as efficiency-seeking reorganizations of the health system, generate changes in population outcomes that may not be evident immediately and may arise over a long time span, such as for life expectancy.[7] In our study we are constrained by the available data series, but a five-year lag period seems appropriate to capture at least some of the changes that could be induced in our set of health outputs by variations in system funding levels. Therefore, by using inputs measured with a lag compared to the measurement of outputs, our analyses account for the fact that increases in health expenditures in one year may take some time to be translated into improvements to the health system and better health conditions judged, for example, by higher life expectancy.[8]

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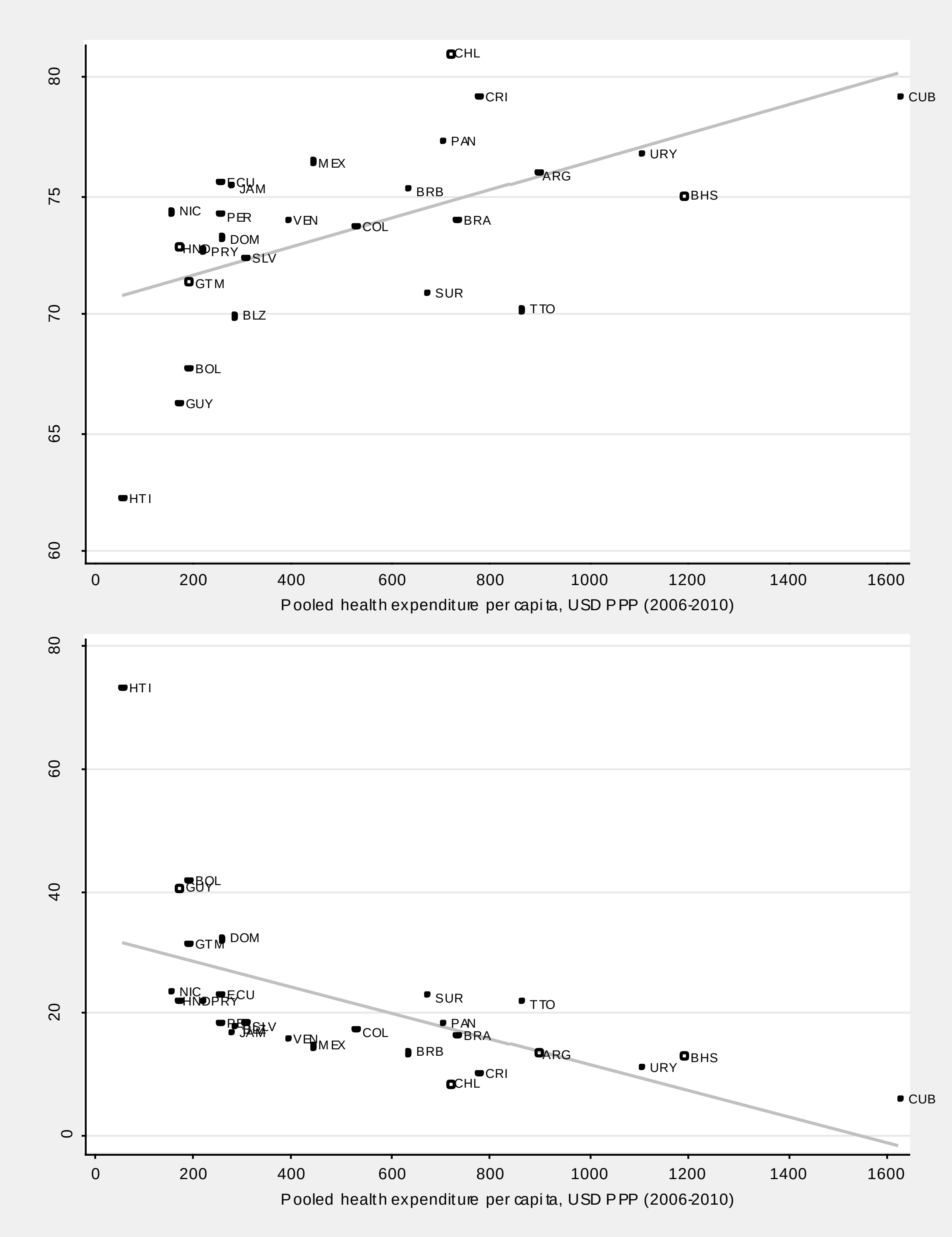
[7] For instance, a study by the Antiretroviral Therapy Cohort Collaboration (2008) found measurable life expectancy gains on the aggregate accruing for periods between 5 to 10 years after access to ART treatment.

[8] Grigoli and Kapsoli (2013) adopt a similar approach in their study, with the five-year averages of health outputs modelled as a function of the average expenditure per capita in the preceding five-year period.

Figure 3: Life expectancy, under-five mortality and pooled health expenditures per capita



3.2.3 Other inputs: external constraints

A country's ability to maximize the impact of a given level of financial resources on access to care and health outcomes may be affected by its levels of economic, social and institutional development. Many of these factors may be completely external to the health system. We

therefore also examine the degree to which the efficiency results are affected by acknowledging that such external factors may be uncontrollable influences on attainment. Subject to the limitations in cross-country data, we include as additional inputs (constraints) in the DEA model:

(i) National income: **GDP per capita** (constant 2011 PPP international dollars);
(ii) Age structure/demographics: **population aged 65 and above** (percentage of total).

Annual information for both variables above is available up to year 2015 for all LAC countries. As in the case of health spending measures, in the DEA estimations we use five-year averages (2006-2010) of GDP per capita and share of population aged 65.[9]

In our analyses we experimented with alternative specifications including other external constraints on performance, such as education achievement (average years of total schooling, age 15+), improved water source (percentage of population with access) and improved sanitation facilities (percentage of population with access). However, these indicators add limited information to the models compared to the information provided by (i) and (ii).[10] Moreover, including these additional external constraints in the models leads to an inflation in the number of countries in the efficiency frontier, as alluded to in the previous sub-section. For these reasons we do not include in our models other external inputs beyond (i) and (ii).[11]

We have therefore opted for estimating three alternative DEA models for each health system output measure. Model (1) has pooled health spending per capita as the sole input. Model (2) includes pooled health spending per capita and GDP per capita. Finally, model (3) includes pooled health spending per capita, GDP per capita and population aged 65 and above as inputs.

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[9] DEA requires that inputs are also measured in a way that 'more' leads to 'better' performance. Therefore we use the inverse of the share of the population aged 65 and above in the estimations, so as to express that a higher share of elderly population in a given country may impose an additional constraint for the achievement of better average health status.

[10] This is shown, for instance, by correlation coefficients ranging between 0.55 and 0.68 (statistically significant at 1%) between GDP per capita and each of the education, sanitation and water indicators. Thus, in our dataset, GDP per capita constitutes a good proxy for these three other indicators as well.

[11] We have also attempted to explore data on lifestyle factors such as alcohol consumption and smoking prevalence figures as additional performance constraints, but these are unavailable for a large number of LAC countries unfortunately. See Section 6 for some restricted analyses using smoking prevalence as an additional DEA input.

Section 4 Main results

4.1 DEA results on the levels of health system efficiency in LAC

The full results with the DEA efficiency scores for the 21 models estimated (three DEA models for each of the seven health system outputs) are presented in Table A 3, Annex A.[12] The overall message from these estimations is that there is scope for efficiency improvements in the health system of many LAC countries, both in terms of access to care and population health indicators.

For example, taking life expectancy as the output and pooled spending as the single input, Chile, Ecuador, Haiti and Nicaragua stand out as the most efficient countries (Table A 3, column 1). Adding GDP per capita to the input set as an external constraint on achievement includes Costa Rica in the list of efficient countries (column 2), whereas the further addition of population aged 65 and above as an input reveals also Barbados, Cuba, Jamaica and Uruguay as efficient countries (column 3). Looking at the DEA scores for health outcomes and 'inefficient' countries, we can see that Trinidad and Tobago reaches 86% of the life expectancy achieved by its efficient peers for a similar level of inputs, while Guyana reaches less than 66% of the performance by its efficient peers in DALYs lost. On the other hand, for outputs pertaining to the conditions of access to health services, Guyana is instead usually among the most efficient performers, alongside countries such as Barbados and Jamaica. By contrast, Guatemala obtains only about 67% and 44% of the performance reached by its efficient peers on overall skilled birth attendance coverage and the poorest/richest skilled birth attendance ratio, respectively.

It is important to emphasize that the efficient countries are not necessarily the best *absolute* performers judged by health outcome and care access outputs; rather, DEA results should be interpreted as indicating that those countries show the best outputs *for their given level of pooled health spending and other inputs*. The correct interpretation of DEA results helps understand the case of Haiti which, despite exhibiting the worst levels of health outputs in the region, is located in the efficiency frontier mainly as a result of the country's very low level of per capita spending on health, for which there are no close peers in the sample (Table A 2). We have previously discussed this limitation of DEA analyses which, as with the limitations of any other methodologies, should be taken into account to avoid unwarranted mechanistic conclusions. We address the possibility of Haiti's outlying indicators driving any of our conclusions by re-running all DEA models excluding Haiti data, and find that our conclusions for all other LAC countries remain unchanged. This result was to be expected as Haiti, because of its input levels far from those of other LAC countries, is not normally used as peer to

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[12] Fewer than 21 models could be estimated for some countries due to missing information on specific output indicators, for instance missing data on both the poorest/richest and rural/urban ratios of skilled birth attendance for Bahamas, Chile, Paraguay and Venezuela.

compute efficiency levels for the other countries in the sample. The DEA efficiency estimates without Haiti are presented as a sensitivity analysis later in this report.

Taking the three DEA model specifications together for each output, a consistent picture in terms of health system performance and country rankings emerges. Table A 4 (Annex A) shows the average efficiency scores across models (1), (2) and (3) for each country, by output indicator, along with the number of times each country ranks in the lowest or highest 25% of efficiency scores (i.e. worst and best performers, respectively) across all models. Chile, Haiti and Nicaragua are among the top 25% performers across most of the DEA models estimated. Cuba and Jamaica also score among top performers in more than half of the models. On the other hand, Bolivia, Guatemala, Panama and Suriname are often among the worst performers.

Disentangling efficiency performance by type of output, we can see from Table A 4 that Chile, Costa Rica, Honduras, Haiti, Jamaica and Nicaragua are consistently among the most efficient countries with respect to population health outcomes given their levels of inputs. As for efficiency on the provision of wider and more equitable access to health services, consistently efficient performers include Guyana and Jamaica.[13]

A graphical representation is useful to visualize the position of all countries relative to the estimated efficiency frontier (Figure 4 to Figure 10). Since the representation is two-dimensional, we focus on pooled health expenditure per capita as single input (model 1). Vertical distances to the efficiency frontier provide a measure of the degree of inefficiency for a country spending a given amount of resources. In general, these distances are typically larger and have wider sample variation for life expectancy, DALYs lost, DPT immunization and the poorest/richest ratio of skilled birth attendance. This can also be seen by plotting country average efficiency scores for each output indicator (Figure A 1-Figure A 7, Annex A).

[13] The estimated efficiency scores are highly and positively correlated across all models for our three health outcomes (average correlation coefficient = 0.73). The same applies to the efficiency score correlations across skilled birth attendance, DPT immunization, and the skilled birth attendance poorest/richest and rural/urban ratios (average correlation coefficient = 0.61). See Table A 5 in Annex A. This further highlights the consistent picture of relative health system performance in LAC arising from our analyses.

Figure 4: Estimated efficiency frontier for life expectancy at birth (years)

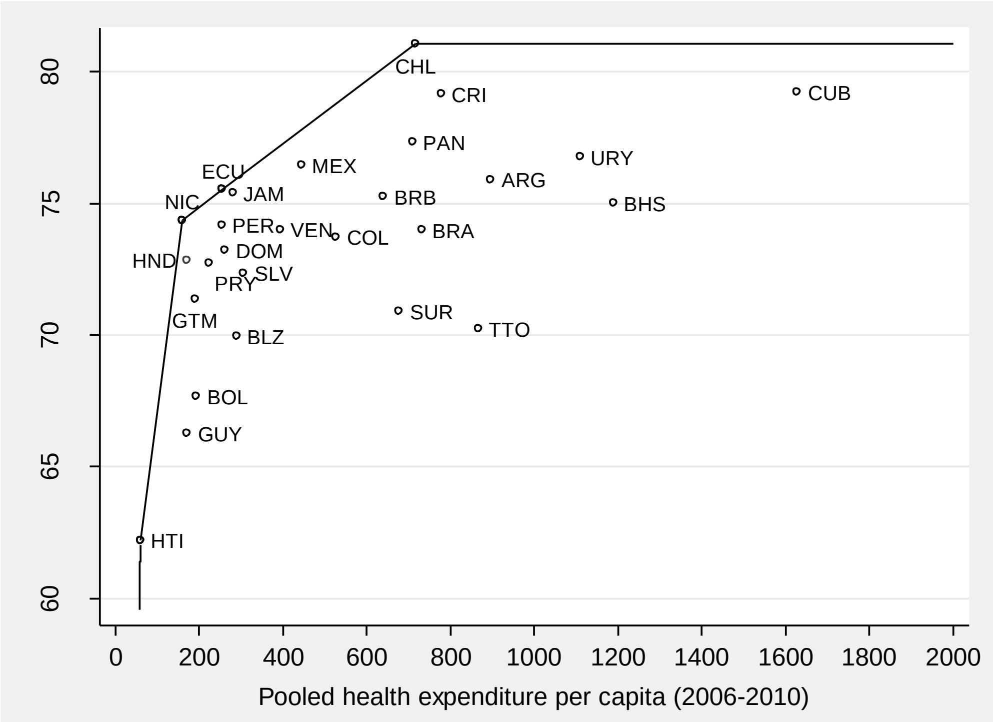


Figure 5: Estimated efficiency frontier for under-five mortality rate (per 1,000)

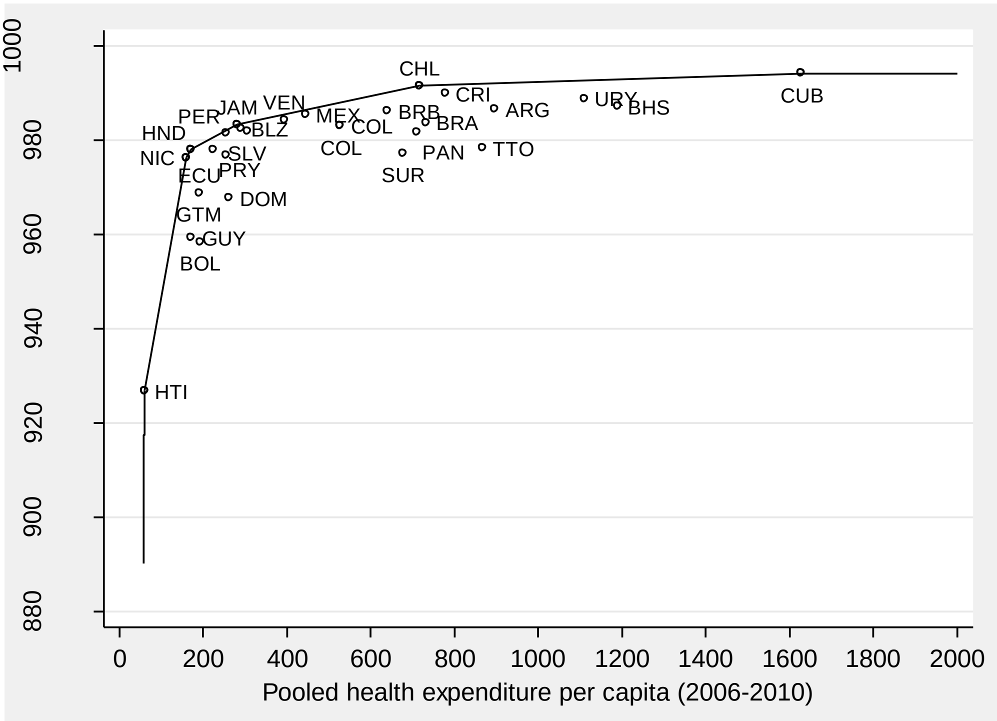


Figure 6: Estimated efficiency frontier for DALYs lost (per 100,000)

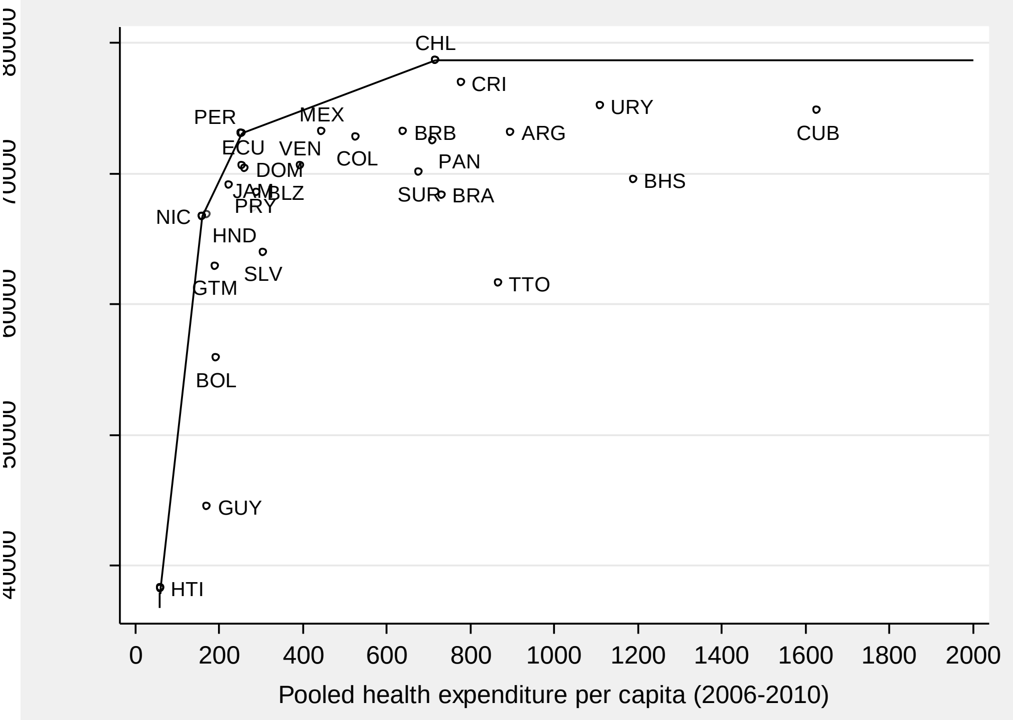


Figure 7: Estimated efficiency frontier for skilled birth attendance rate (percentage of total)

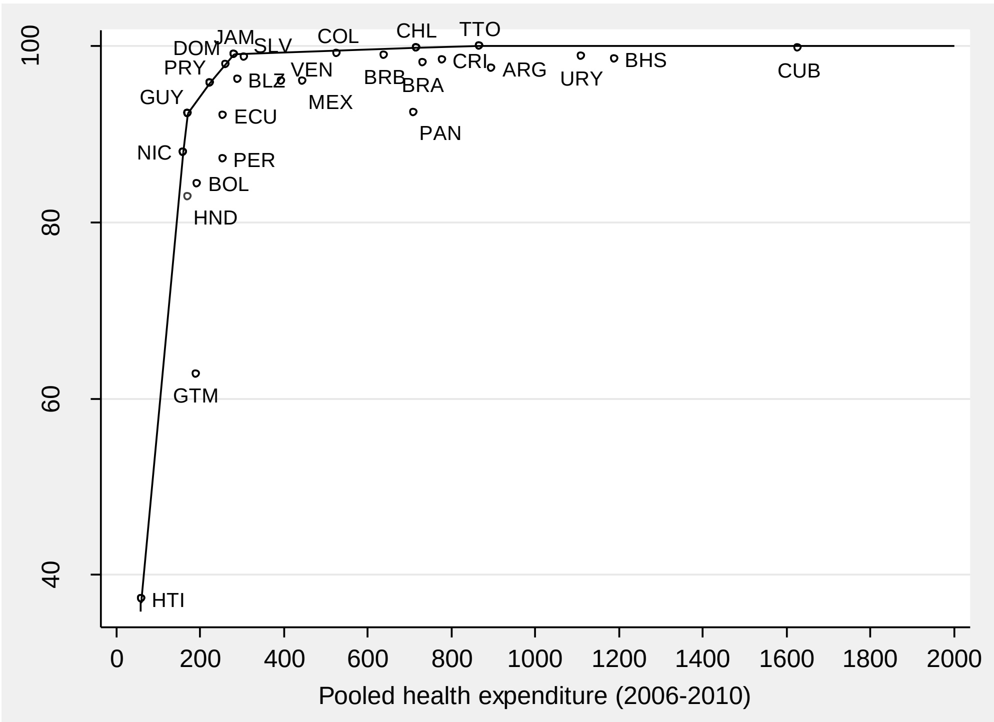


Figure 8: Estimated efficiency frontier for DPT immunization rate (percentage)

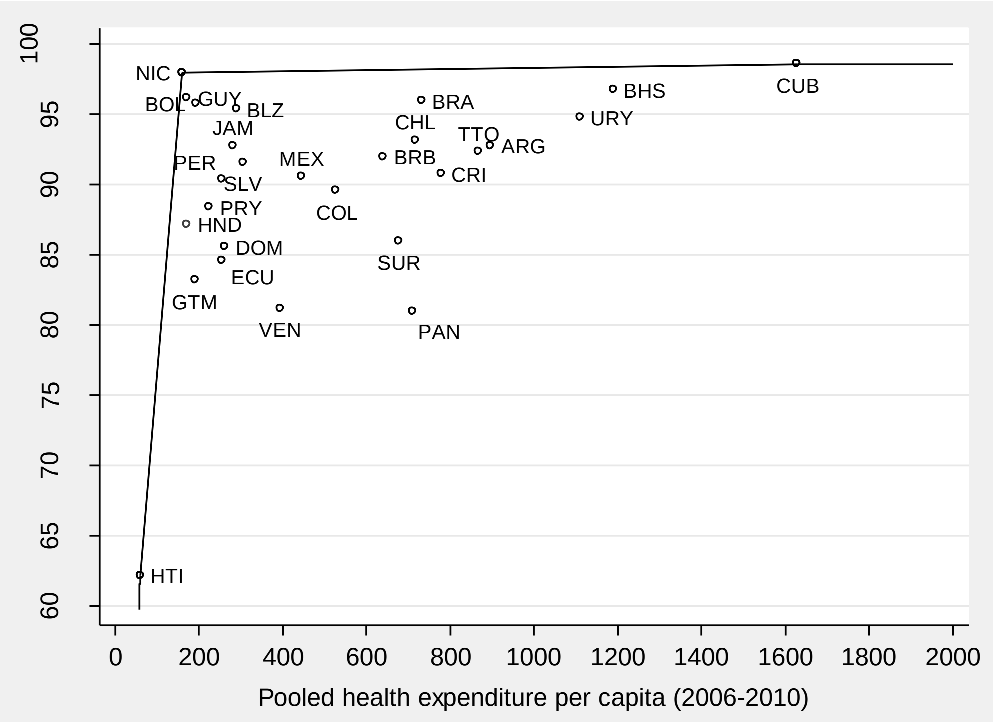


Figure 9: Estimated efficiency frontier for skilled birth attendance ratio poorest/richest

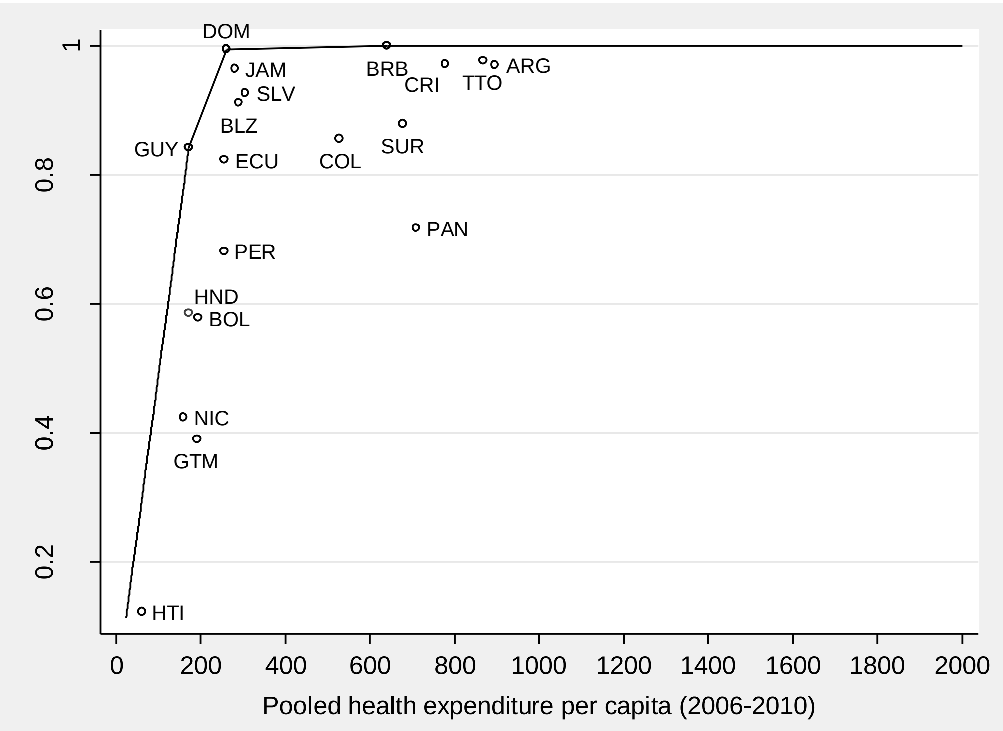


Figure 10: Estimated efficiency frontier for skilled birth attendance ratio rural/urban

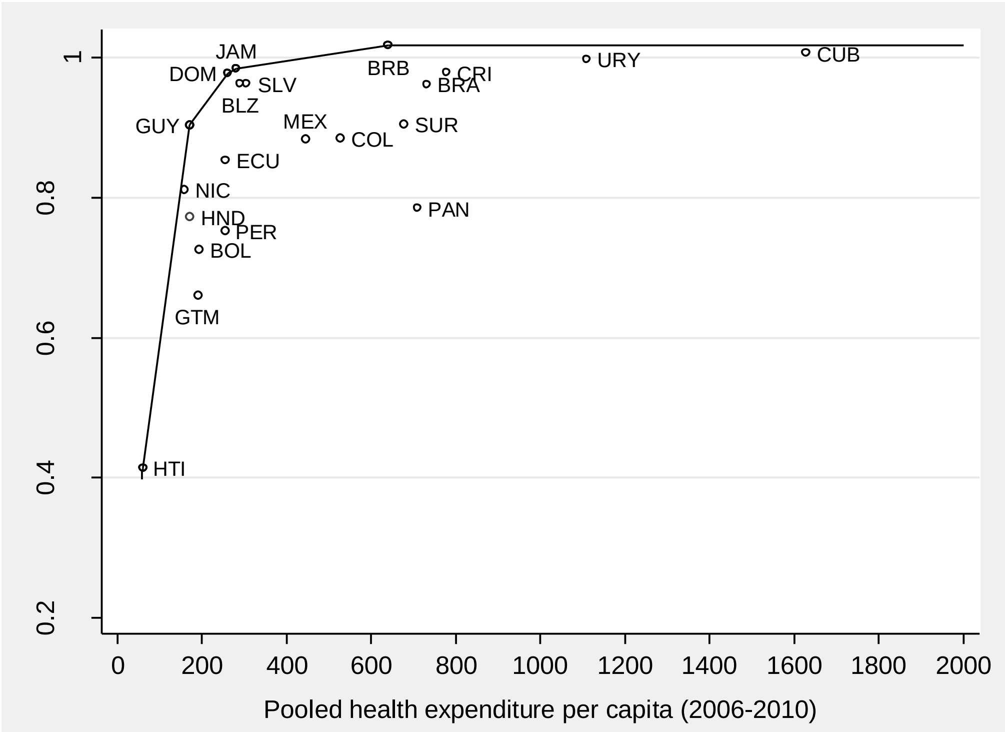


Figure 11 and Figure 12 show average efficiency scores across all outputs (with available data) for countries of similar levels of pooled health expenditure. Figure 11 presents a comparison for relatively high spender peers: Chile (generally an 'efficient' country), Brazil and Costa Rica. Conversely, Figure 12 presents a comparison for low spender peers: Nicaragua (generally 'efficient'), Guyana and Bolivia. This visual representation is useful to pinpoint broad output areas where 'inefficient' countries perform better and worse. For instance, Brazil gets closer to Chile's efficiency levels for service access indicators than for health outcomes, while Costa Rica performs better for health outcomes than access to care. Among low spenders, efficiency bottlenecks regarding health outcomes achieved are clearly the main issue in Guyana, as its efficiency levels for service coverage indicators are generally higher than those of Nicaragua. Bolivia's efficiency performance, however, suffers comparatively both for service coverage and health outcomes.

The degree to which inefficient countries could make improvements in some outputs may seem relatively small by looking at efficiency scores only. Nonetheless, this narrow view would mask the existing scope for many countries to make *absolute* improvements in health outcomes and access to care that can be very important from a health and economic perspectives. Some insights on the latter are given by calculating potential gains per country for each of our seven system output measures. These potential gains are calculated as the improvement a country could achieve on its average output indicator if the country moved to the corresponding efficiency frontier. Average potential gains per country for each health

outcome and access indicator, alongside the minimum and maximum potential gains estimated from models (1) to (3), are displayed in Figure A 8-Figure A 14 (Annex A).

Figure 11: Comparison of average efficiency scores: Brazil, Chile and Costa Rica

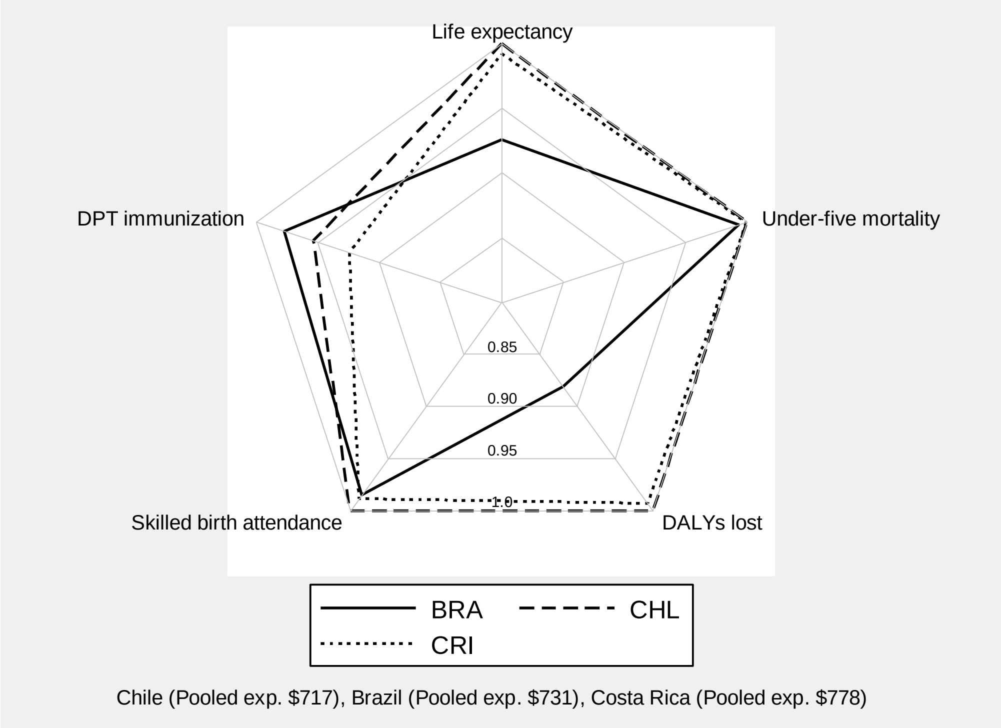
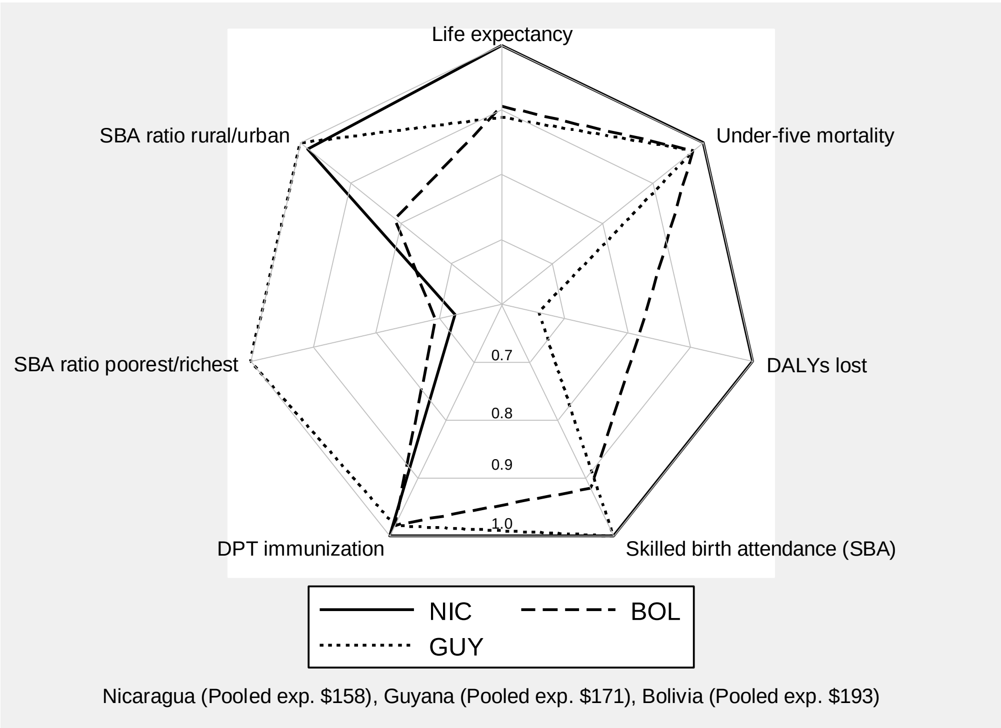


Figure 12: Comparison of average efficiency scores: Bolivia, Guyana and Nicaragua



In LAC, on average, life expectancy could be increased by 3.7 years for inefficient countries – or 5% compared to the region's average life expectancy – if they moved from their current situation to the efficiency frontier, with corresponding figures of above 7 years for Guyana, Suriname and Trinidad and Tobago (Table 1). Under-five mortality could be reduced on average by 6.4 deaths per 1,000 in LAC, which would correspond to reducing current average under-five mortality in the region by almost one-third, with potential reductions of between 18-19 deaths per 1,000 in Guyana and Bolivia. We estimate that DALYs lost for all causes could be reduced on average by around 5,000 DALYs per 100,000 in LAC.

Table 1: Potential gains estimated by output indicator

	Potential gains by output indicator						
Country	Life expectancy (years)	Under-five mortality (per 1,000)	DALYs (per 100,000)	Skilled birth attendance (percentage points)	DPT immunization (percentage points)	Skilled birth attendance ratio poorest/richest (units)	Skilled birth attendance ratio rural/urban (units)
ARG	4.5	5.1	4,794	2.3	4.7	0.03	
BHS	5.6	5.7	8,068	1.4	1.6		
BLZ	5.5	0.3	3,539	2.5	2.6	0.04	0.01
BOL	6.3	19.0	10,128	6.9	1.8	0.17	0.14
BRA	5.5	6.6	8,149	1.5	2.2		0.05
BRB	3.0	2.4	2,712	0.4	3.9	0.00	0.00
CHL	0.0	0.0	0	0.0	4.3		
COL	4.1	4.0	2,424	0.1	7.8	0.12	0.10
CRI	0.6	0.6	549	1.1	6.9	0.02	0.03
CUB	1.1	0.0	2,933	0.1	0.0		0.01
DOM	2.3	14.4	2,680	0.1	10.6	0.00	0.00
ECU	0.0	5.1	2,387	5.2	11.4	0.12	0.10
GTM	3.2	10.1	5,429	20.7	12.6	0.22	0.19
GUY	7.3	18.4	15,194	0.0	1.8	0.00	0.00
HND	1.6	0.0	377	6.5	9.6	0.09	0.07
HTI	0.0	0.0	0	0.0	0.0	0.06	0.00
JAM	0.3	0.0	4,757	0.0	3.9	0.01	0.00
MEX	1.3	1.0	2,087	3.3	6.9		0.10
NIC	0.0	0.0	0	0.0	0.0	0.14	0.01
PAN	2.6	8.5	4,830	6.7	14.2	0.20	0.18
PER	1.3	0.4	0	9.2	6.7	0.20	0.17
PRY	2.4	2.6	1,350	0.0	8.6		
SLV	3.3	0.7	6,798	0.1	5.4	0.02	0.01
SUR	7.8	12.4	6,536		10.7	0.11	0.09
TTO	9.4	13.4	13,342	0.0	5.5	0.02	
URY	2.4	2.3	1,945	0.6	2.3		0.01
VEN	3.1	1.1	3,950	3.2	14.0		
	Above 75th percentile						
	Below 25th percentile						

Note: Potential gains represent the average gain estimated across three DEA models. See text for a description of each model.

As for health system access indicators, skilled birth attendance could be improved by 3.8 percentage points on average for inefficient countries by moving to the efficiency frontier (reaching over 20 percentage points of potential improvement for Guatemala), whereas DPT immunization rates could be improved on average by 6.7 percentage points (and about 14 percentage points for Panama and Venezuela). There could also be substantial gains in equitable access to care through efficiency improvements. For instance, the gap between the skilled birth attendance rates of the poorest and richest citizens could be reduced by about 10 percentage points in inefficient countries (on average) by moving to the corresponding efficiency frontier – and by at least 20 percentage points in Guatemala, Panama and Peru.

The above calculations of potential gains raise a crucial question from a policymaking viewpoint: what actions could 'inefficient' countries take to improve their health system efficiency levels? This question requires some understanding of the main factors likely influencing measured levels of health system efficiency in LAC, both within and outside the health sector. The analyses in the next section seek to offer some insights on this matter.

4.2 The potential determinants of differences in health system efficiency

In this section we assess what factors act as the main possible determinants, and to what extent, for some countries to be able to translate a given level of health financing into better performance on access and health outputs than that achieved by other countries. Importantly, the potential efficiency determinants examined must refer to policy *choices* related, for example, to the organization of health system institutions, and not exogenous (non-discretionary) determinants of health system outputs – beyond health spending – that should have been captured in the initial DEA efficiency estimations (Jacobs et al. 2006). This analytical step is crucial for deriving useful insights for policymaking.

4.2.1 Data on potential efficiency determinants

Analytically, our goal is to explain statistically the DEA efficiency scores, investigating systematic associations between these scores and some characteristics of LAC health systems. There are significant limitations for LAC countries regarding comparative data on the organization of healthcare resources and system institutions. This has precluded the examination of data on various aspects that have been shown to affect healthcare costs and potentially health system efficiency in other contexts, related to the organization of the supply side, demand side and the public management, coordination and financing aspects of the health system (cf. de la Maisonneuve et al. 2017; Medeiros and Schwierz 2015).

Despite these limitations, we have been able to gather useful data on potentially important efficiency determinants, some of which have not been investigated comparatively for LAC countries before. These factors can be grouped into three broad categories:

(i) <u>Organization of healthcare financing and delivery</u>: **out-of-pocket (OOP) health expenditure share** (proportion of total health expenditure); **hospital beds** (per 1,000 people);

(ii) <u>Quality of governance</u>: **governance indices for six dimensions** (government effectiveness; voice and accountability; rule of law; regulatory quality; political stability and absence of violence/terrorism; control of corruption); we also construct an **average governance index** for the six individual dimensions;

(iii) <u>Quality of health system institutions</u>: **institutional quality indices for three dimensions** (medium-term sectoral vision for the health system in line with the government plan; results-based management in the production of goods and services;

sectoral information systems); we also construct an **average health system institutional quality index** for the three individual dimensions.

The precise definitions of the indicators above, their sources and year of measurement are given in Table A 1 in Annex A.

The OOP share of health expenditure serves as an indicator of the reliance of health system financing on pooled prepaid revenue sources (or lack thereof). Revenue raising through prepaid sources such as general taxes and social insurance contributions has been shown to favor the production of better population health outcomes for a given health budget (Moreno-Serra and Smith 2014). Therefore, *a priori*, we could expect to find a negative relationship between the OOP share indicator and system efficiency in our analyses. The hospital beds indicator, on the other hand, may provide information on the availability of physical resources for the provision of care in a health system; but it may also pick up other aspects such as a country's reliance on hospital care compared to primary care. Thus the expected direction of relationship between hospital beds and efficiency is unclear *a priori*.[14]

Higher quality of governance in a country is expected to be positively related to the efficiency of its health system (Wagstaff and Claeson 2004). The governance variables are published by the World Bank and are constructed so that higher indices reflect better performance.

The data on the quality of health system institutions have been obtained directly from the Inter-American Development Bank's (IDB PRODEV Evaluation Tool, PET). PET is an instrument developed by the IDB mainly to evaluate countries' institutional capacity to implement results-based public management, including assessments of the existence and alignment of health system planning with the overall government strategy, as well as availability of information systems in areas such as healthcare costs and quality.[15] The three main indicators range from 0 (worst) to 5 (best); each of them is computed from various sub-indicators (see Table A 1), all of which arguably can be expected to have a positive impact on efficiency in areas such as continuity of care, access to timely and clinically effective services, and spending on services (Moreno-Serra 2014).

In the estimations we use the 2006-2010 country average of the indicators (i)-(ii) above, to account for possible lags in the relationship between these indicators and efficiency levels, and maintain consistency with the measurement of DEA inputs. The exceptions are the

[14] We would have liked to examine further indicators related to the organization of physical and human resources in health. Unfortunately, including even basic indicators from the World Bank and WHO sources in our analyses would have resulted in an important loss of LAC countries due to missing data. For instance, the inclusion of physicians per population or nurses/midwives per population would have meant efficiency determinant regressions being undertaken with a sample of just 20 LAC countries which have better data, leading to concerns about sample selection and representativeness.

[15] See: http://www.iadb.org/en/topics/government/management-for-development-results/diagnostic-tool,8360.html

indicators of quality of health system institutions, for which we use data for year 2013 only.[16] The data used for each country are shown in Table A 2 in Annex A.

4.2.2 Methods and estimation results

There is no consensus in the literature about what methodology should be used for explaining efficiency scores (Jacobs et al. 2006). Because DEA efficiency scores are censored with an upper limit of one (or 100%), it is conventional to model the relationship between scores and potential determinants using a censored (Tobit) regression (Cameron and Trivedi 2005). In our study we use a more robust approach to analyze DEA efficiency scores, developed by Simar and Wilson (2007). This estimation approach corrects the standard errors obtained from conventional regression models such as Tobit by simulating the unknown error correlation among efficiency scores and calculating bootstrapped standard errors.[17]

We use Simar-Wilson cross-sectional regressions to estimate the degree of association between countries' average DEA efficiency scores for each output (from the previous section, see Table A 4) as the dependent variable, and our candidate efficiency determinants as explanatory variables. We focus below on the results for four main regression specifications (Table A 6-Table A 12, Annex A). Results for a number of additional specifications are also presented in Annex A (Table A 13-Table A 19). The general conclusions are robust across all models so we concentrate on the main messages.

Health outcomes. Overall, there is no discernible, systematic association between efficiency scores for health outcomes (life expectancy, under-five mortality or DALYs lost) and any of the indicators of health system organization, governance and institutional quality. This applies to all models estimated.

Access to services. Higher quality of governance is strongly associated with higher efficiency in providing access to necessary services for the general population. The coefficients on the average governance quality indicator are positive and statistically significant both for skilled birth attendance and DPT immunization rates (columns 2-3, Table A 9; and columns 2 and 4, Table A 10). An examination of the additional estimations presented in Annex A suggests that this positive association between governance and access efficiency is a general result for most sub-dimensions of governance when they are analyzed separately (Table A 16-Table A 17).[18]

[16] Although the institutional quality variables are also available for 2007, the research team has been advised by the data provider (IDB) that data reliability is higher for 2013.
[17] The Simar-Wilson approach therefore accounts for the facts that: (i) DEA efficiency scores are bounded, and (ii) DEA generates a complex and unknown correlation pattern among estimated efficiency scores.
[18] Results for a few governance and institutional indicators could not be obtained with skilled birth attendance rate as the dependent variable, because the corresponding Simar-Wilson regressions failed to reach convergence. This has been the case when analyzing specific indicators entered as the only explanatory variable (e.g. average institutional quality or the government effectiveness indicator). The reason behind the lack of statistical convergence for these models seems to be relatively limited cross-country variation in the estimated

Higher quality of health system institutions is also associated with more efficiency in the provision of access to services, judged by skilled birth attendance (column 3, Table A 9). Further estimations in Annex A indicate that a key institutional element linked to higher access efficiency is the existence of a medium-term health sector plan that encompasses citizens' consultation and is in line with the overall government planning strategy (columns 5-6, Annex Table A 16). Finally, we find no systematic statistical associations between the service access efficiency scores and the OOP share or hospital beds indicators.[19]

We use the estimated coefficients in the last columns of Table A 9-Table A 10 to provide some intuition on the magnitude of associations between efficiency and the governance and institutional quality indicators. Our estimations imply, for example, that a one-unit increase in the average governance quality indicator is associated with an improvement of 0.363 in the efficiency score for skilled birth attendance. Consider a comparison between Guatemala, the 'better' country among those in the lowest 25% of average governance quality (indicator = -0.591), and Trinidad and Tobago, the 'worst' country among those in the highest 25% of average governance quality (indicator = 0.110). According to our estimations, if Guatemala were to improve its governance quality to reach the position of Trinidad and Tobago among the top 25% countries, this would result (all else equal) in a 38.8% increase in its skilled birth attendance efficiency score (from 0.67 to 0.93). From the DEA estimations in the previous section, these improvements in governance and efficiency would, in turn, be equivalent to an increase of about 24 percentage points in Guatemala's skilled birth attendance rate, from the observed 62.8% to 86.6%, for the same level of health spending. Using the same rationale and country comparison but for DPT immunization, the aforementioned governance improvement in Guatemala would result in a 5% higher efficiency score (0.85 to 0.89) and a DPT immunization coverage 4 percentage points higher than its current level (83.2% to 87.3%).

The comparison between Guatemala and Trinidad and Tobago in terms of health system institutional quality is also illustrative of how better institutions can be important for improved system efficiency. Following the rationale described above, if Guatemala were to move to Trinidad and Tobago's health system institutional quality (a jump of about one unit in the average index, from 1.7 to 2.6), our estimates suggest that Guatemala would move to the efficiency frontier of skilled birth attendance (a 49% increase in its current efficiency score). These improvements in institutional quality and efficiency would, in turn, translate into a gain of over 31 percentage points in Guatemala's current skilled birth attendance rate (reaching 94%), keeping its same level of pooled health expenditure per capita.

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skilled birth attendance efficiency scores, which is compounded in some cases by less variation in specific efficiency determinant indicators.

[19] The only significant result (column 1, Table A 10) suggests that higher shares of OOP expenditures are associated with lower efficiency in the provision of DPT immunization. However, this result is not robust to specification changes where governance and institutional indicators are included (see Annex Table A 17).

Equity in access to services. Higher quality of governance is associated with higher efficiency in providing equitable access to health services judged by a key indicator: the poorest/richest ratio of births attended by skilled health staff (Annex Table A 11). Although the average governance quality coefficient loses statistical significance in column (4), this seems due to statistical noise arising from the introduction of a statistically insignificant variable into the model (average health system institutional quality). The positive association between governance quality and the poorest/richest ratio of skilled birth attendance is corroborated further by the additional estimations presented in Annex A (Table A 18), which show the positive link with average governance quality being led specifically by better government effectiveness.

Using once again the comparison between governance quality levels in Guatemala (a bottom 25% governance performer) and Trinidad and Tobago (among the top 25% performers) to put our estimates in perspective, if Guatemala were to improve its governance quality to reach the position of Trinidad and Tobago, our estimations imply that Guatemala could almost double its efficiency score for the poorest/richest skilled birth attendance ratio (from 0.45 to 0.89), all else equal. This in turn would be equivalent to a reduction of 39 percentage points in the gap between the skilled birth attendance rates of the poorest versus richest citizens, keeping health spending and other inputs constant.

On the other hand, no consistently robust association is found between governance indicators and efficiency scores for the rural/urban ratio of skilled birth attendance (Table A 12 and Table A 19), or between any equity efficiency scores and the indicators of health system institutional quality, OOP financing share and hospital beds.[20]

Overall message. The results above unveil some reasonably clear patterns of how aspects related to the organization of the health system, the quality of its institutions, and quality of governance, are linked to variations in health system efficiency in the LAC region. In general, the quality of governance and system institutions (measured by the best available cross-country data) does not seem to be linked *directly* to achieving better population health outcomes for a given level of spending. But this seems to be because any influence of governance and institutions on the production efficiency of health outcomes is in fact mediated by the direct influence that these factors have on the efficiency with which health systems provide wider and equitable access to key health services. In other words, the influence of the quality of governance and institutions on health system efficiency is only picked up clearly when we examine system outputs pertaining to the efficiency with which

[20] One potential explanation for the lack of significant estimates for governance quality when examining the rural/urban skilled birth attendance ratio is the relatively low cross-country variation in efficiency scores for that variable, compared to the corresponding poorest/richest ratio. This low variability makes it harder for the regressions to pick up discernible associations in the data. But it is interesting that, even in the rural/urban skilled birth ratio models, most of the estimated coefficients for governance variables have positive signs despite the lack of statistical significance (see Table A 12 and Table A 19).

countries give all citizens adequate access to necessary services – a crucial element within the UHC agenda (WHO 2010).

It seems reasonable to postulate that, through their link with improved efficiency in access to services, better governance and system institutional quality are likely to affect *indirectly* the efficiency with which LAC countries translate a given health budget into population health outcomes later down the line. Although we do not estimate formal models of the relationship between efficiency in ensuring access to care and efficiency to generate health outcomes, the DEA results in the previous section offer some preliminary support to this idea. For instance, the most efficient countries in granting wider and more equitable access to the health system tend to be also those that are the most efficient with respect to production of health outcomes for their levels of health spending (cf. e.g. Table A 4; examples include Barbados, Chile, Cuba, Jamaica, Nicaragua and Uruguay).[21]

A word of caution is in order regarding the estimation results in this section. The limitations inherent to our data prevent a firm interpretation of the estimates obtained as *causal* effects running from potential determinant factors to efficiency scores. Our estimates in principle reflect *associations* in the data, indicating that health system efficiency and (say) governance quality move together, but cannot ascertain definitively the direction of causality between these two factors. This issue is important for the interpretation of our results and we discuss it further later in this report.

[21] Moreover, the available cross-country literature for other regional settings also suggests a positive relationship between broader access to services and population health. See Moreno-Serra and Smith (2012) for a review.

Section 5 Model extensions and sensitivity analyses

5.1 Extension: assessing financial protection as a health system output

Financial protection against the costs of ill health has been acknowledged as a fundamental objective of health systems (WHO 2000; 2010). By ensuring that households make healthcare payments according to their ability to pay rather than risk of illness, through prepaid financing sources instead of direct OOP payments made to healthcare providers at the point of use, health systems should favor the effective spread of financial risk across all population groups and reduce barriers to access to care (Moreno-Serra et al. 2011).

Although there is now a global consensus about the importance of financial protection as a health system objective, measuring the concept to track country progress and perform international comparisons over time has been less straightforward. Two financial protection indicators usually mentioned by commentators, catastrophic health spending incidence and impoverishing health spending incidence (and their variations), are available in a comparable fashion for only a limited set of countries, excluding most LAC countries (WHO and World Bank 2015). Researchers working on cross-country comparisons have thus resorted to constructing other 'indirect' measures that may be informative about financial protection patterns. Indicators related to the participation of pooled or government health financing in total health expenditures have been frequently used in the literature (cf. e.g. Jowett et al. 2016), due to their high (negative) correlation with national figures of catastrophic and impoverishing spending incidence (Xu et al. 2007).

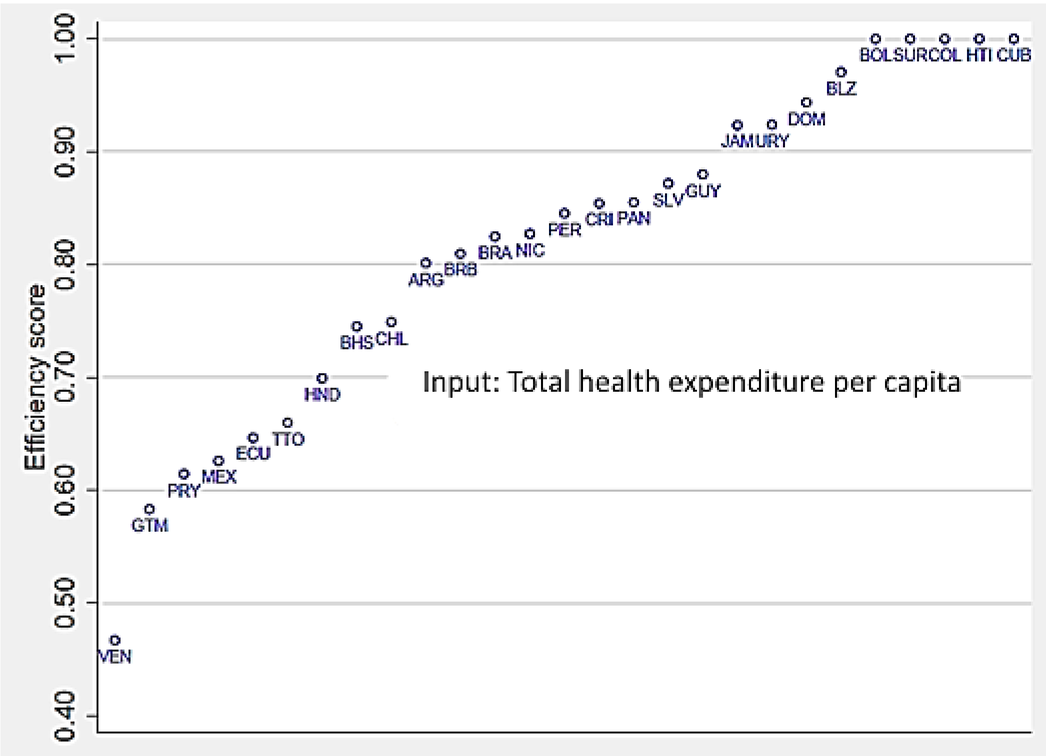
In Section 4.2 we explored the share of OOP health spending in total health financing as a potential discretionary *determinant* of cross-country variations in system efficiency. The rationale for analyzing the OOP share as a determinant of system efficiency, instead of a health system output in itself, is our belief that the share of pooled (and non-pooled) health financing constitutes largely a *policy choice*. Countries make different decisions about how to channel resources to the health sector, or their degree of reliance on pooled prepaid revenue sources (e.g. mostly general taxes in Brazil; social insurance implementation in Argentina and Colombia) vis-à-vis OOP payments (particularly significant in countries such as Guatemala, Paraguay, Mexico and Venezuela). Such policy decisions are reflected in the pooled and non-pooled shares of total health spending; although these financing choices ultimately influence the ability of health systems to protect people against financial catastrophe, the latter system objective should in principle be assessed by indicators that measure the ultimate phenomenon of interest (i.e. the extent of financial protection) *directly*, for instance the catastrophic spending incidence.

Nonetheless, we acknowledge that there is an unavoidable judgment value underlying our treatment of pooled and non-pooled shares of health financing in the main analyses. Therefore, in this section we extend our analyses to examine the pooled spending share of

total health financing (average 2011-2015) as an output in a further DEA model, acting as a proxy for financial protection, or the degree of protection citizens enjoy against the financial consequences of illness.[22] The specifications of the three DEA models estimated for the financial protection output follow the description given in Section 3, except for the use of total health expenditure per capita (average 2006-2010) as the key input of interest for assessing efficiency in financial protection.[23]

The results of the estimations of DEA models (1)-(3) are summarized in Figure 13.[24] The same countries appear in the efficiency frontier regardless of the specification: Bolivia, Colombia, Cuba, Suriname and the outlier Haiti. Apart from Haiti, all these countries show relatively low reliance on OOP health financing as expected (latest figures between 5%-25% of OOP share, ranking between the 1st and 8th lowest OOP shares in the region). They are not necessarily big health spenders however, with Bolivia ($263) and Colombia ($653) spending below the 2006-2010 average health expenditure per capita for the region ($749).

Figure 13: Comparison of country average efficiency scores, pooled health expenditure share (financial protection proxy)



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[22] Recall that DEA requires output variables to be measured in a way to indicate that 'more is better'. See Table A 2 for the pooled health expenditure share data used for each country.

[23] We do not use pooled health spending per capita as input here to avoid imposing a link by construction between input (pooled spending level) and output (pooled spending share). For the same reason, we exclude the OOP share from the set of potential efficiency determinants used in the Simar-Wilson regressions for financial protection.

[24] Full results for DEA scores by country and model are given in the final part of Annex Table A 20.

The least efficient country in using total health funds to provide financial protection is Venezuela by a large margin; other underperformers include Ecuador, Guatemala, Honduras, Mexico, Paraguay and Trinidad and Tobago. Again as expected, the inefficient countries judged by the financial protection output are also those relying more heavily on OOP health financing in LAC, representing the highest seven OOP shares (between 38%-59% according to the latest available data). And once again these countries vary significantly in their total health spending per capita, which ranges from $338 in Honduras to $1,443 in Trinidad and Tobago.

We analyze potential determinants of cross-country efficiency differences in providing financial protection through Simar-Wilson regressions, as detailed in Section 4.2. The focus here is on the governance and institutional quality aspects. The regression estimates suggest that higher average governance quality is associated with higher efficiency scores for our pooled spending measure of financial protection (Annex Table A 21, column 1). Although the relevant coefficient is not statistically significant in model 3, the influence of governance aspects is supported by additional regressions examining the individual governance indicators separately (not shown). The latter point to positive and statistically significant associations with efficiency for the indicators of voice and accountability, rule of law, and political stability. The association with better voice and accountability is the strongest when all governance indicators are included jointly in the regression. On the other hand, the regression models do not pick up any statistically significant associations between our health system institutional capacity measures and efficiency regarding financial protection.

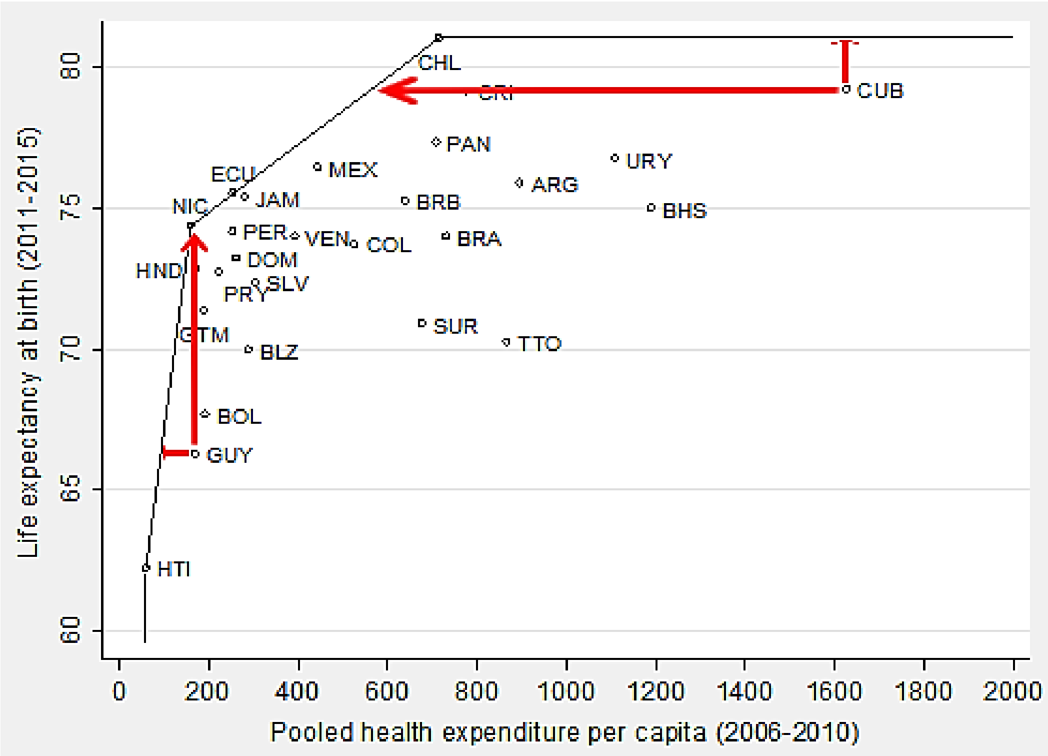
5.2 Extension: input orientation

In all DEA estimations so far we have adopted an *output orientation*, meaning that health system efficiency is defined as maximization of outputs (e.g. health outcomes) for a given level of inputs (e.g. pooled health expenditure per capita). An alternative way of defining efficiency would be in terms of minimization of inputs for a given level of outputs. The latter case corresponds to the *input orientation* of DEA, which helps answer the question of by how much inputs could be reduced while achieving the same level of output, if such inputs were used efficiently.

We can illustrate the input orientation approach using Figure 14, which presents the efficiency frontier constructed in Section 4.1 for life expectancy at birth as the output, and pooled health expenditure per capita as single input. While an output orientation measures efficiency slacks by the vertical distance from the country's position to the efficiency frontier, the input orientation assesses efficiency slacks by measuring the *horizontal* distance from the country's position to the frontier – i.e. by how much health expenditures could be reduced while keeping the same life expectancy. In other words, the input orientation offers insights into potential health cost savings for each country. Since the specific questions being asked from output and input orientations differ, the efficiency scores computed through these two alternatives are expected to differ as well. For example, visual inspection of Figure 14 suggests that the potential for efficiency gains (the arrows in the figure) will be much higher using an

input orientation than output orientation in the case of Cuba, and much lower using the input rather than output orientation in the case of Guyana.

Figure 14: Estimated efficiency frontier for life expectancy at birth (years)



The input-oriented DEA efficiency scores for LAC countries are shown in Annex Table A 22. In general, the most efficient countries for each output identified formerly in the output-oriented analyses remain the most efficient ones also in the input orientation. This is clearly the case in the models where pooled health expenditure per capita is the only input examined. Even Cuba, which is 'penalized' in some of the latter DEA estimations due to spending more per capita on health than any other LAC country, rejoins the group of most efficient countries once its environmental constraints are accounted for (particularly the 12% share of population aged 65 and above, third highest in LAC).

On the other hand, more substantial changes in comparative efficiency between output and input orientations take place among some of the least efficient countries identified in Section 4.1. For instance, Bolivia and Guyana tend to perform better across our seven main health outputs if efficiency is assessed through the input orientation. Guatemala and Honduras also climb on the input-oriented efficiency rankings for service coverage and equity outputs. The results for these countries imply that there is comparatively little scope in their health systems to reduce health expenditures while keeping the same levels of outputs (which are in fact generally lower than regional averages).

Similarly to the case of DEA estimations, the fact that output and input orientations answer efficiency questions from a different angle may lead to different conclusions about the

possible determinants of efficiency scores between these two alternatives. We examine this possibility using the same Simar-Wilson regression specifications detailed in Section 4.2.

The first finding from the estimations of efficiency determinants using input-oriented scores is a negative association between the hospital beds indicator and efficiency related to service access (skilled birth attendance, DPT immunization and the poorest/richest ratio of skilled birth attendance; Table A 23-Table A 25 in Annex A). Countries with a higher number of beds per 1,000 population tend to have lower efficiency scores, i.e. more scope to reduce pooled health expenditure per capita while keeping such outputs constant. The estimates suggest that one extra bed per 1,000 population is linked to average reductions of about 5 percentage points in the efficiency scores for skilled birth attendance and DPT immunization, and an average increase of 8 percentage points in the gap between the skilled birth attendance rates of the poorest *vs.* richest groups. One plausible interpretation of these results is that countries that rely more heavily on (costly) hospital care face stronger financial constraints to cover higher proportions of their populations with effective primary care interventions, as well as to extend primary care coverage to areas and populations that are more difficult and expensive to reach. Unfortunately, we are unable to test this hypothesis further with the available data for LAC countries.[25]

The second – and perhaps surprising – finding from the efficiency determinant regressions is a negative association between average governance quality and efficiency in skilled birth attendance and DPT coverage. This suggests that better governed countries tend to have lower efficiency scores for these coverage indicators, implying comparatively more scope to reduce pooled health expenditures while keeping service coverage at their current levels. A possible explanation for this finding is that the relevant regression results are being driven by a strong positive correlation between governance quality and national health expenditures.[26] DEA efficiency score estimations using the input orientation tend to 'penalize' more heavily the biggest health spenders in our sample (see Figure 14), and these tend to be also the LAC countries with higher average governance quality.[27] As an illustration, average pooled health expenditure per capita in the worst 25% countries of average governance quality (e.g. Bolivia, Guatemala, Paraguay) is $420, compared to $883 in the 25% best governed countries (e.g.

[25] A statistically significant estimate for the hospital beds indicator was also found for the DALYs lost regression (coefficient = -0.039, standard error = 0.020, significant at the 10% level). However, this association with hospital beds was not corroborated by any of the results for the other health outcomes, unlike the case for service access outputs. Thus, for conciseness, we only present and discuss the results for three service access outputs (no statistically significant estimates were found for the rural/urban ratio of skilled birth attendance).

[26] The corresponding pairwise correlation coefficient is 0.52, statistically significant at the 1% level.

[27] Such efficiency 'penalty' is even stronger in the case of output indicators with more limited sample variability. The skilled birth attendance rate is one such case, presenting a median value of 97% in the LAC region, with a low standard deviation (14%) and interquartile range (difference between the 75th and 25th percentiles) of just 6.8 percentage points. In this context, the biggest spenders are 'penalized' significantly in the DEA efficiency analyses because many countries achieve similar skilled birth attendance rates but spend less per capita on health.

Bahamas, Trinidad and Tobago, Uruguay). This issue highlights one limitation of our analyses, namely the aforementioned possibility that the estimates from Simar-Wilson regressions may not be picking up *causal* links running to efficiency levels from potential determinant factors, but rather reflect (possibly bi-directional) associations in our data.

Despite some interesting insights from the input orientation discussed above, assessing efficiency from an output orientation perspective – as in our main analyses – seems more appropriate for the group of LAC health systems. The fact that in most LAC countries there is scope for important gains in health outputs – compared to a 'health production possibility frontier' defined by the outputs typically achieved by high-income countries – means that an output orientation should be more informative from a policymaking viewpoint. For example, asking by how much health expenditures could be reduced while keeping the current level of life expectancy at birth (as per the input orientation) seems much more relevant for the group of OECD countries with a median life expectancy at birth of 80 years (Medeiros and Schwierz 2015), than for the LAC countries who exhibit a median life expectancy 6 years lower.[28] In our LAC data, only three countries have a life expectancy figure within one year of a 'possibility frontier' defined by the OECD median: Chile (81 years), Cuba (79.2) and Costa Rica (79.1). Thus, while for the latter three countries an input-oriented DEA could add helpful information for efficiency assessments, for most LAC countries an output orientation seems far more insightful, also because some countries of the region achieve much better results than others for a similar level of resources.

5.3 Sensitivity check: excluding Haiti from the analyses

In this section we address the concern that the outlying input and output data for Haiti may be distorting the calculations of DEA efficiency scores for the other LAC countries, and hence our conclusions about levels and potential determinants of health system efficiency in the region. We do so by excluding Haiti from our sample and re-running all the main analyses described in Section 4.

The first conclusion from the re-estimations excluding Haiti is that the DEA efficiency scores for all outputs and remaining countries are virtually unchanged compared to the original models. In fact, there are *no* changes whatsoever in *any* efficiency scores of models (1)-(3) for life expectancy, under-five mortality, DALYs, skilled birth attendance and DPT immunization. This is because Haiti was not acting as a peer for any other LAC country in the original DEA models for these outputs. In the very few cases where Haiti did act as a peer for other countries, specifically for models (2)-(3) of the poorest/richest skilled birth attendance ratio, and model (1) of the rural/urban skilled birth attendance ratio, this occurred due to the smaller sample of countries for these output indicators, and excluding Haiti leads to only very small changes in efficiency scores for a few countries (Annex Table A 26). Among these, the

[28] The OECD median figure excludes LAC countries (Chile and Mexico).

only noteworthy change is that Honduras becomes an efficient country in terms of the poorest/richest skilled birth attendance ratio – although it already had a high efficiency score of 0.925 in the corresponding original models.

In light of the above, it is hardly surprising that the original coefficients from the Simar-Wilson regressions too are virtually unchanged when Haiti is excluded from the sample (results not shown). This sensitivity check thus confirms the important role of governance and institutional quality for differences in service access and equity efficiency across LAC health systems.

5.4 Sensitivity check: using total health expenditures as the main input

Here we explore the robustness of our results to changing the key DEA input of interest for assessing health system efficiency, from pooled health expenditure to total health expenditure per capita (i.e. including both pooled *and* OOP expenditures). LAC countries vary widely in terms of total health spending figures, due to their substantial differences in the levels and shares of OOP health financing (Annex Table A 2). *A priori*, we could expect some changes in efficiency rankings by using total health expenditures as input: cross-country studies have found, for example, that increases in OOP spending per capita may improve aggregate health outcomes, but to a lower extent than commensurate increases in pooled spending per capita (Moreno-Serra and Smith 2014). Thus, all else equal, if two countries were to increase total health expenditure per capita by one dollar, but one country does so through additional pooled prepaid financing while the other does so through additional OOP spending, the latter country would be expected to obtain lower population health gains on aggregate (i.e. be less efficient in generating better health outcomes) than the former country.

We re-run all the main analyses in Section 4 using total health expenditure per capita as input (results in Annex Table A 20). Our original DEA conclusions about the rankings of efficient countries and their levels of efficiency for each health system output remain generally unaltered. On average for the seven DEA outputs, the correlation coefficient between DEA scores in the models using total health spending and the original models using pooled spending is as high as 0.96, with a minimum of 0.92 for skilled birth attendance models and reaching 0.99 for DPT immunization and the two skilled birth attendance ratio variables.

Using DEA model (1) for each output as a benchmark (i.e. health expenditure per capita as the single input), not many noteworthy changes in country rankings can be identified. Among all our output indicators and the corresponding efficient countries identified in the original models, the most significant changes occur for Paraguay and Nicaragua with regard to skilled birth attendance coverage: these countries leave the efficiency frontier and move well down the skilled birth attendance rankings, to the 17th and 20th positions respectively. In fact, Paraguay tends to fall in the efficiency rankings for all outputs when total health expenditure is used as input. Since Paraguay exhibits a very high reliance on OOP payments for health system financing (53.9% average for 2006-2010, the second highest in the sample only behind

Guatemala – the latter another generally inefficient country), this provides some support to the deleterious effects of non-pooled financing for health system efficiency found in other studies.[29] The least efficient countries across all re-estimated models are generally unchanged with respect to the original DEA estimations.

Changing the measure of health expenditure used as input does not change the conclusion that governance quality represents a key factor for cross-country efficiency differences in service coverage. The latter is reinforced by the results of the re-estimated Simar-Wilson regressions (Table A 27-Table A 30, Annex A). The noteworthy changes relative to our main regression results occur for skilled birth attendance coverage: higher OOP shares of health financing are found to be associated with lower system efficiency; more beds per capita are associated with higher efficiency; and health system institutional capacity now shows no association with efficiency. These results for the skilled birth attendance rate should be interpreted with due caution, however, as the Simar-Wilson method runs into convergence issues to estimate some of the corresponding regression models (see footnote 18).

5.5 Sensitivity check: using public health expenditures as the main input

We now undertake a similar robustness check to the one described above but using public expenditures on health as the main DEA input of interest. Although improvements in health outcomes and system efficiency could arise in principle from publicly and/or privately pooled health funds, it may be argued that the measured efficiency of LAC health systems will be more directly related to public funding, since governments typically have a major role in health system functions in the LAC region.

We thus re-run our main analyses using public health expenditures per capita as input, instead of pooled spending (Annex Table A 31). Again, our general conclusions about efficiency performance and rankings for each output remain the same as in the main analyses, with virtually the same groups of countries making up the top and bottom 25% of efficiency rankings as before. Changes with respect to the main analyses are few and even less important here than when total health expenditure is used as input, something that should be expected given that pooled health expenditures in most LAC countries are mostly comprised of government spending (82% on average). For example, focusing on DEA model (1), the few noteworthy changes in comparative efficiency refer to Guyana (skilled birth attendance and poorest/richest ratio of skilled birth attendance) and Honduras (DALYs lost) falling in some rankings, while Cuba (life expectancy), Ecuador (skilled birth attendance) and

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[29] Further support to this result comes from the observation that the other countries whose slight reductions in re-estimated efficiency scores cause them to leave the efficiency frontier for some outputs – for instance, Ecuador, Honduras and Dominican Republic – are also among the most reliant on OOP health financing in the LAC region. Conversely, the countries added to the re-estimated efficiency frontiers using total health expenditures, for under-five mortality (Belize) and DPT immunization (Guyana), exhibit OOP financing shares that are relatively low for the region (around 26%, ranking 7th and 10th lowest in LAC, respectively).

Haiti (poorest/richest ratio of skilled birth attendance) move up to the top 25% in specific cases.

As for the factors related to system efficiency variations, the Simar-Wilson regressions (Table A 32-Table A 35, Annex A) confirm a positive relationship between governance quality and service coverage efficiency, for both skilled birth attendance and DPT immunization. No consistent results emerge for the other potential determinant factors, despite a positive and marginally significant coefficient found for average health institutional quality in the skilled birth attendance case (caution is needed on the latter as some of these models run into convergence issues). As before, no statistically significant coefficients are estimated in the models for life expectancy, under-five mortality and DALYs lost (results not shown).

5.6 Sensitivity check: estimating robust DEA efficiency scores

The Simar-Wilson regression methodology that we employ to estimate the influence of potential efficiency determinants is well suited to deal with DEA efficiency scores, for the reasons explained in Section 4.2.2. However, our estimation approach assumes that the efficiency frontier estimated in the DEA is indeed the 'true' frontier, so that any uncertainty around the data generating process arises in the estimation of potential efficiency determinants (second stage) but not in the estimation of DEA efficiency scores themselves (first stage). This assumption may be challenged, as the 'true' data generation process for efficiency scores cannot be known with certainty in most scenarios, meaning that DEA efficiency scores may be estimated with bias, and making the appropriateness of the functional form adopted in the second stage estimations unclear.

Therefore, as a further robustness check, we adopt the approach suggested by Simar and Wilson (2007) to estimate robust (i.e. bias-corrected) DEA efficiency scores. The authors develop a method to estimate efficiency scores that are consistent with the regression approach we use to investigate possible efficiency determinants in the second stage (see Simar and Wilson 2007 for details). We apply their method to correct the 'naïve' DEA efficiency scores presented in Section 4.1 (first stage), and then re-run our main regressions of possible efficiency determinants as explained in Section 4.2 (second stage). Because the general conclusions regarding country efficiency rankings across health outputs, and potential efficiency determinants, remain unchanged compared to the main analyses, we only briefly comment on these new results below.

Overall, changes in efficiency rankings using bias-corrected DEA scores are minimal compared to rankings based on the original ('naïve') scores. In the LAC data, bias-correction tends to induce a roughly 'parallel shift' in the efficiency frontiers estimated originally for each output. For instance, for life expectancy at birth as the output and pooled health expenditure as single input, the bias correction implies DEA scores that are lower across the board but highly correlated with the original estimates: the overall correlation coefficient of 'naïve' and bias-corrected efficiency scores is 0.97 (Figure A 15, Annex A).

As expected due to the nature of the bias correction, no country appears as 'fully' efficient, i.e. no DEA scores of 1 are estimated (see Annex Table A 36 for the case of life expectancy). Yet the countries that make the top and bottom 25% of efficiency scores are virtually the same between 'naïve' and bias-corrected estimation methods. Perhaps the only noteworthy change is for Haiti, who is not among the countries closest to the frontier anymore but is still on the top of the efficiency table because of the mechanics of DEA estimations discussed previously. In terms of the estimations for potential efficiency determinants (second stage), the general conclusions described previously for the main analyses still hold.[30]

[30] The relevant coefficients estimated in the new models are close in size to the corresponding coefficients from the main analyses reported in Section 4.2. However, the convergence issues for the skilled birth attendance models become more severe when using the bias-corrected DEA scores, preventing the estimation of most such models.

Section 6 Benchmarking health system efficiency in the LAC region: a comparison with OECD countries and selected emerging economies

6.1 Aims, methodology and data

The goal of this additional set of analyses is to provide further perspective into the measured levels of health system efficiency in the LAC region. In order to do so, we apply the same methods described in Section 3 and Section 4 on an enlarged sample of countries including, in addition to LAC, the group of OECD member countries as well as selected non-OECD, non-LAC emerging economies. The analyses below are useful not only to shed light on how efficient LAC health systems look when benchmarked against high-income countries, but also against peer countries that present levels of economic development similar to the development spectrum observed in the LAC region.

6.1.1 The enlarged sample of countries

The enlarged sample includes 32 OECD countries and 12 non-OECD, non-LAC middle-income countries (MICs).[31] Overall, then, our sample for the analyses in this section is comprised of 71 countries when LAC is included. The countries in the OECD and MIC groups are:

(i) OECD: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Rep., Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States;

(ii) MICs: Botswana, Cameroon, China, Ghana, India, Indonesia, Nigeria, Russian Federation, South Africa, Sri Lanka, Thailand and Vietnam.

Availability of the relevant data to estimate at least the majority of our DEA models has been the key criterion for selecting the MICs above. We have subsequently narrowed down the list of selected MICs so as to have countries representing different world regions (e.g. BRICS nations) and levels of national income per capita roughly similar to the corresponding distribution across LAC countries (i.e. both lower-middle-income and upper-middle-income economies).

6.1.2 Data additions and caveats

In principle, the inclusion of OECD countries in the sample could enable links to be made between our analytical results for LAC countries and those from analyses such as Medeiros and Schwierz (2015) for the OECD. With this in mind, we have sought to collect additional data that would facilitate more direct comparisons; for example, Medeiros and Schwierz

[31] See: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

examine various measures of life expectancy, including life expectancy at old age (65) and life expectancy at birth adjusted for lifestyle factors. The latter two indicators are relevant also for LAC countries, many of which have experienced a rapid epidemiological transition in recent decades and a shift in consumption/behavioral patterns pushed by rising living standards (Dmytraczenko and Almeida 2014).

Yet data limitations for LAC countries preclude our use of the same indicators examined by Medeiros and Schwierz, particularly with respect to lifestyle variables. As explained previously, lifestyle indicators measured over time in a systematic and comparable cross-country fashion are unavailable for many LAC countries. In the final part of this section we present some results using an indicator of **smoking prevalence in the population** as a further DEA input. The smoking prevalence indicator is defined as the percentage of adults ages 15 and over who smoke any form of tobacco, and the data have been obtained from the World Bank (WDI database). As before, we use the 2006-2010 average of this input variable in our DEA models. The results from models using smoking prevalence as an input are not presented within the main analyses in this report due to the need to exclude as many as 10 LAC countries with unavailable data from the estimation sample. This severely hampers the possibility of comparing these results with those in the previous sections, as well as the generalization of results for the LAC region more broadly.

We have been able, on the other hand, to gather data for all LAC countries on an additional output indicator, **life expectancy at age 60** (from WHO). The addition of this output facilitates comparisons with studies looking specifically at the group of OECD countries, and enriches our study more generally. As before, our DEA models use the average value of the life expectancy output for each country for the period 2011-2015.

A final data caveat refers to the indicators of access to services and equity of access that are available for LAC countries. Figures for skilled birth attendance and associated ratios (poorest/richest and rural/urban) are outright unavailable for high-income OECD countries from international sources. This makes it necessary to adopt some data imputation strategy for the feasibility of the relevant DEA estimations with our enlarged sample. Despite this important constraint, for the sake of comparability with the analyses in previous sections, we examine the aforementioned access and equity indicators as DEA outputs in this section too. We do so by imputing figures of 100% for skilled birth attendance, and of 1 for the skilled birth attendance ratios, for high-income OECD countries with the corresponding missing information. In practice, this means that imputed data on these outputs is used for all OECD countries except in the cases of Canada (skilled birth attendance coverage is available) and Turkey (skilled birth attendance coverage and ratios are available).

All data caveats above should be kept in mind for the interpretation of DEA results using the enlarged sample of countries. The data we use in this section is presented for selected indicators in Table A 37 (Annex A).

6.2 Main DEA results for the enlarged sample

6.2.1 Efficiency scores and rankings

Table A 38 summarizes the resulting efficiency scores obtained for the enlarged sample of countries, estimated through 24 different DEA models (three DEA models per output as in Section 4, but now for eight system outputs including the life expectancy at age 60 indicator). For conciseness, the estimated efficiency scores in each model for each of the 71 countries are not reported.[32] Given the aims and scope of this report, the focus here is on the efficiency performance of LAC countries; specific results for OECD countries and non-LAC MICs are discussed only insofar as they offer insights useful to interpret the relative performance of LAC countries.

The results for the enlarged sample indicate that no LAC country consistently ranks among the top 25% of efficiency scores across all DEA models. However, the best all-round performer in LAC, Chile, is highly ranked (at 10th) for overall average efficiency. Chile's high health system efficiency is particularly driven by its solid performance with respect to generating good population health for its level of inputs: the country belongs to the highest 25% efficiency performers for both life expectancy indicators and DALYs lost. There are other relatively good LAC performers in terms of overall health system efficiency yet they do not come very close to Chile's ranking. Barbados (ranked 29th), Costa Rica (31st), Cuba (32nd) and Uruguay (35th) are all in the top half of the average efficiency table. Barbados and Cuba exhibit notably good efficiency performance concerning the provision of wider and equitable access to health services.

Most LAC countries (22) are, nevertheless, located in the bottom half of the average efficiency ranking table, and there are 10 LAC countries among the 17 (25%) worst system efficiency performers. Among these, some countries are consistently among the worst performers across the 8 outputs examined: Bolivia, Ecuador, Guatemala, Guyana, Haiti, Panama, Peru and Suriname. Figure 15 to Figure 18 show the position of all countries relative to the estimated efficiency frontiers for selected health system outputs.

[32] These are available upon request from the authors.

Figure 15: Estimated efficiency frontier for life expectancy at birth (enlarged sample)

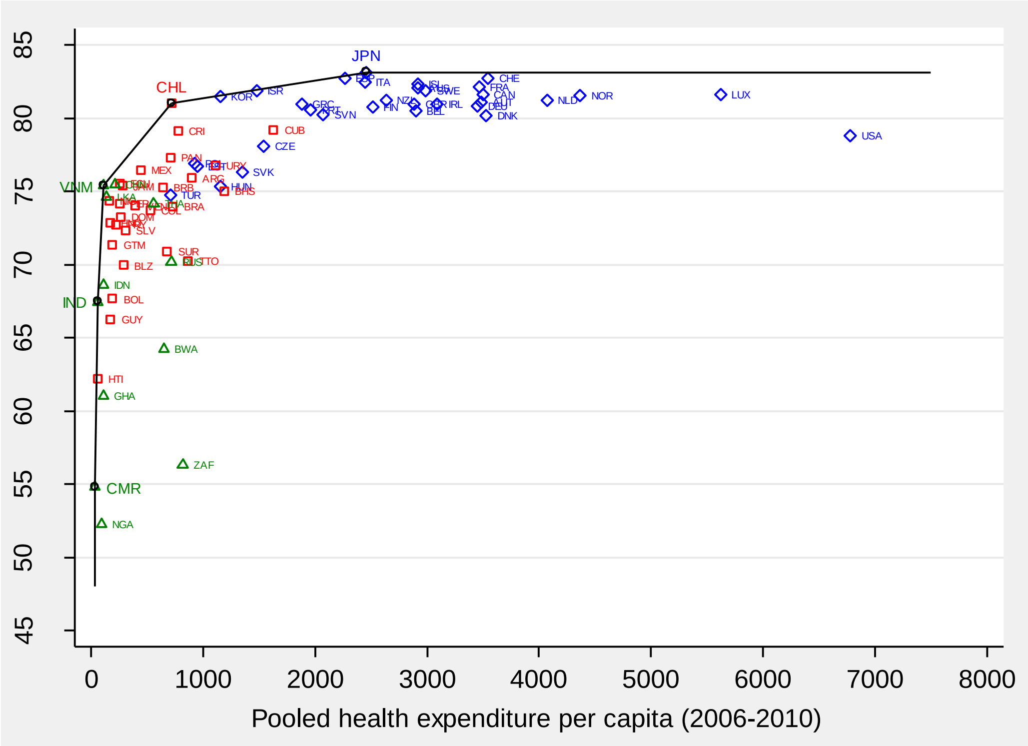


Figure 16: Estimated efficiency frontier for life expectancy at age 60 (enlarged sample)

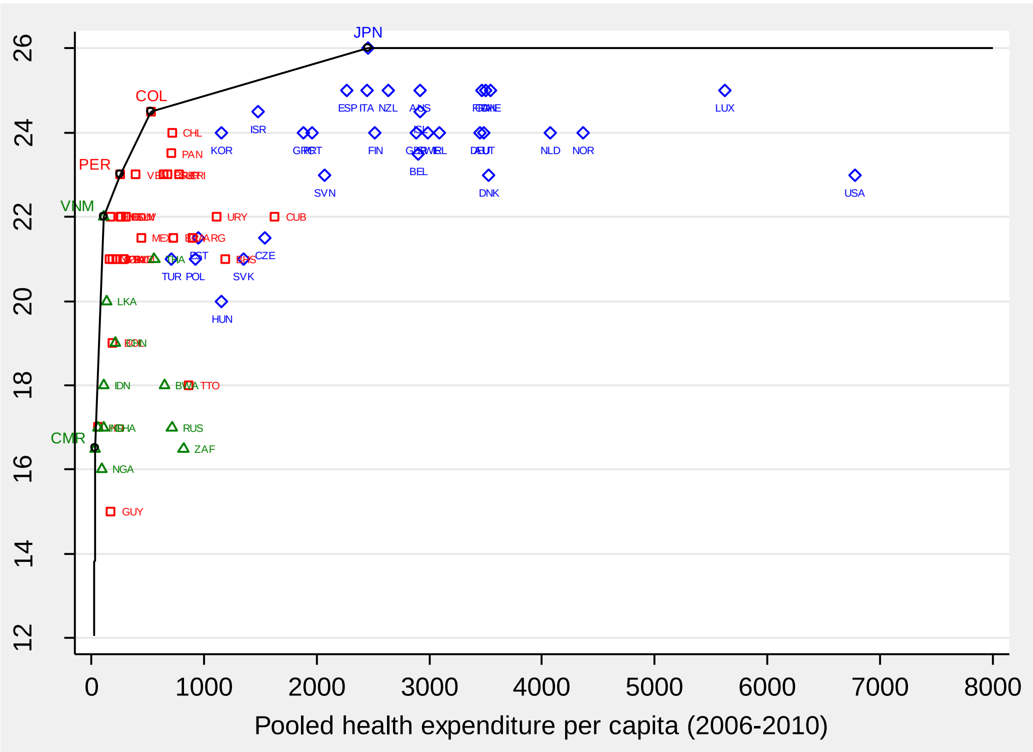


Figure 17: Estimated efficiency frontier for DPT immunization rate (enlarged sample)

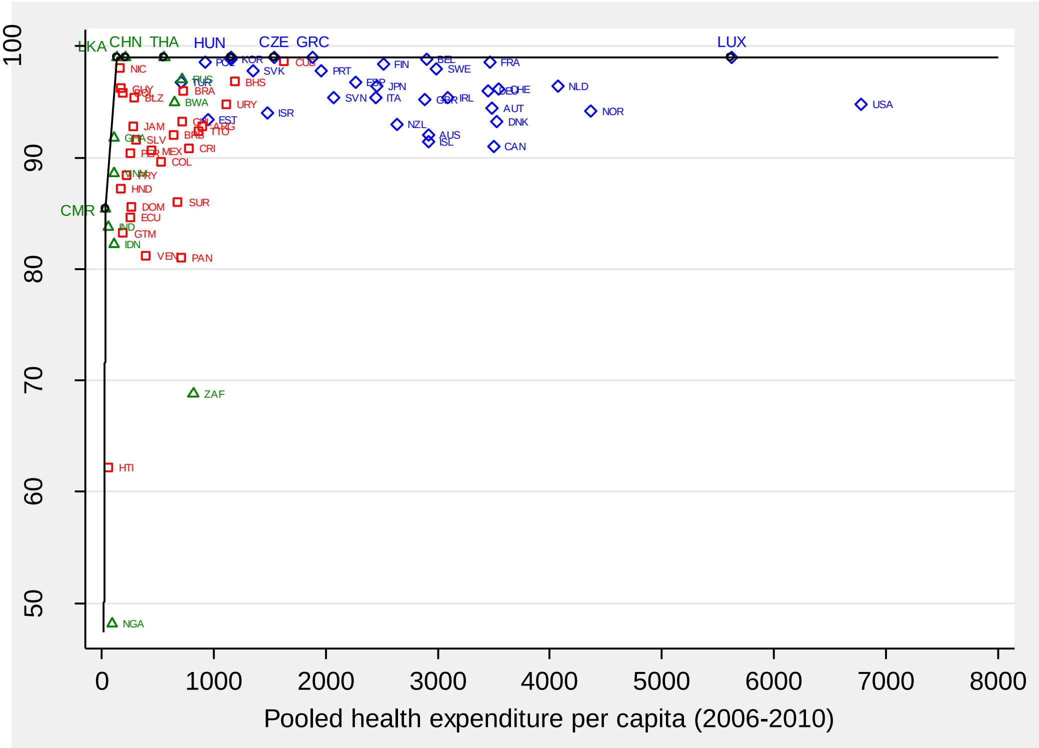
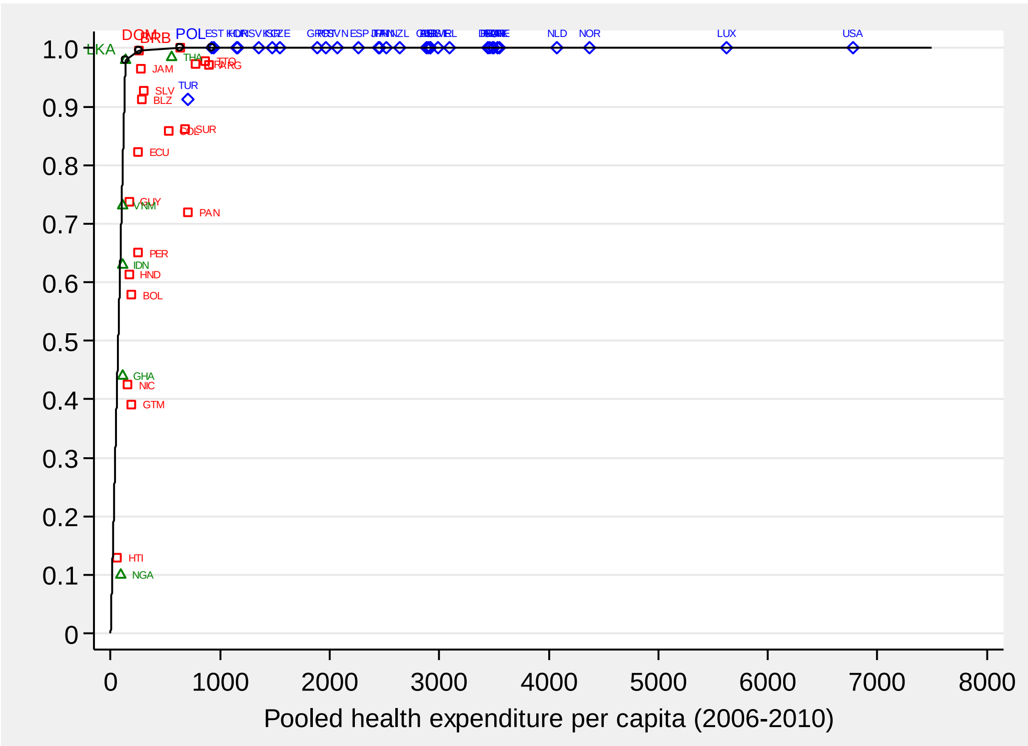
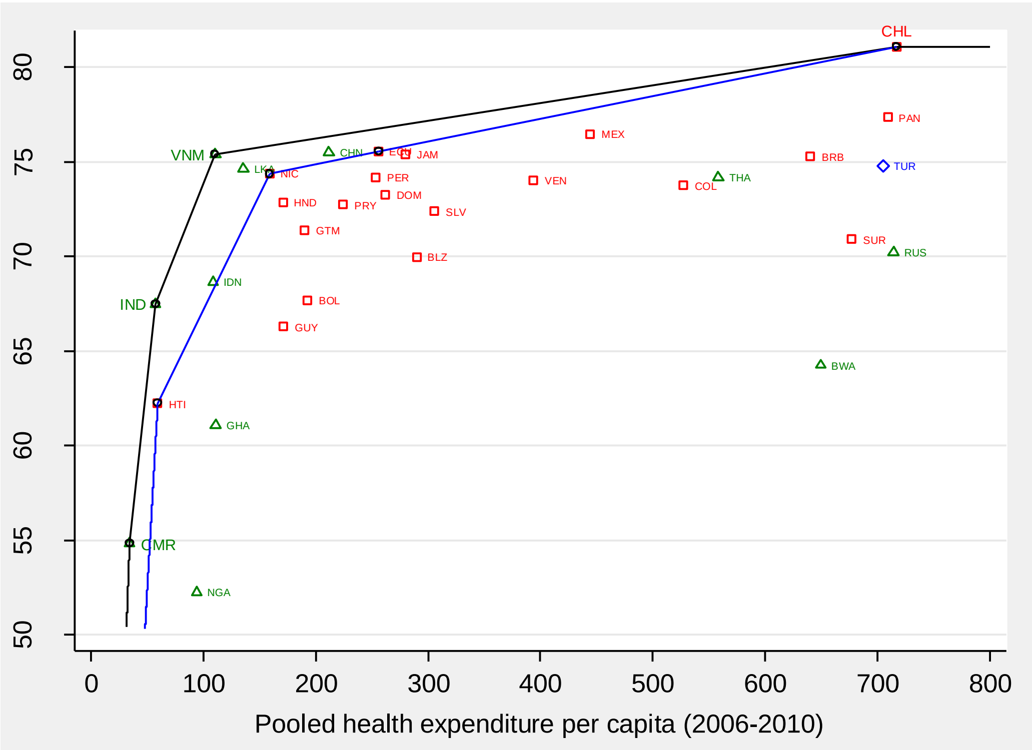


Figure 18: Estimated efficiency frontier for skilled birth attendance ratio poorest/richest (enlarged sample)



OECD countries occupy the large majority of the top 25% positions in terms of average efficiency score for the 8 DEA outputs. As it should be expected given their typically higher input levels (especially health expenditures and national income), OECD countries act as efficient peers for LAC countries in only very few instances (e.g. Korea and Israel).[33] Most peer pairings for LAC countries end up occurring among themselves and/or with some good performing MICs at different levels of inputs (e.g. China, Sri Lanka and Vietnam).[34] Using life expectancy at birth as an example, Figure 19 shows how the addition of non-LAC MICs to the sample pushes the efficiency frontier outwards with respect to the previous frontier constructed using only LAC countries (Section 4.1), and thus changes the measured levels of efficiency for some LAC countries – notably for the lowest health spenders in the region.

Figure 19: Comparison of estimated efficiency frontiers using the LAC-only and enlarged samples of countries, life expectancy at birth



Notes: Single DEA input is pooled health expenditure per capita. The left-most frontier has been constructed from the enlarged sample of countries (N = 71), while the inner frontier refers to the sample of LAC countries only (N = 27). The figure only shows countries with pooled health expenditure per capita below $800.

[33] Of course, because we have had to impute maximum figures for the access to care outputs in the case of most high-income OECD countries, some of these (e.g. Poland, Hungary, Slovak Republic) tend automatically to become efficient peers for a few LAC countries with similar input levels (e.g. Bahamas, Chile, Cuba) in the corresponding DEA estimations.

[34] Because Cameroon has uniquely low levels of health expenditures in the enlarged sample (pooled spending per capita of $37, compared to almost $60 in both India and Haiti, the next lowest spenders), it ends up lacking peers in the DEA estimations. Consequently, Cameroon appears among the 'efficient' countries due to the mechanics of the DEA – similarly to what is observed for Haiti in the previous analyses in this report.

If we restrict our attention to how LAC countries perform comparatively among themselves, the positioning of individual countries in the efficiency rankings tends to be similar to that presented in Section 4.1. For example, Chile, Costa Rica, Cuba, Jamaica and Uruguay are consistent frontrunners among countries in the LAC region. Poor efficiency performers include once again Bolivia, Guatemala, Panama, Peru and Suriname. However, some changes in efficiency rankings among LAC countries are induced by the addition of another health system output in the DEA estimations (life expectancy at age 60), as well as the inclusion of MICs that can act as peers for LAC countries – particularly for those that exhibit low health spending per person for regional standards. A notable case is Haiti, for which the availability of peers in the enlarged sample (e.g. India) is able to shed light on its relatively poor health system efficiency performance, with the country's average efficiency score now ranking 24th among the 27 LAC countries.[35] Nicaragua also falls in the LAC average efficiency ranking (to 18th) but, as before, the country still shows good efficiency performance regarding the production of population health outcomes, implying that the fall in the ranking is led primarily by lower measured efficiency in the provision of wider and equitable access to care when non-LAC peers are considered.

Efficiency rankings excluding life expectancy at age 60 and outputs with imputed data. To facilitate direct comparisons between the average efficiency scores of the enlarged sample and those estimated with the LAC-only sample (Section 4.1), Table A 39 (Annex A) displays the resulting average efficiency scores and rankings excluding life expectancy at age 60 from the set of outputs used in the computation of averages (columns 1-2). Chile is still the best performing LAC country and makes the top 25% of the average efficiency ranking, although it falls to the 16th place overall. In general, excluding life expectancy at age 60 tends to improve the efficiency performance of LAC health systems; only 10 LAC countries now remain among the least 25% efficient systems, but the consistently bad LAC performers are the same as in the main analyses above. Table A 39 also shows efficiency rankings where the three output indicators with imputed data for OECD countries – skilled birth attendance, and the poorest/richest and rural/urban ratios of skilled birth attendance – are excluded from the computed averages (columns 3-4). Chile is now joined by Nicaragua among the top 25% most efficient health systems, reflecting the latter country's good performance in generating population outcomes for its level of health spending. At the other end of the spectrum, Bolivia, Guatemala, Guyana, Panama and Suriname are still among the 25% least efficient health systems.

[35] Figure 19 shows this clearly for the case of life expectancy at birth. This result is corroborated by the low level of health system efficiency estimated for Haiti by Herrera and Pang (2005), who focus on a larger sample of developing countries (containing more potential peers for Haiti than in our study).

6.2.2 A closer look at the efficiency scores and their implications

We can use the average efficiency scores estimated across all models for the enlarged sample to draw comparisons between country groups. Figure 20 shows how the average efficiency scores per DEA output compare for the LAC, MICs and OECD groups. OECD health systems are the most efficient for all DEA outputs considered, while the MIC group is the least efficient for health outcomes and service coverage. Some important insights arise regarding the comparative efficiency of LAC health systems. On the positive side, the LAC region outperforms its comparable group of MICs for most health outputs, with an efficiency performance that is relatively close to that observed in the OECD for some health outcomes (life expectancy at age 60 and under-five mortality). On the negative side, LAC health systems perform particularly poorly as far as efficiency in providing equitable access to services is concerned. In addition to lagging well behind the OECD area for skilled birth attendance ratios, LAC health systems are at least as inefficient as the MIC group for these equity of access indicators.

Figure 20: Comparison of average efficiency scores: LAC, MICs and OECD

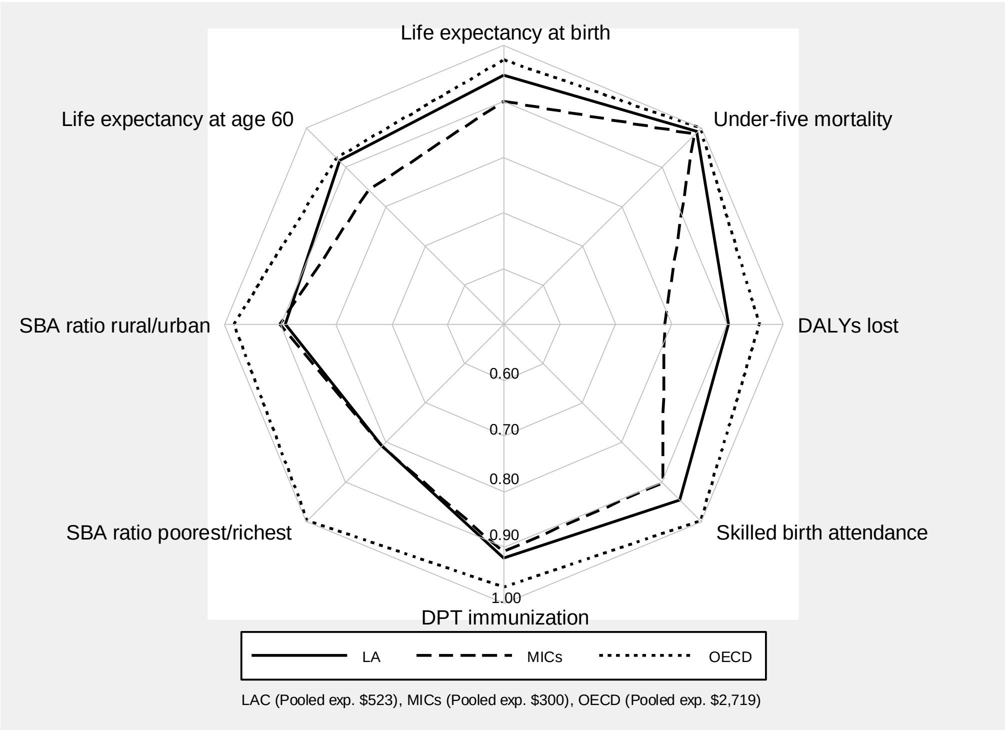


Figure 21 to Figure 23 present head-to-head comparisons of average efficiency scores across all available outputs, for LAC countries and peer countries outside the region with similar pooled health expenditure figures. This sheds further light into specific health system areas for efficiency improvements. Among 'high' LAC spenders, Bahamas and Uruguay get close to the efficiency levels of Korea (efficient peer) for under-five mortality and service coverage indicators, with larger gaps arising for the other population health outcomes, especially in the case of Bahamas. Brazil's efficiency scores are similar to Turkey's but generally low when

compared to its efficient peer Chile, notably for population health indicators. Among 'low' LAC spenders, Honduras and Nicaragua lag behind their efficient peer Vietnam for all DEA outputs, notably for service access and (in particular) equity indicators.

Figure 21: Comparison of average efficiency scores: Bahamas, Korea and Uruguay

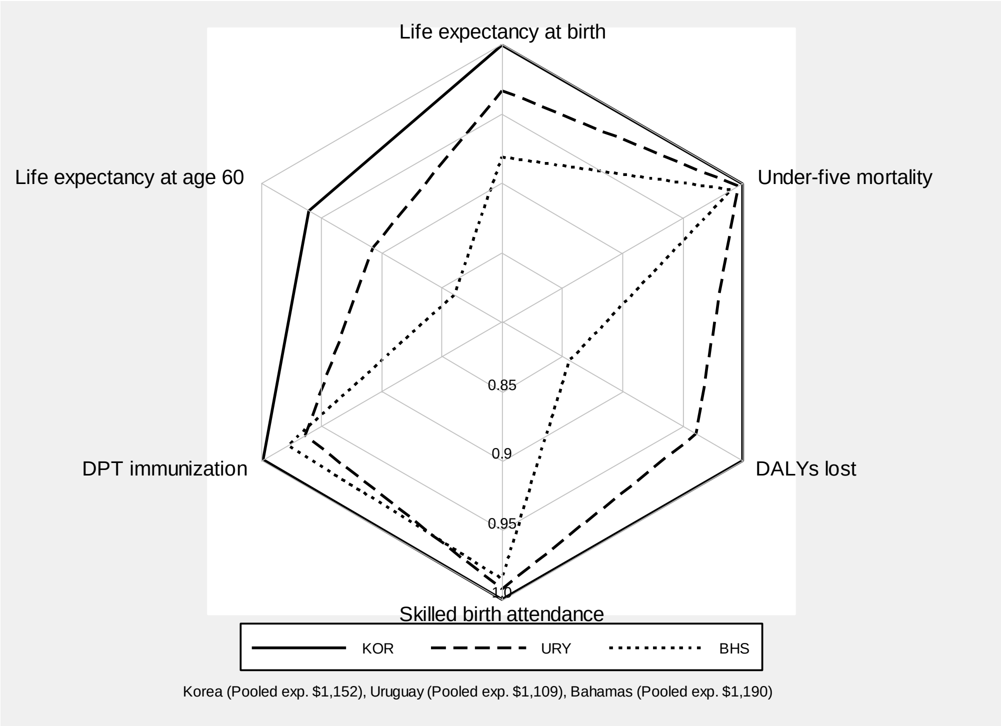


Figure 22: Comparison of average efficiency scores: Brazil, Chile and Turkey

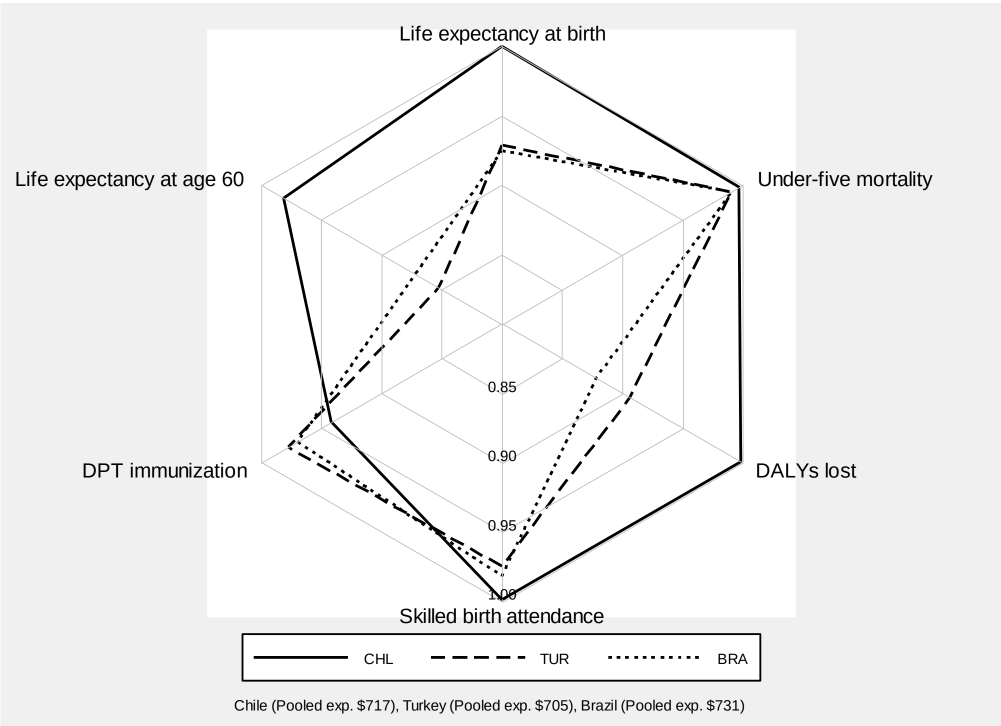
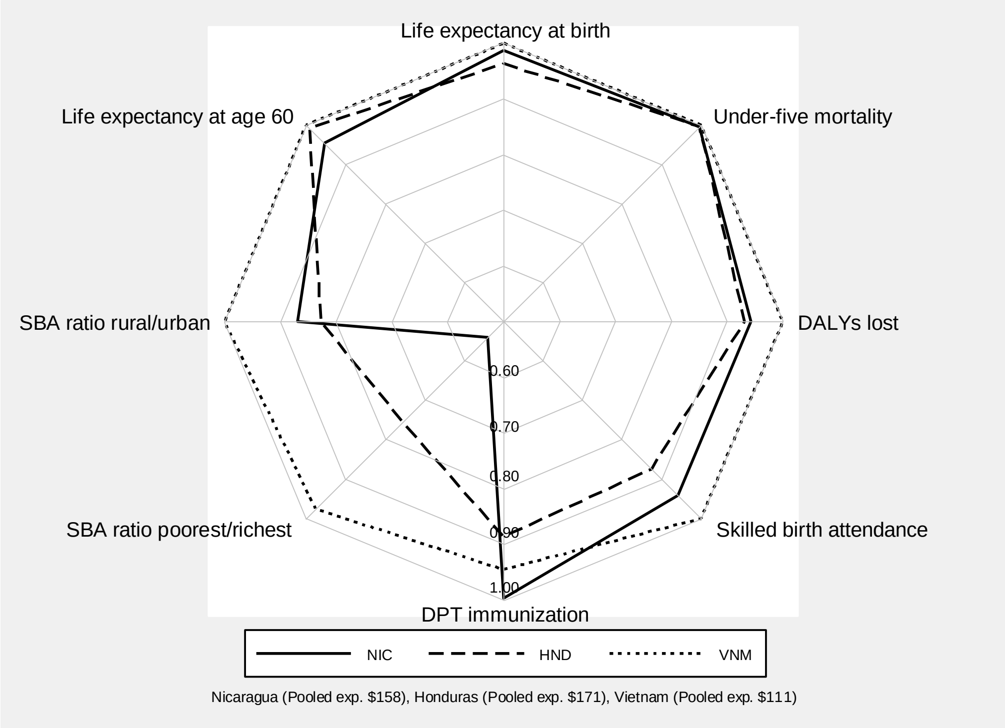


Figure 23: Comparison of average efficiency scores: Honduras, Nicaragua and Vietnam



The magnitude of average gains that LAC countries could make by moving to the efficiency frontier for each DEA output is substantial – and typically higher for the enlarged sample than for the LAC-only sample used in previous sections (Table 2). For instance, life expectancy at birth could now be increased on average by 4 years for inefficient LAC countries, reaching over 8 years for Guyana and 9.5 years for Trinidad and Tobago, for these countries' current level of health spending. Under-five mortality could be reduced on average by 10 deaths per 1,000 for inefficient countries, or almost halved relative to the current regional average rate.

Cross-country lifestyle differences and multiple output analysis. Before turning to the determinants of system efficiency, we briefly comment on the DEA results for the models that add smoking prevalence to the set of inputs, as well as on a summary DEA model that estimates efficiency for a bundle of health outputs examined jointly.

As noted previously, the results for the smoking prevalence models are not directly comparable to others in this report: although the efficiency rankings for LAC countries may change in part due to the addition of the smoking indicator, such changes are bound to be influenced quite significantly by the exclusion from the sample of 10 LAC countries with unavailable smoking data (e.g. Belize, Guatemala, Guyana and Nicaragua). Table A 40 (Annex A) shows that Chile, Costa Rica, Cuba, Haiti and Uruguay are usually among the most efficient countries when differences in smoking prevalence are considered as an additional constraint for system performance. On the other hand, many LAC countries are among the most inefficient countries, often including countries like Bolivia, Brazil and Ecuador.

Table 2: Potential gains estimated by output indicator (enlarged sample)

	Potential gains by output indicator							
Country	Life expectancy at birth (years)	Life expectancy at age 60 (years)	Under-five mortality (per 1,000)	DALYs (per 100,000)	Skilled birth attendance (percentage points)	DPT immunization (percentage points)	Skilled birth attendance ratio poorest/richest (units)	Skilled birth attendance ratio rural/urban (units)
Argentina	**4.6**	**2.7**	**8.0**	**5,530**	**2.5**	**5.8**	**2.82**	
Australia	1.1	1.0	1.9	1,949	0.0	6.5	0.00	1.65
Austria	2.0	1.8	1.6	3,868	0.0	4.4	0.00	1.41
Bahamas, The	**6.1**	**3.4**	**9.3**	**10,017**	**1.5**	**2.2**		
Barbados	**3.6**	**1.0**	**7.0**	**3,786**	**0.9**	**6.3**	**0.00**	**0.00**
Belgium	2.5	2.3	2.0	3,971	0.0	0.2	0.00	1.41
Belize	**6.4**	**2.0**	**7.7**	**6,189**	**3.5**	**3.5**	**6.88**	**3.45**
Bolivia	**7.4**	**2.9**	**24.9**	**12,952**	**10.4**	**2.6**	**18.76**	**17.89**
Botswana	12.4	4.8	38.4	19,372		3.8		9.35
Brazil	**5.5**	**2.8**	**9.2**	**8,328**	**1.8**	**2.9**		**4.88**
Cameroon	0.0	0.0	0.0	0	0.0	0.0	0.00	0.00
Canada	1.5	1.0	3.0	3,021	0.1	7.4	0.00	1.62
Chile	**0.0**	**0.4**	**2.8**	**153**	**0.1**	**5.5**		
China	0.6	3.0	1.7	0	0.0	0.0		0.03
Colombia	**4.5**	**0.0**	**8.5**	**3,638**	**0.6**	**8.5**	**11.93**	**10.96**
Costa Rica	**0.6**	**1.5**	**2.9**	**763**	**1.5**	**7.5**	**2.44**	**3.23**
Cuba	**1.5**	**2.5**	**0.9**	**4,848**	**0.2**	**0.4**		**1.00**
Czech Republic	3.8	3.2	0.5	4,349	0.0	0.0	0.00	1.56
Denmark	2.9	2.7	1.5	4,484	0.0	5.5	0.00	1.48
Dominican Republic	**3.4**	**1.0**	**22.4**	**4,804**	**1.8**	**11.6**	**0.00**	**2.12**
Ecuador	**1.2**	**1.0**	**13.4**	**4,555**	**7.1**	**12.3**	**13.89**	**12.49**
El Salvador	**4.3**	**1.1**	**7.6**	**9,453**	**0.6**	**6.8**	**4.28**	**2.98**
Estonia	2.9	2.3	0.0	4,152	0.0	3.5	0.00	1.14
Finland	2.3	1.8	0.1	3,940	0.0	0.6	0.00	1.45
France	1.0	1.0	2.0	3,267	0.0	0.4	0.00	1.43
Germany	2.3	1.8	1.5	3,377	0.0	2.6	0.00	1.24
Ghana	8.5	2.8	26.6	12,361	5.7	1.2	6.48	8.71
Greece	1.1	1.3	1.7	2,186	0.0	0.0	0.00	1.30
Guatemala	**4.5**	**1.4**	**18.2**	**9,345**	**22.5**	**13.1**	**22.65**	**21.55**
Guyana	**8.4**	**5.0**	**24.6**	**17,246**	**3.6**	**2.3**	**11.16**	**4.65**
Haiti	**1.7**	**0.4**	**7.1**	**3,501**	**6.1**	**6.2**	**7.54**	**5.21**
Honduras	**2.7**	**0.2**	**3.9**	**4,570**	**10.4**	**9.9**	**14.98**	**13.56**
Hungary	4.7	3.7	2.4	7,462	0.0	0.0	0.00	1.28
Iceland	0.8	1.4	0.0	1,529	0.0	7.0	0.00	1.71
India	0.0	1.1	0.0	0		4.2	8.14	9.60
Indonesia	5.9	3.2	5.1	5,447	8.4	11.3	11.42	6.28
Ireland	2.1	1.8	1.7	3,464	0.0	3.5	0.00	1.71
Israel	0.1	0.7	1.1	116	0.0	4.7	0.00	1.71
Italy	0.7	1.0	1.1	1,222	0.0	3.1	0.00	1.24
Jamaica	**1.3**	**1.7**	**6.7**	**7,318**	**0.7**	**5.8**	**2.07**	**1.63**
Japan	0.0	0.0	0.3	0	0.0	1.7	0.00	1.14
Korea, Rep.	0.0	0.9	0.3	0	0.0	0.2	0.00	1.71
Luxembourg	1.5	1.0	0.0	2,845	0.0	0.0	0.00	1.59
Mexico	**2.0**	**2.3**	**6.9**	**3,485**	**3.7**	**7.7**		**10.94**
Netherlands	1.9	1.8	1.8	2,959	0.0	2.5	0.00	1.55
New Zealand	1.7	0.9	3.4	2,553	0.0	5.6	0.00	1.68
Nicaragua	**0.9**	**1.0**	**4.5**	**3,788**	**5.1**	**0.3**	**19.48**	**10.65**
Nigeria	14.8	3.7	77.3	11,658	21.7	23.2	8.47	20.98
Norway	1.6	1.8	0.7	3,733	0.0	4.6	0.00	1.55
Panama	**2.7**	**1.1**	**11.3**	**5,058**	**6.9**	**14.7**	**20.13**	**17.74**
Paraguay	**3.5**	**1.6**	**9.5**	**4,810**	**2.6**	**9.3**		
Peru	**2.5**	**0.0**	**8.8**	**2,331**	**11.0**	**7.9**	**22.30**	**19.83**
Poland	3.3	2.9	0.6	4,102	0.0	0.4	0.00	1.64
Portugal	1.5	1.3	0.7	2,164	0.0	1.0	0.00	1.34
Russian Federation	8.4	5.0	5.0	13,526		1.3		
Slovak Republic	5.1	3.5	4.1	6,553	0.0	1.2	0.00	1.71
Slovenia	2.2	2.4	0.0	3,909	0.0	3.5	0.00	1.47
South Africa	16.5	5.5	36.1	18,916		21.0		
Spain	0.2	0.8	1.6	943	0.0	2.2	0.00	1.43
Sri Lanka	0.9	1.9	0.0	335		0.0	0.00	0.00
Suriname	**7.9**	**1.5**	**15.4**	**6,880**		**11.3**	**11.87**	**11.55**
Sweden	1.3	1.8	0.7	2,527	0.0	1.0	0.00	1.37
Switzerland	0.4	1.0	1.9	1,933	0.0	2.7	0.00	1.45
Thailand	4.6	2.8	5.4	5,678	0.3	0.0	1.27	1.00
Trinidad and Tobago	**9.5**	**4.9**	**17.1**	**14,139**	**0.0**	**6.2**	**2.23**	
Turkey	5.3	3.1	9.1	6,655	2.5	2.2	8.03	7.60
United Kingdom	2.1	1.8	2.2	4,417	0.0	3.7	0.00	1.48
United States	4.1	2.7	4.7	6,482	0.0	4.0	0.00	1.68
Uruguay	**2.5**	**2.0**	**3.9**	**2,914**	**0.7**	**3.5**		**1.23**
Venezuela, RB	**3.8**	**0.7**	**7.6**	**5,473**	**3.7**	**14.6**		
Vietnam	0.0	0.0	0.0	0	0.0	4.9	1.75	0.00

Above 75th percentile
Below 25th percentile

Note: Potential gains represent the average gain estimated across three DEA models. See text for a description of each model.

We now look at the DEA results of a summary, multi-output model. In Section 3.1 we noted that DEA methods allow assessments of efficiency performance according to multiple criteria (outputs) simultaneously and without pre-defining weights. This comes at the expense of reduced ability to discriminate between more and less efficient countries: DEA shows countries in the best possible light meaning that good performance for one output, despite not so good performance for the others, will be given greater weight and put the country close to (or on) the efficiency frontier.

For our multi-output analysis, we examine health system efficiency with respect to a set of three outputs: life expectancy at birth, DPT immunization and the ratio poorest/richest of skilled birth attendance. These outputs have been selected to represent the key domains of health outcomes, service coverage and equity in access to services.[36] The first finding from the DEA results outlined in Table A 41 is that between 39-44 out of the 59 countries with available data achieve maximum efficiency in the multi-output models. Virtually all OECD countries are deemed fully efficient, chiefly due to their superior efficiency performance on service coverage and/or equitable access. Good performance in at least one domain also drives most non-LAC MICs to the efficiency frontier. This is in contrast with LAC countries: with a single input (pooled spending, column 1), only three out of the 19 countries examined are in the efficiency frontier (Barbados, Costa Rica and Dominican Republic). Across the three DEA models, only seven LAC countries reach the efficiency frontier; on the other hand, Colombia, Guatemala and Suriname appear consistently among the five least efficient health systems in the sample.

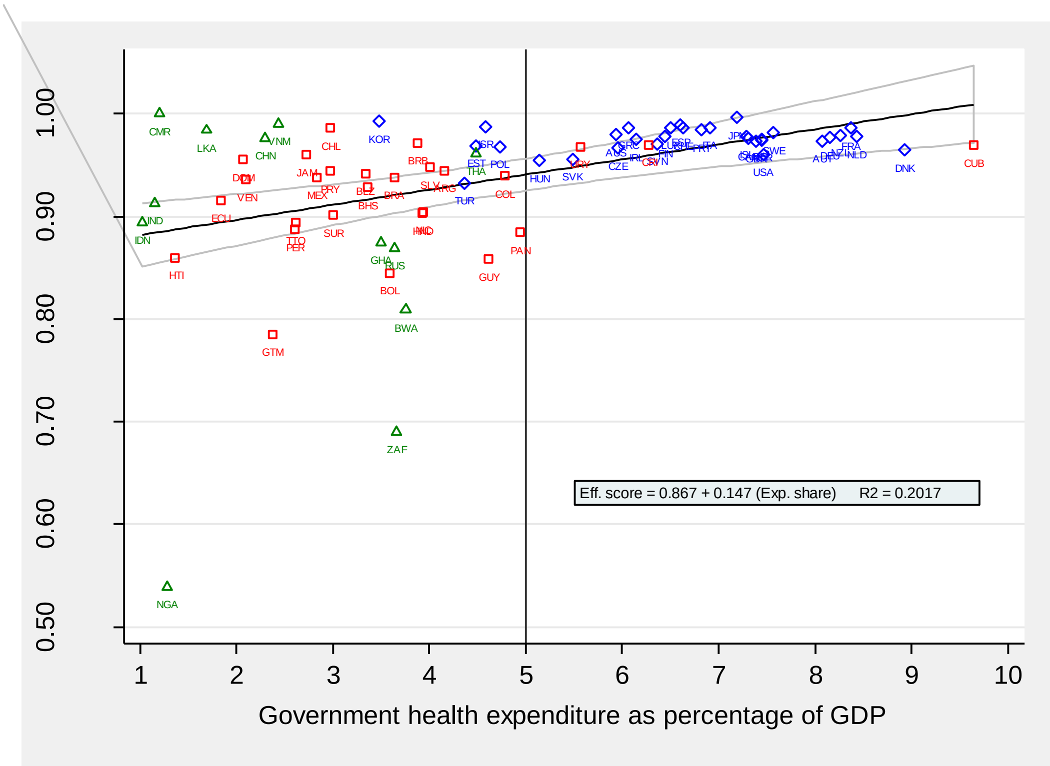
System efficiency and UHC health spending targets. As a preamble to the econometric analysis of factors that may be driving differences in measured health system efficiency across countries, we look graphically at how efficiency performance varies according to the health spending target of **total government spending on health of at least 5% of GDP**. This target, based on the Abuja declaration and widely used in policy discussions, is often recommended to low- and middle-income countries as the minimum health spending necessary for countries to get close to UHC (Jowett et al. 2016).[37] Its link to health system efficiency is less clear, however. On the one hand, more efficient health systems may be better positioned to compete successfully for public resources with other government sectors (based on demonstrably good value-for-money of health investments), hence favoring higher public spending on health. On the other hand, increases in the amount of public resources devoted

[36] Increasing the number of outputs would further bias efficiency scores towards one and thus reduce the usefulness of this exercise. Another limitation comes from the fact that only countries with data for all outputs can be included in the DEA estimation, which in the LAC case results in a loss of 8 countries due to missing data.
[37] Other similar targets exist (for example, the Abuja 2001 target recommending a minimum of 15% of the government budget directed to the health sector) but they have limited relevance for policymakers; see Jowett et al. 2016 for a discussion.

to health may be driven, at least in part, by inefficiencies in the health system reflected in wasted resources and sub-optimal investments.

Figure 24 offers *prima facie* support to the existence of a positive correlation between health system efficiency and the GDP share of government health spending in the enlarged sample. Such relationship becomes weaker, however, when only LAC countries are considered.[38] This is also suggested by closer inspection of the data points in Figure 24. Most LAC countries have government health spending shares of GDP that are below the 5% target. The exceptions are Costa Rica, Cuba and Uruguay – who are all among the most efficient health systems in LAC. Yet other LAC countries with much lower government health spending shares are also among the best performers in the system efficiency analyses, including Barbados, Chile and Jamaica. Within LAC, being closer to the 5% target does not seem to be linked clearly to higher (or lower) system efficiency. In fact, looking at the overall sample of low- and middle-income economies, there is considerable heterogeneity in efficiency performance at all levels of government health spending shares. The next section uses more formal econometric modelling to examine other potential determinants of differences in health system efficiency.

Figure 24: Average efficiency scores and government health spending as share of GDP



Note: Fitted regression line with 95% confidence interval bands.

[38] The regression coefficient shown in the figure (0.147) is statistically significant at the 1% level for the enlarged sample of 71 countries. When the sample includes only LAC countries, the corresponding coefficient is reduced substantially in magnitude (to 0.009) and becomes significant only at the 10% level.

6.3 Potential determinants of health system efficiency in the enlarged sample

6.3.1 Econometric methodology and data on potential efficiency determinants

We use Simar-Wilson cross-sectional regressions, as described in Section 4.2, to investigate associations between countries' average efficiency scores and a set of potential efficiency determinants. The latter include the same indicators of the organization of healthcare financing and delivery (OOP share and hospital beds) as well as quality of governance measured by an average index, again as in Section 4.2.

For the quality of health system institutions, we have sought comparable data from a number of sources. The only related data series are published for the group of OECD member countries, notably the OECD *Government at a Glance*[39] and *Health System Characteristics Survey*[40] databases; no corresponding information is compiled systematically and in a comparable fashion for our non-LAC MICs. Yet even in the case of OECD countries, indicators are not constructed using the same type of information and methodology used for the construction of PRODEV indicators for LAC countries, which limits their usefulness for our econometric exercise.

In order to allow some empirical assessment of the influence of health system institutional quality in the enlarged sample, we have extracted two indicators from the above OECD databases, "Use of a medium term perspective in the budget process" and "Setting and monitoring public health objectives". These have been selected due to their similarities to two PRODEV indicators available for LAC: respectively, "Medium term sectoral vision in line with the government plan", and two sub-indicators of "Results-based management in the production of goods and services". We have used additional information to rescale the OECD indicators into the same scale used for the PRODEV indicators, and then construct two composite indicators of health system institutional quality that are common to LAC and OECD countries: **medium term sectoral vision** and **setting and monitoring plans and objectives**. Details about the construction, definition and sources of these two composite indicators are given in Table A 42 in Annex A. Both indicators range from 0 (worst) to 5 (best). The empirical results for the composite indicators must be interpreted with great caution, however, due to the differences in the definition and construction of underlying indicators between PRODEV and OECD sources.

6.3.2 Estimation results

We focus below on the results for five main regression specifications and their key messages (Table A 43-Table A 50). Differences in the sample sizes used across regressions are due to

[39] http://www.oecd.org/gov/government-at-a-glance-2015-database.htm.
[40] http://www.oecd.org/els/health-systems/characteristics.htm.

variations in data availability, particularly regarding health system quality indicators (which are unavailable for non-LAC, non-OECD MICs).

Health outcomes. Unlike the analyses in Section 4.2, the results for the enlarged sample now indicate explicitly the existence of some association between average governance quality and system efficiency with respect to population health outcomes. In three models – life expectancy at birth, life expectancy at age 60 and under-five mortality – we find that higher governance quality is linked to the achievement of better health outcomes for a given level inputs. The latter result is stronger for under-five mortality than for the other outcomes. As a sense of the magnitudes involved, the under-five mortality results imply that if Mexico were to improve its average governance index by one standard deviation (0.90), thus reaching a governance quality similar to Korea's, the Mexican under-five mortality rate could be almost halved (i.e. a reduction of over 7 child deaths per 1,000) for the country's current health spending level. There is also some suggestion that higher quality of health system institutions, measured by the medium-term sectoral vision indicator, is linked to higher efficiency with respect to lowering under-five mortality rates for a given level of inputs.[41] No systematic relationship is found across models between efficiency scores and our measures of OOP spending share and beds per population.

Service access and equity of access. The regressions once again indicate that higher quality of governance is linked to higher efficiency in the provision of access to services (DPT immunization) and, more strongly, in equitable access to services (poorest/richest and rural/urban ratios of skilled birth attendance). For health system institutional quality, there is some indication – albeit weak – that medium-term sectoral vision correlates with higher efficiency in service coverage (skilled birth attendance and DPT immunization). From the remaining results, the only robust link found is a positive association between hospital beds per population and efficiency in the provision of DPT immunization.

Overall message. The above results reinforce our conclusion from the analyses in Section 4.2 that differences in governance quality are related to variations in health system efficiency. The estimates using the enlarged sample offer further support to the link, hypothesized previously in this report, between better country governance and achievement of better population health for a given level of health spending, channeled also through higher efficiency in the provision of wider and equitable access to services. Although other factors may well be important in influencing health system efficiency, such as the organization of health sector financing, delivery, and institutions, this can only be tentatively backed up by

[41] Subject to the aforementioned limitations of our health system institutional data for the enlarged sample, the relevant estimates are again important in magnitude. They imply, for instance, that an increase in Mexico's medium-term sectoral vision indicator to reach a level close to that of Turkey (equivalent to a rise of one standard deviation) could be associated with a one-quarter decrease in the Mexican under-five mortality, or almost 3 child deaths per 1,000 live births.

the empirical results in this section, not least in light of the limitations of the relevant health institutional data.

6.4 Sensitivity analyses

We have undertaken sensitivity checks and model extensions for this enlarged sample as described in Section 5 (except excluding Haiti from the sample, as there are now MIC peers for this country). The results from these estimations for the LAC group are generally similar to the main findings and do not change our general conclusions. Thus, for brevity, we focus below on a few more relevant sensitivity checks specifically for the enlarged sample case.

6.4.1 Using public health expenditures as the main DEA input

This section explores the robustness of the results about potential efficiency determinants to changing the main input to public health expenditure per capita, instead of pooled health spending. With one exception, the overall message from Table A 51 is the same as in the main analyses using pooled expenditures. Most LAC countries are again in the bottom half of the average efficiency table when public health expenditure is used as the main DEA input, and the consistent underperformers are again the same as discussed in Section 6.2.1. The exception is Haiti, who is now part of the efficiency frontier for DEA outputs. This is because of the country's uniquely low level of government expenditure on health (it reaches just below $21 per capita, less than 35% of its pooled health spending), which results in Haiti now being paired only with Cameroon for many DEA estimations – and the former country performs much better than the latter in a few outputs (health outcomes).[42] This is otherwise the only noteworthy change compared to the analyses with pooled health expenditures: apart from Haiti, Chile (8th) is the only LAC health system to make it among the top 25% of average efficiency, with Barbados, Costa Rica, Cuba and Uruguay also in the top half of the efficiency table.

Table A 52-Table A 59 (Annex A) present the results of the Simar-Wilson estimations when efficiency scores are computed using public health expenditure per capita as input.[43] These results confirm the strong relationship between better governance and higher system efficiency, which is once again stronger for the under-five mortality and equity of access indicators, and somewhat weaker – although statistically significant in various models and with the expected direction – for service coverage indicators. The estimations point to higher

[42] Haiti has the lowest 2006-2010 average public health expenditure per capita in the sample. The second lowest figure is for Cameroon ($29), and there are relatively large gaps between these figures and the next lowest public spending figures in the sample (India $43, Indonesia $75, Nigeria $86). This is in contrast with the situation where pooled expenditures per capita are used as DEA input: there, Cameroon ($34, not much higher than its public health spending figure) is well below everyone else while Haiti ($59) is much closer to India ($57); see Table A 37 in Annex A.

[43] Some models run into convergence problems and hence the corresponding coefficients could not be estimated in a few instances.

system efficiency being related also to better quality of health institutions, through the medium-term sectoral vision indicator: this result now appears strongly for two health outcomes (life expectancy at birth, under-five mortality). Although a few instances of statistically significant coefficients arise for the OOP spending and beds per population measures (with mostly negative and positive signs, respectively), these are not robust to specification changes within any of the output models.

6.4.2 Miscellaneous changes in model specifications

As mentioned at the beginning of this section, we have estimated a number of variations in model specifications to test our main results, and our general conclusions about health system efficiency in LAC remain unchanged across all these tests. For conciseness, only some of these tests for the potential determinants of health system efficiency are presented here (Table A 60-Table A 67, Annex A).

We find, for example, that excluding the indicator 'hospital beds' from the Simar-Wilson regressions, while keeping the OOP health spending share as the only proxy for the organization of care financing and delivery, does not change the conclusions that system efficiency is positively linked to general governance (for two health outcomes and the two equitable access indicators), and less clearly to the quality of health institutions (under-five mortality, relating to medium-term sectoral vision). There is still no clear pattern of relationship between the OOP share of health financing and system efficiency. We also add the governance sub-indicators separately, yet no clear insight emerges about what the most relevant governance aspects are for system efficiency: despite positive and significant coefficients for 'rule of law' and 'regulatory quality' in some models, a counter-intuitive negative result appears for 'government effectiveness' in a couple of cases.[44]

The last five columns of Table A 60-Table A 67 present the estimation results for the main models discussed in Section 6.3.2, but restricting the estimation sample to include only LAC countries (the efficiency scores used are still those computed using the enlarged sample). As it should be expected, this sample restriction tends to increase the estimated standard errors and makes it more difficult to identify statistically significant coefficients. However, the results still suggest a positive and significant relationship between system efficiency and governance in this LAC-restricted sample (under-five mortality, poorest/richest ratio of skilled birth attendance). On the other hand, there is no robust link identified between the indicators for quality of health institutions and efficiency scores in the restricted sample.

[44] As in previous estimations, some Simar-Wilson models fail to reach convergence precluding the estimation of coefficients in a few models (e.g. model with only OOP share for some health outcomes).

6.4.3 Estimating robust DEA efficiency scores

In this sub-section we estimate robust (bias-corrected) DEA efficiency scores using the approach suggested by Simar and Wilson (2007), following the procedure described in Section 5.6. As expected, and akin to the findings for the LAC-only sample, there are no major changes in country efficiency rankings using the bias-corrected DEA scores compared to the rankings based on 'naïve' (uncorrected) scores, with a high correlation between the two sets of score estimates (0.95). Figure A 16 (Annex A) shows that bias-correction mostly lowers the estimated scores across the board, resulting in a roughly parallel shift of the score distribution, with just a few instances of efficiency score increases in the lower tail or changes in relative positions.[45]

Annex Table A 68 displays the average robust efficiency scores across all DEA models and corresponding country rankings. The most and least efficient LAC countries tend to remain the same as in the main analyses with 'naïve' DEA scores. As before, no LAC country is consistently among the top 25% efficient across all DEA models, although Chile is again one of the best overall performers on average efficiency, reaching the 7th position in the enlarged sample. Barbados, Costa Rica and Cuba are still in the top half of average efficiency. All other LAC countries belong to the bottom half of the efficiency table, and the least efficient LAC countries remain the same as in the corresponding analyses with 'naïve' scores discussed previously.

As for factors associated with efficiency performance, Table A 69-Table A 76 in Annex A show the regression estimates using robust, bias-corrected DEA scores. As in the main analyses for this enlarged sample, the results point to a strong association between better governance and higher system efficiency. This relationship seems consistent for health outcomes (and stronger than for the models with 'naïve' scores), specifically in the cases of life expectancy at birth, under-five mortality and DALYs lost. There is still a strong association between better governance and higher efficiency in the provision of equitable access to services, and a weaker positive relationship with respect to overall access to DPT immunization and skilled birth attendance. Better quality of health institutions is again linked to higher system efficiency, particularly through the medium-term sectoral vision indicator, which correlates positively with efficiency performance for most population health outcomes and for DPT immunization coverage. Finally, once again there is no generally consistent picture – across groups of health outcomes, service access, or equity of access indicators – of a relationship between efficiency and the measures of OOP spending and beds per population.[46]

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[45] Among non-LAC countries, a noteworthy change occurs for Cameroon, who falls considerably in the rankings to a place in the bottom half of the average efficiency table (54th).

[46] Some models run into convergence problems when the OOP share and/or bed per population indicators are included (for the under-five mortality and skilled birth attendance coverage outputs), and consequently the corresponding OOP and beds coefficients could not be estimated in a few instances.

Section 7 Conclusions

7.1 Main messages for policy

The analyses in this report offer numerous insights for health policy in the LAC region. We discuss some of the main implications below.

There is substantial room for efficiency improvements in the health system of most LAC countries. This message arises both from the analyses restricted to LAC countries as well as from those comparing LAC with health systems in the OECD and selected MICs. The potential gains that LAC countries could make by approaching the estimated efficiency frontier for population health outcomes and provision of access to services, while keeping their current health budget, are typically large. For example, at current spending levels, LAC countries could improve life expectancy at birth up to about 4 years on average if they followed best practices. This magnitude is larger than the comparable estimate of about 3 years for LAC countries found by Grigoli and Kapsoli (2013), and not too far away from their estimate of 5 potential years on average found for African economies. And despite relatively good efficiency performance for under-five mortality and life expectancy at age 60, LAC health systems perform especially poorly compared to the OECD and other MICs regarding the provision of equitable access to services for their levels of health spending.

This great potential for efficiency gains in LAC is in contrast with the findings of studies undertaken previously that include LAC countries, but are less comprehensive in the scope and depth of analyses (including with respect to the number of LAC countries considered, as well as health system dimensions and outputs examined; see Section 2.2). These efficiency gains should be sought not only as a matter of public sector accountability (since health financing in most LAC countries relies heavily on public sources including taxes and social insurance contributions), but also because the health gains from efficiency improvements could represent a crucial step in the progress of less efficient countries towards UHC (Moreno-Serra and Smith 2012). Arguably, improving population health and equitable access to services by spending currently available resources more wisely represents a 'low-hanging fruit' for health financing in LAC, which can be used to relieve acute budgetary constraints as well as to make a stronger case for increases in the share of government resources devoted to the health sector.

Efforts to increase health system efficiency could be focused in a few key policy areas linked empirically to cross-country efficiency variations in LAC, including general governance aspects. The relationship between better governance and higher system efficiency is apparent when comparing LAC countries among themselves and (even more strongly) when LAC countries are contrasted to their OECD and MIC counterparts. A closer look at efficient OECD and MIC peers reveals that these countries score highly in aspects such as government effectiveness; transparency and citizens' participation in policymaking; and regulatory quality. All these factors are likely to impact favorably on the functioning and efficiency of the

public sector (Wagstaff and Claeson 2004), which plays a pivotal role for the organization and functioning of most health systems in LAC. Some of the more health efficient LAC countries have indeed made important advances in improving public sector regulation, transparency and accountability to citizens – for instance, by embarking in sensible open government reforms – and these may make policymaking and public spending processes more efficient. In Costa Rica, the implementation of a General Comptroller's Office web-based tool allowing citizens to monitor public spending is believed to have favored better public spending targeting, through fostering citizens' engagement and social control of government expenditures (OECD 2014). Similar initiatives have been adopted in Chile and Uruguay, and may be behind these countries' relatively high public sector efficiency performance (and health sector efficiency) within the region (Scrollini and Durand Ochoa 2015). The experiences of Chile, Costa Rica and Uruguay of developing an e-government system and advancing on e-procurement processes could offer leads to other countries in the region about promising initiatives for improving governance and public spending efficiency in healthcare.

Our study provides a few further specific pointers for policy action. For the analyses with the enlarged sample of countries, information on "Medium term expenditure frameworks" (MTEFs) implemented by national governments is used in the construction of health system quality indicators for OECD countries. MTEFs have been found to help manage expenditures across government sectors and ensure fiscal discipline, as well as giving ministries time to adjust and better plan operations by signaling the direction of policy and funding changes (World Bank 2013). An examination of the corresponding underlying data for Korea, the OECD member often identified as efficient peer for 'high-spender' LAC countries in the DEA estimations, suggests that the country's high efficiency levels may have been helped by the adoption of a medium-term perspective in the public budget process. Sustained political support for clear and transparent MTEFs has been a key feature for their success in the Korean case – and indeed a common pattern for the group of most efficient OECD countries in our analyses. Although the process of setting the five-year MTEFs in Korea is led by the Ministry of Finance, there is strong participation from other ministries including Health, and a performance monitoring and review system links funding to results. The Korean MTEF is perceived to have improved fiscal responsibility, spending planning capacity, and spending efficiency across all areas of government (World Bank 2013).

In some cases, however, MTEFs have not been successful in achieving the desired objectives, failing to drive a strategic shift in expenditures toward national priorities, and not reflecting an actual commitment to annual budget implementation and respect to medium-term priorities (Gottret and Schieber 2006). This highlights the importance of the careful design of, and political commitment to, MTEF terms, beyond a mere *de jure* adoption of an MTEF. General characteristics shared by successful experiences in this regard include: ensuring that the MTEF reflects the annual budget for the first year and that spending priorities can be easily identified from the chart of accounts; identifying domestic resource requirements for the coming period, which should be timed to feed into the budget preparation cycle; and

implementing an annual review of sector-level progress (Gottret and Schieber 2006). The Korean experience provides a good example of the above and could serve as an initial blueprint for the development of MTEFs in LAC countries who rely solely on annual budgetary processes, or who could improve their use of medium-term budgeting processes already in place so these become more effective (e.g. Brazil, Chile, Nicaragua). The mere implementation or presence of an MTEF should not be expected to drive public sector efficiency improvements automatically, since much depends on the details of its preparation and execution.

Greater health system efficiency in LAC could also be stimulated by other initiatives that seem linked to cross-country efficiency variations, specifically improvements in the quality of health institutions. From the empirical results in this report, the most compelling evidence about the importance of health system institutions for country differences in system performance refers to the association of institutional factors with efficiency in the provision of access to health services. Countries with 'better' health system institutions tend to be also those providing wider access to needed healthcare services, for a given level of health expenditure. In the context of our dataset, 'better' institutions in the health system refer mainly to the existence of (1) a medium-term sectoral vision aligned with the overall government strategy, and (2) results-based management of health service provision.

The empirical link detected between more developed medium-term planning processes specifically for the health sector and higher system efficiency echoes our previous discussion about the potential benefits of a medium-term perspective in the general budget. Once again, the experiences of some efficient health systems may offer useful insights to LAC countries currently considering planning and organization reforms to improve spending efficiency. The Korean health system reforms of 2000 sought to bring expenditure planning, operating budgets and the human resource policy strictly under the control of the Ministry of Health. The latter leads on the development of sectoral five-year expenditure plans in line with the central government's MTEF. This planning process has progressively incorporated public participation through the creation of citizen councils where lay citizens can influence decisions about public spending on health services (WHO 2015). In LAC, Costa Rica has also made improvements to planning processes particularly around benefit package expansions and human resource management, in a bid to boost the efficiency of health spending by the single insurer (Montenegro-Torres 2013). This may already have been reflected at least in part in the country's relatively high system efficiency scores. As discussed before, *how* a medium-term planning process is actually adhered to (and used to inform decisions) is far more relevant for improving efficiency performance than *whether* there is any medium-term planning in place.

Experiences of efficiency improvements in the health sector through results-based management of service provision, induced among others by reforms to provider reimbursement mechanisms, are abundant in the OECD. In Korea, a system of diagnosis-

related groups (DRG) for reimbursement of all inpatient care funded by the national health insurance program was piloted and rolled-out in the late 1990s and early 2000s, replacing the previous system of fee-for-service reimbursement for hospitals. An evaluation of the pilot DRG program concluded that total medical expense per claim decreased after DRG introduction, led by reductions in average length-of-stay (Kwon 2003). This result concurs with findings from studies conducted elsewhere suggesting that well-designed case-based payment systems for providers have often encouraged curtailment of overprovision of services and reduced hospital expenditures (compared to retrospective reimbursement), generally with no negative impacts on care quality (see Moreno-Serra 2014 for a review).

The above is a particularly relevant area for policy action in the LAC region, where several health systems rely primarily on historic budgets and/or uncapped fee-for-service (FFS) schemes to pay hospitals (Dmytraczenko and Almeida 2014). There is substantial accumulated evidence in that over-reliance on retrospective budgets and FFS arrangements tends to encourage supplier-induced demand, particularly where reimbursement costs are not subject to service fee cuts beyond pre-specified volumes, or FFS operates within a soft budget (Moreno-Serra 2014). Within the LAC region, Chile and Uruguay, two of the most efficient health systems, have both adopted some degree of case-based financing for hospitals, alongside pay-for-performance elements for the reimbursement of public providers particularly in primary care. Chile reimburses public hospitals through a mixture of FFS and case-based payments, while Uruguay pays public and private providers using risk-adjusted capitation complemented by performance-based payment. The implementation of these prospective and performance-based reimbursement mechanisms, while having been perceived as successful overall, has not been without its pitfalls in these and other countries (e.g. Argentina, Colombia). Moreover, other relatively efficient LAC countries (e.g. Costa Rica) have yet to depart from traditional provider payment arrangements including historic budgets (Dmytraczenko and Almeida 2014). Thus, although it seems sensible to expect that a stronger shift in LAC toward results-based management strategies – including improvements to provider reimbursement mechanisms – should spur health system efficiency gains, LAC policymakers would be well-advised to learn from their ‘efficient’ neighbors’ experiences of results-based management in health, and must tailor interventions wisely to their specific context.

Many other health policy areas and initiatives could be expected, in theory, to influence system efficiency, yet developing relevant policy guidance based on evidence becomes challenging in the LAC context due to limited data. Our previous discussion of potential strategies to stimulate efficiency gains focuses on the areas that we have been able to explore empirically with the available data for LAC health systems. These relate mainly to general governance aspects, and the presence of a medium-term sectoral vision and results-based management in health. There are, to be sure, several other domains of the health system that could be the focus of attention for policymakers wishing to improve system performance,

pertaining to the supply side, demand side, coordination and financing (de la Maisonneuve et al. 2017).

For instance, commentators have reported that the prioritization of cost-effective primary care in the public health network has become a more common feature in LAC countries, which could be expected to improve health spending efficiency (Dmytraczenko and Almeida 2014). Yet, as a general rule, the health systems of LAC countries are still heavily reliant on specialist, hospital-based and more expensive curative care (Atun et al. 2015). The more efficient LAC health systems identified in our analysis, including Costa Rica and Uruguay, have offered comprehensive primary care coverage to citizens from early stages, whereas less efficient ones (e.g. Argentina and Peru) have started with limited coverage and gradually expanded the primary care package (Dmytraczenko and Almeida 2014). Chile introduced reforms in 2005 (Plan AUGE) to reinforce primary care as the center of healthcare networks, which covered the entire country by 2012. Unfortunately, without systematically collected and comparable time series of data for most LAC countries on aspects like health spending by levels of care, or service coverage and use by levels of care and population groups, we are unable to move from preliminary speculation about the possible link between coverage expansions in primary care and system efficiency, toward policy guidance based on empirical evidence.

The above is true also about other macro-level factors that have been suggested as key influences on health system efficiency in LAC, including the link posited elsewhere between lower system efficiency and the presence of mixed health financing and delivery sources (Atun et al. 2015). While it is true that some of the most efficient health systems in LAC are characterized by low levels fragmentation in financing and delivery (e.g. Costa Rica and Cuba), other relatively efficient systems (e.g. Chile, Uruguay) rely instead on mixed sources of health funding (general taxes, social insurance contributions) with some purchase-provision split, as well as on mixed public/private insurer and provider networks. Conversely, among relatively inefficient LAC health systems, some rely basically on general tax financing channeled into a single pool (e.g. Guatemala, Peru, Trinidad and Tobago) while others have a more fragmented system organization (e.g. Bolivia, Panama). As we discuss below, better sources of information for LAC, e.g. akin to the OECD Health Systems Characteristics Survey, could offer the basis for more in-depth analyses of the topic to guide future policy. Meanwhile, LAC policymakers considering reforms to resource mobilization, pooling and purchasing mechanisms (toward either promoting or restricting fragmentation), with the goal of achieving greater system efficiency, should seek insights from the development of these mechanisms in the more efficient countries of the region, instead of basing their decisions on similar initiatives elsewhere whose impacts on health system efficiency are yet to be detected (e.g. the merging of various social insurance schemes into a single one in Turkey; Atun et al. 2015).

Along with insights into what LAC countries could do to achieve higher health system efficiency, our analyses point to at least one route countries <u>should not</u> take with that aim, namely to reduce current public financing of health. The input-oriented DEA in Section 5.2 examined the question of how much inputs – mainly health expenditure – could be reduced while keeping health system outputs constant. These results provide insights into potential savings that could be sought by a few LAC countries, particularly those with the highest health spending levels in the region, but *should not* be interpreted as advocating reductions in health spending in LAC, even for these high health spenders. Even the highest health spenders in the region are not necessarily close to a 'health production frontier', and reductions in current health expenditure levels – a key input to enhance the quantity and quality of health services – would likely be counterproductive for health development (Moreno-Serra and Smith 2012, 2014).[47] Furthermore, the input orientation results have highlighted the very limited scope for health expenditure savings in the countries deemed 'inefficient' in the main output-oriented analyses (e.g. Bolivia and Guyana), as opposed to the potentially huge gains in health outputs that the same countries could achieve by using existing resources more efficiently. Taken together with the corresponding output orientation results, the policy implication for health system efficiency is that LAC countries should seek ways to improve the health outcomes and coverage indicators achieved for their *current* levels of resources, rather than seek to reduce their – already comparatively low – health expenditure levels.

7.2 Study limitations

As with any empirical work, the analyses in this report have caveats arising from unavoidable methodological choices and data constraints.

From a methodological perspective, the features and limitations of DEA for efficiency assessments are well known; these have been outlined in Section 3.1 and Annex B. In summary, DEA specifications need to be parsimonious in the number of inputs and constraints examined in order to discriminate between more and less efficient units, and the results may be sensitive to outliers in some contexts. Our study addresses these limitations by performing a range of sensitivity analyses on DEA modelling choices to test the robustness of results. We believe that, with our data, the benefits of a carefully undertaken DEA approach outweigh the costs of adopting parametric, less flexible statistical methods such as frontier analyses.

Our study goes one step further than typical DEA efficiency assessments, by examining empirically some potential determinants of cross-country differences in health system

[47] For instance, among the seven biggest health spenders in LAC (25% top countries for total health spending per capita), five countries have a life expectancy at birth between 70 and 76 years, i.e. at least 4 years below the OECD median. Moreover, even in these seven LAC countries, current levels of health spending per capita (median = $1,298) are not particularly high compared to health spending per capita in OECD countries (median = $2,028; cf. Medeiros and Schwierz 2015)

efficiency. The key word above is 'potential'. Although it seems sensible in theory to expect factors like governance and health institutions to influence system efficiency directly, with our data we cannot ascertain whether the relevant relationships estimated in our study do indeed represent causal links. We can only claim that our Simar-Wilson estimates reflect associations in the data, suggesting that the efficiency performance of LAC countries and some of its potential determinants move together systematically. Country-case studies based on 'natural experiments' and finer data would be better positioned to identify causal relationships (cf. e.g. Moreno-Serra and Wagstaff 2010). Notwithstanding this caveat, it is reassuring that our estimates of links between health system efficiency and key potential determinants generally follow the direction one would expect for these relationships, based on theory and evidence for other contexts discussed in various points of this report.

The study limitations imposed by data availability for LAC countries have been highlighted throughout this report. Stepped up efforts by international organizations are needed to compile comprehensive and harmonized data over time on health system throughput and outcome indicators, disaggregated among others by levels of care provision and population groups. Data series from repositories such as the World Bank often combine multiple sources into single indicators; hence efforts to harmonize different cross-national data collection procedures in LAC (and elsewhere) are warranted. Although skilled birth attendance and immunization rates represent reasonable proxies for the general conditions of access to the health system, availability of other utilization measures for outpatient and inpatient care would have enriched our comparisons of efficiency performance. This is true also of measures of health system inputs and environmental constraints. For example, with regard to lifestyle factors that may influence aggregate health outcomes, there are substantial gaps in data availability for LAC countries compared to OECD countries, on aspects such as smoking prevalence, alcohol consumption and diet patterns. Health expenditure figures disaggregated by areas of spending (e.g. primary care) are unavailable as comparable series for LAC countries. Furthermore, in Section 5.1 we alluded to the difficulties associated with finding comparable cross-country data on the incidence of catastrophic and impoverishing health spending, which have become standard indicators to assess the degree of financial protection across health systems (Moreno-Serra et al. 2011). More comprehensive data collection on all areas above should be a priority for regional and international agencies, as it would facilitate better understanding of the strengths and weaknesses of LAC health systems, enabling LAC countries to learn from their regional neighbors while adequately taking into account contextual differences.

A final and crucial data issue for our analyses has been limited information about the institutional characteristics of LAC health systems. We have been able to examine empirically the efficiency influence of a small number of health system characteristics, taken from IDB PET (PRODEV). PET data are certainly helpful, but this dataset has been designed with the aim of evaluating countries' capacity to adopt results-based public management, and not specifically to offer a comprehensive assessment of health system organization and functions

across LAC countries. A few studies have made valuable efforts to gather comparative information on health system characteristics in the LAC region, such as financing and provision factors, but this has been restricted to selected countries and/or short descriptions of high-level characteristics (e.g. Dmytraczenko and Almeida 2014; Maceira 2012).

Surveys that collect harmonized information on health system characteristics across several countries have been useful tools for international comparisons of system performance and national health policy, notably in the case of OECD countries. A leading example is the OECD Health Systems Characteristics Survey which has, to date, collected three rounds of information on aspects including the organization of healthcare financing and delivery, public/private mix of provision, provider payment schemes, user choice, competition among providers, regulation of healthcare supply and prices, decentralization of system functions and use of health technology assessment, among others. The information is collected through questionnaires sent to government agencies by the OECD, and the qualitative information (269 variables) is then transformed into a smaller number of quantitative indicators (Paris et al. 2010). The quantitative indicators have allowed researchers to produce hard evidence on the comparative performance of OECD health systems, including the main drivers of health expenditures and system efficiency for these countries (e.g. de la Maisonneuve and Oliveira Martins 2013; de la Maisonneuve et al. 2017). Similar surveys for the LAC region would enable future comparisons of health system performance to offer more granular evidence to better inform national and regional health policy.

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Annex A: Additional tables and figures

Table A 1: Definition of variables, data period and sources

Indicator	Data period used	Source	Definition
Outputs			
Life expectancy at birth, total (years)	Average 2011-2015	WB, WDI	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Mortality rate, under-5 (per 1,000 live births)	Average 2011-2015	WB, WDI	Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, if subject to age-specific mortality rates of the specified year.
DALYs, All Causes, Age-standardized (per 100,000 people)	Average 2011-2015	WHO	DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences
Skilled birth attendance rate (Percentage of total births)	Average 2011-2015	WB, WDI	Births attended by skilled health staff are the percentage of deliveries attended by personnel trained to give the necessary supervision, care, and advice to women during pregnancy, labor, and the postpartum period; to conduct deliveries on their own; and to care for newborns.
Immunization, DPT (Percentage of children ages 12-23 months)	Average 2011-2015	WB, WDI	Child immunization measures the percentage of children ages 12-23 months who received vaccinations before 12 months or at any time before the survey. A child is considered adequately immunized against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of vaccine.
Skilled birth attendance: ratio poorest/richest quintiles	Latest data available from 1996-2015	WB, WHO, UNICEF	Ratio poorest/richest wealth quintiles of births attended by skilled health staff.
Skilled birth attendance: ratio rural/urban	Latest data available from 1996-2015	WB, WHO, UNICEF	Ratio rural/urban populations of births attended by skilled health staff.
Pooled health expenditure (share of total)	Average 2011-2015	WB, WDI	Ratio of pooled prepaid health expenditure over total health expenditure. See below for the definition of pooled prepaid health expenditure.

Notes: WB, WDI = World Bank, World Development Indicators. WHO = World Health Organization. DALYs = Disability-adjusted life years.

Table A 1: Definition of variables, data period and sources *(continued)*

Indicator	Data period used	Source	Definition
Inputs			
Pooled health expenditure per capita, PPP (constant 2011 international USD $)	Average 2006-2010	WB, WDI	Pooled health expenditure is the sum of public health expenditure and Voluntary Health Insurance (VHI) expenditure. VHI has been estimated for this report as a difference of private health expenditure and out-of-pocket health expenditure. Data are in international dollars converted using 2011 purchasing power parity (PPP) rates.
Total health expenditure per capita, PPP (constant 2011 international USD $)	Average 2006-2010	WB, WDI	Total health expenditure is the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Data are in international dollars converted using 2011 purchasing power parity (PPP) rates.
GDP per capita, PPP (constant 2011 international USD $)	Average 2006-2010	WB, WDI	GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2011 international dollars.
Population ages 65 and above (Percentage of total)	Average 2006-2010	WB, WDI	Population ages 65 and above as a percentage of the total population. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.

Notes: WB, WDI = World Bank, World Development Indicators.

Table A 1: Definition of variables, data period and sources *(continued)*

Indicator	Data period used	Source	Definition
Efficiency determinant indicators			
Out-of-pocket health expenditure (share of total)	Average 2006-2010	WB, WDI	Ratio of out-of-pocket health expenditure over total health expenditure. Out of pocket expenditure is any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceuticals, therapeutic appliances, and other goods and services whose primary intent is to contribute to the restoration or enhancement of the health status of individuals or population groups. It is a part of private health expenditure.
Hospital beds (per 1,000 people)	Average 2006-2010	WB, WDI	Hospital beds include inpatient beds available in public, private, general, and specialized hospitals and rehabilitation centers. In most cases beds for both acute and chronic care are included.
Average governance quality index	Average 2006-2010	WB, WGI	Simple average of WGI governance indices for six dimensions: Government effectiveness; Voice and Accountability; Rule of Law; Regulatory Quality; Political stability and absence of violence/terrorism; Control of corruption. Higher average and individual indices denote better governance.
Average health system institutional quality index	2013	IDB, PRODEV	Simple average of IDB PRODEV Evaluation Tool (PET) indices for three domains of health system institutional capacity: Medium term sectoral vision in line with the government plan; Results-based management in the production of goods and services; Sectoral information systems. Individual indicators range from 0 (worst) to 5 (best). Higher average PET is an instrument developed by the IDB to evaluate countries' institutional capacity to implement results-based public management, including assessments of the existence and alignment of health system planning with the overall government strategy, as well as availability of information systems in areas such as healthcare costs and quality.

Notes: WB, WDI = World Bank, World Development Indicators. WB, WGI = World Bank, World Governance Indicators. IDB = Inter-American Development Bank.

Table A 2: Sample averages

Country	Country code	Life expectancy (years)	Under-five mortality (per 1,000)	DALYs lost (per 100,000)	Skilled birth attendance (%)	DPT immunization (%)	Skilled birth attendance: ratio poorest/richest	Skilled birth attendance: ratio rural/urban	Pooled health expenditure share (%)
Argentina	ARG	75.9	13.3	26,808	97.5	92.8	0.97		72.4
Bahamas, The	BHS	75.0	12.8	30,459	98.5	96.8			70.4
Belize	BLZ	70.0	17.5	31,420	96.2	95.4	0.91	0.96	76.3
Bolivia	BOL	67.7	41.5	44,087	84.4	95.8	0.58	0.73	75.5
Brazil	BRA	74.0	16.2	31,632	98.1	96.0		0.96	73.8
Barbados	BRB	75.3	13.7	26,768	99.0	92.0	1.00	1.02	70.5
Chile	CHL	81.0	8.4	21,333	99.8	93.2			67.6
Colombia	COL	73.7	16.9	27,188	99.2	89.6	0.86	0.89	85.2
Costa Rica	CRI	79.1	10.0	23,017	98.4	90.8	0.97	0.98	75.5
Cuba	CUB	79.2	5.7	25,180	99.8	98.6		1.01	94.9
Dominican Republic	DOM	73.2	32.1	29,597	98.0	85.6	1.00	0.98	75.0
Ecuador	ECU	75.5	23.0	29,357	92.1	84.6	0.82	0.85	52.6
Guatemala	GTM	71.4	31.1	37,079	62.8	83.2	0.39	0.66	46.1
Guyana	GUY	66.3	40.6	55,470	92.4	96.2	0.84	0.90	65.6
Honduras	HND	72.9	21.9	33,106	82.9	87.2	0.59	0.77	52.9
Haiti	HTI	62.2	73.1	61,717	37.3	62.2	0.12	0.41	70.2
Jamaica	JAM	75.4	16.7	32,646	99.1	92.8	0.97	0.98	72.5
Mexico	MEX	76.4	14.6	26,763	96.0	90.6		0.88	55.5
Nicaragua	NIC	74.4	23.6	33,239	88.0	98.0	0.42	0.81	61.7
Panama	PAN	77.3	18.1	27,476	92.5	81.0	0.72	0.79	76.2
Peru	PER	74.2	18.4	26,911	87.2	90.4	0.68	0.75	67.0
Paraguay	PRY	72.7	21.9	30,862	95.8	88.4			48.9
El Salvador	SLV	72.4	18.0	36,007	98.8	91.6	0.93	0.96	69.6
Suriname	SUR	70.9	22.7	29,901		86.0	0.88	0.90	87.8
Trinidad and Tobago	TTO	70.2	21.6	38,360	100.0	92.4	0.98		61.3
Uruguay	URY	76.8	11.1	24,820	98.9	94.8		1.00	83.5
Venezuela, RB	VEN	74.0	15.7	29,410	96.0	81.2			41.1

Note: For details about the definition and measurement of all variables, see Table A 1.

Table A 2: Sample averages *(continued)*

Country	Country code	Pooled health expenditure per capita (USD)	Total health expenditure per capita (USD)	GDP per capita (USD)	Population 65+ (%)	Out-of-pocket health expenditure share (%)	Hospital beds (per 1,000)	Average governance quality index	Average health system institutional quality index
Argentina	ARG	896.24	1,172.28	17,818.80	10.3	23.9	4.50	-0.28	2.5
Bahamas, The	BHS	1,189.76	1,668.59	24,218.97	6.7	28.7	3.14	1.04	1.7
Belize	BLZ	289.96	391.53	7,907.28	3.6	26.2	1.20	-0.11	2.3
Bolivia	BOL	193.06	263.25	5,137.10	5.7	26.6	1.10	-0.60	
Brazil	BRA	731.47	1,074.74	13,459.06	6.3	32.1	2.40	-0.02	3.6
Barbados	BRB	640.61	881.42	15,746.56	12.1	27.4	6.90	1.16	2.1
Chile	CHL	717.53	1,125.25	18,614.64	9.2	36.5	2.17	1.16	3.6
Colombia	COL	527.77	653.33	10,422.95	5.6	19.2	1.00	-0.42	4.0
Costa Rica	CRI	778.53	1,054.24	12,261.65	7.0	26.3	1.25	0.53	2.3
Cuba	CUB	1,628.68	1,715.76	17,449.71	11.9	5.3	5.52	-0.59	
Dominican Republic	DOM	262.07	425.58	10,451.26	5.9	38.6	1.15	-0.36	3.3
Ecuador	ECU	255.80	502.61	9,107.74	5.9	49.2	1.53	-0.84	2.4
Guatemala	GTM	190.49	429.15	6,620.69	4.4	55.6	0.63	-0.59	1.7
Guyana	GUY	171.44	233.80	5,407.04	4.3	26.9	2.13	-0.40	2.2
Honduras	HND	171.00	338.45	4,297.14	4.3	49.6	0.77	-0.59	2.8
Haiti	HTI	59.35	95.96	1,575.17	4.4	38.6	1.30	-1.14	0.8
Jamaica	JAM	280.39	410.46	8,765.88	8.3	31.6	1.83	-0.02	2.5
Mexico	MEX	444.65	892.92	15,500.45	5.7	50.3	1.64	-0.16	3.6
Nicaragua	NIC	158.98	257.27	4,007.26	4.6	38.2	0.90	-0.58	3.0
Panama	PAN	709.58	949.88	14,346.50	6.5	25.6	2.27	0.10	2.4
Peru	PER	253.82	417.05	8,984.13	6.0	39.3	1.43	-0.32	2.1
Paraguay	PRY	224.46	493.03	6,720.16	5.1	53.9	1.30	-0.72	1.8
El Salvador	SLV	305.94	469.03	7,464.21	7.0	34.8	0.90	-0.13	2.5
Suriname	SUR	677.57	781.17	13,649.03	6.4	13.2	3.03	-0.12	2.1
Trinidad and Tobago	TTO	866.55	1,443.32	30,362.27	7.8	40.0	2.52	0.11	2.6
Uruguay	URY	1,109.70	1,298.32	15,221.37	13.8	14.4	2.33	0.76	2.0
Venezuela, RB	VEN	393.87	807.61	16,999.37	5.2	51.5	1.20	-1.20	

Note: For details about the definition and measurement of all variables, see Table A 1.

Table A 3: DEA efficiency scores

Life expectancy					Under-five mortality			
Country	Input variables				Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+			Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)			(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000		Chile	1.0000	1.0000	1.0000
Ecuador	1.0000	1.0000	1.0000		Cuba	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000		Haiti	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000		Honduras	1.0000	1.0000	1.0000
Jamaica	0.9940	0.9941	1.0000		Jamaica	1.0000	1.0000	1.0000
Mexico	0.9827	0.9827	0.9827		Nicaragua	1.0000	1.0000	1.0000
Peru	0.9822	0.9822	0.9826		Peru	0.9996	0.9996	0.9996
Honduras	0.9778	0.9779	0.9779		Mexico	0.9990	0.9990	0.9990
Cuba	0.9773	0.9816	1.0000		Belize	0.9990	1.0000	1.0000
Costa Rica	0.9765	1.0000	1.0000		Venezuela, RB	0.9988	0.9988	0.9988
Dominican Republic	0.9683	0.9683	0.9683		Costa Rica	0.9983	1.0000	1.0000
Paraguay	0.9675	0.9676	0.9676		El Salvador	0.9981	0.9998	1.0000
Venezuela, RB	0.9588	0.9588	0.9588		Paraguay	0.9974	0.9974	0.9974
Panama	0.9552	0.9714	0.9714		Uruguay	0.9962	0.9969	1.0000
Guatemala	0.9548	0.9548	0.9548		Barbados	0.9961	0.9965	1.0000
El Salvador	0.9503	0.9522	0.9607		Colombia	0.9950	0.9965	0.9965
Uruguay	0.9472	0.9592	1.0000		Ecuador	0.9947	0.9947	0.9947
Barbados	0.9392	0.9425	1.0000		Argentina	0.9945	0.9947	0.9952
Argentina	0.9366	0.9393	0.9479		Bahamas, The	0.9942	0.9942	0.9942
Colombia	0.9357	0.9488	0.9488		Brazil	0.9922	0.9938	0.9938
Bahamas, The	0.9254	0.9254	0.9254		Panama	0.9904	0.9918	0.9918
Belize	0.9210	0.9212	0.9212		Guatemala	0.9896	0.9896	0.9896
Brazil	0.9128	0.9319	0.9319		Suriname	0.9864	0.9878	0.9878
Bolivia	0.9048	0.9049	0.9095		Trinidad and Tobago	0.9863	0.9863	0.9863
Guyana	0.8893	0.8893	0.8893		Dominican Republic	0.9852	0.9852	0.9852
Suriname	0.8798	0.8943	0.8943		Guyana	0.9808	0.9808	0.9808
Trinidad and Tobago	0.8664	0.8664	0.8664		Bolivia	0.9789	0.9790	0.9828

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 3: DEA efficiency scores *(continued)*

DALYs lost				Skilled birth attendance			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Peru	1.0000	1.0000	1.0000	Jamaica	1.0000	1.0000	1.0000
Honduras	0.9901	0.9965	0.9965	Nicaragua	1.0000	1.0000	1.0000
Costa Rica	0.9786	1.0000	1.0000	Paraguay	1.0000	1.0000	1.0000
Paraguay	0.9720	0.9847	0.9847	Trinidad and Tobago	1.0000	1.0000	1.0000
Mexico	0.9715	0.9715	0.9715	Dominican Republic	0.9993	0.9993	0.9993
Ecuador	0.9662	0.9662	0.9662	Cuba	0.9977	1.0000	1.0000
Dominican Republic	0.9619	0.9619	0.9619	Colombia	0.9970	0.9999	0.9999
Uruguay	0.9557	0.9667	1.0000	El Salvador	0.9960	1.0000	1.0000
Colombia	0.9532	0.9734	0.9734	Barbados	0.9929	0.9937	1.0000
Cuba	0.9511	0.9548	0.9765	Uruguay	0.9885	0.9925	1.0000
Venezuela, RB	0.9440	0.9440	0.9440	Bahamas, The	0.9850	0.9858	0.9858
Barbados	0.9420	0.9469	1.0000	Costa Rica	0.9849	0.9903	0.9903
Belize	0.9328	0.9562	0.9562	Brazil	0.9823	0.9863	0.9863
Argentina	0.9304	0.9329	0.9402	Argentina	0.9746	0.9767	0.9778
Panama	0.9230	0.9386	0.9386	Belize	0.9706	0.9751	0.9751
Jamaica	0.9175	0.9250	0.9455	Venezuela, RB	0.9668	0.9668	0.9668
Guatemala	0.9137	0.9137	0.9137	Mexico	0.9660	0.9660	0.9660
Suriname	0.8966	0.9119	0.9119	Ecuador	0.9432	0.9432	0.9432
Bahamas, The	0.8840	0.8840	0.8840	Panama	0.9261	0.9289	0.9289
Brazil	0.8691	0.8867	0.8867	Bolivia	0.9001	0.9221	0.9314
El Salvador	0.8681	0.8993	0.9139	Honduras	0.8987	0.9324	0.9324
Bolivia	0.8099	0.8199	0.8268	Peru	0.8944	0.8944	0.8944
Trinidad and Tobago	0.7836	0.7836	0.7836	Guatemala	0.6708	0.6708	0.6708
Guyana	0.6588	0.6588	0.6588	Suriname			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 3: DEA efficiency scores *(continued)*

DPT immunization				Skilled birth attendance ratio poorest/richest			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Cuba	1.0000	1.0000	1.0000	Barbados	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Bahamas, The	0.9835	0.9835	0.9835	Trinidad and Tobago	0.9773	0.9773	0.9773
Guyana	0.9816	0.9816	0.9816	Costa Rica	0.9730	0.9760	0.9760
Bolivia	0.9774	0.9774	0.9883	Argentina	0.9710	0.9710	0.9710
Brazil	0.9773	0.9773	0.9773	Jamaica	0.9694	1.0000	1.0000
Belize	0.9729	0.9729	0.9729	El Salvador	0.9315	1.0000	1.0000
Uruguay	0.9635	0.9635	1.0000	Belize	0.9154	0.9703	0.9703
Chile	0.9488	0.9488	0.9633	Suriname	0.8793	0.8810	0.8810
Jamaica	0.9465	0.9465	0.9803	Colombia	0.8576	0.8609	0.8609
Argentina	0.9440	0.9440	0.9600	Ecuador	0.8357	0.8553	0.8553
Trinidad and Tobago	0.9401	0.9401	0.9401	Panama	0.7170	0.7179	0.7179
Barbados	0.9369	0.9369	1.0000	Honduras	0.6986	0.9251	0.9251
El Salvador	0.9341	0.9341	0.9534	Peru	0.6948	0.7114	0.7114
Costa Rica	0.9241	0.9241	0.9241	Bolivia	0.6583	0.7309	0.7285
Mexico	0.9234	0.9234	0.9234	Nicaragua	0.5572	0.7329	0.7323
Peru	0.9221	0.9221	0.9327	Guatemala	0.4468	0.4468	0.4468
Colombia	0.9129	0.9129	0.9129	Haiti	0.4219	0.5014	0.5014
Paraguay	0.9018	0.9018	0.9035	Bahamas, The			
Honduras	0.8898	0.8898	0.8898	Brazil			
Suriname	0.8757	0.8757	0.8757	Chile			
Dominican Republic	0.8731	0.8731	0.8814	Cuba			
Ecuador	0.8629	0.8629	0.8712	Mexico			
Guatemala	0.8489	0.8489	0.8489	Paraguay			
Venezuela, RB	0.8278	0.8278	0.8278	Uruguay			
Panama	0.8246	0.8246	0.8246	Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 3: DEA efficiency scores *(continued)*

Skilled birth attendance ratio rural/urban			
Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)
Barbados	1.0000	1.0000	1.0000
Dominican Republic	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000
Jamaica	1.0000	1.0000	1.0000
Cuba	0.9898	0.9898	0.9898
Uruguay	0.9809	0.9833	1.0000
Belize	0.9782	0.9941	0.9941
El Salvador	0.9764	1.0000	1.0000
Costa Rica	0.9617	0.9777	0.9777
Nicaragua	0.9555	1.0000	1.0000
Brazil	0.9457	0.9560	0.9560
Suriname	0.8893	0.8982	0.8982
Mexico	0.8845	0.8845	0.8845
Colombia	0.8791	0.8925	0.8925
Ecuador	0.8774	0.8804	0.8804
Honduras	0.8568	0.9302	0.9302
Bolivia	0.7878	0.8192	0.8267
Peru	0.7750	0.7777	0.7777
Panama	0.7717	0.7768	0.7768
Guatemala	0.7188	0.7188	0.7188
Argentina			
Bahamas, The			
Chile			
Paraguay			
Trinidad and Tobago			
Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 4: Average efficiency scores by output indicator and country

	Average efficiency scores by output indicator							Efficiency across all DEA models		Counting low and high performers across models			
Country	Life expectancy	Under-five mortality	DALYs lost	Skilled birth attendance	DPT immunization	Skilled birth attendance ratio poorest/richest	Skilled birth attendance ratio rural/urban	Average efficiency	Ranking	Lowest to 25th	From 25 to 75th	75th to highest	Number of DEA models
ARG	0.941	0.995	0.934	0.976	0.949	0.971		0.961	11	0	18	0	18
BHS	0.925	0.994	0.884	0.986	0.984			0.955	12	6	6	3	15
BLZ	0.921	1.000	0.948	0.974	0.973	0.952	0.989	0.965	9	3	18	0	21
BOL	0.906	0.980	0.819	0.918	0.981	0.706	0.811	0.875	26	18	0	3	21
BRA	0.926	0.993	0.881	0.985	0.977		0.953	0.952	14	6	10	2	18
BRB	0.961	0.998	0.963	0.996	0.958	1.000	1.000	0.982	4	0	10	11	21
CHL	1.000	1.000	1.000	1.000	0.954			0.991	1	0	3	12	15
COL	0.944	0.996	0.967	0.999	0.913	0.860	0.888	0.938	17	0	21	0	21
CRI	0.992	0.999	0.993	0.988	0.924	0.975	0.972	0.978	6	0	13	8	21
CUB	0.986	1.000	0.961	0.999	1.000		0.990	0.989	2	0	8	10	18
DOM	0.968	0.985	0.962	0.999	0.876	1.000	1.000	0.970	7	6	9	6	21
ECU	1.000	0.995	0.966	0.943	0.866	0.849	0.879	0.928	20	9	9	3	21
GTM	0.955	0.990	0.914	0.671	0.849	0.447	0.719	0.792	27	16	5	0	21
GUY	0.889	0.981	0.659	1.000	0.982	1.000	1.000	0.930	19	9	1	11	21
HND	0.978	1.000	0.994	0.921	0.890	0.850	0.906	0.934	18	7	9	5	21
HTI	1.000	1.000	1.000	1.000	1.000	0.475	1.000	0.925	22	3	0	18	21
JAM	0.996	1.000	0.929	1.000	0.958	0.990	1.000	0.982	5	0	7	14	21
MEX	0.983	0.999	0.972	0.966	0.923		0.884	0.955	13	5	11	2	18
NIC	1.000	1.000	1.000	1.000	1.000	0.674	0.985	0.951	15	1	3	17	21
PAN	0.966	0.991	0.933	0.928	0.825	0.718	0.775	0.877	25	14	7	0	21
PER	0.982	1.000	1.000	0.894	0.926	0.706	0.777	0.898	24	9	7	5	21
PRY	0.968	0.997	0.980	1.000	0.902			0.970	8	0	10	5	15
SLV	0.954	0.999	0.894	0.999	0.941	0.977	0.992	0.965	10	2	12	7	21
SUR	0.889	0.987	0.907		0.876	0.880	0.895	0.906	23	12	6	0	18
TTO	0.866	0.986	0.784	1.000	0.940	0.977		0.926	21	9	5	4	18
URY	0.969	0.998	0.974	0.994	0.976		0.988	0.983	3	0	12	6	18
VEN	0.959	0.999	0.944	0.967	0.828			0.939	16	3	12	0	15

Below 25th percentile

Above 75th percentile

Table A 5: Spearman correlation coefficients of efficiency scores across DEA models

		Life expectancy			Under-five mortality			DALYs lost			Skilled birth attendance			DPT immunization			Skilled birth attendance ratio poorest/richest			Skilled birth attendance ratio rural/urban		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Life expectancy	Model 1	1.000																				
	Model 2	0.958	1.000																			
	Model 3	0.838	0.840	1.000																		
Under-five mortality	Model 1	0.639	0.605	0.626	1.000																	
	Model 2	0.593	0.626	0.647	0.959	1.000																
	Model 3	0.493	0.509	0.689	0.875	0.929	1.000															
DALYs lost	Model 1	0.749	0.744	0.666	0.645	0.596	0.493	1.000														
	Model 2	0.678	0.726	0.618	0.642	0.630	0.506	0.976	1.000													
	Model 3	0.596	0.618	0.743	0.657	0.649	0.655	0.910	0.911	1.000												
Skilled birth attendance	Model 1	0.125	0.108	0.199	0.216	0.256	0.244	0.027	0.037	0.107	1.000											
	Model 2	0.114	0.096	0.192	0.308	0.361	0.386	0.003	0.015	0.100	0.959	1.000										
	Model 3	0.050	0.018	0.256	0.296	0.349	0.451	-0.017	-0.020	0.170	0.917	0.961	1.000									
DPT immunization	Model 1	-0.065	-0.098	0.029	0.322	0.314	0.292	0.006	0.015	0.117	0.605	0.598	0.648	1.000								
	Model 2	-0.065	-0.098	0.029	0.322	0.314	0.292	0.006	0.015	0.117	0.605	0.598	0.648	1.000	1.000							
	Model 3	-0.053	-0.116	0.158	0.327	0.299	0.376	0.041	0.022	0.237	0.551	0.548	0.671	0.948	0.948	1.000						
Skilled birth attendance ratio poorest/richest	Model 1	-0.382	-0.337	-0.073	-0.253	-0.144	-0.034	-0.331	-0.297	-0.120	0.358	0.359	0.423	-0.038	-0.038	0.006	1.000					
	Model 2	-0.296	-0.298	-0.034	-0.047	0.055	0.175	-0.320	-0.310	-0.124	0.487	0.549	0.607	0.161	0.161	0.192	0.916	1.000				
	Model 3	-0.296	-0.298	-0.034	-0.047	0.055	0.175	-0.320	-0.310	-0.124	0.487	0.549	0.607	0.161	0.161	0.192	0.916	1.000	1.000			
Skilled birth attendance ratio rural/urban	Model 1	-0.033	-0.077	0.179	0.182	0.233	0.287	-0.036	-0.048	0.130	0.821	0.800	0.852	0.559	0.559	0.569	0.614	0.709	0.709	1.000		
	Model 2	0.080	0.017	0.241	0.316	0.358	0.433	0.040	0.005	0.178	0.860	0.891	0.930	0.633	0.633	0.644	0.484	0.686	0.686	0.923	1.000	
	Model 3	0.080	0.017	0.241	0.316	0.358	0.433	0.040	0.005	0.178	0.860	0.891	0.930	0.633	0.633	0.644	0.484	0.686	0.686	0.923	1.000	1.000

Table A 6: Simar-Wilson regression results of potential efficiency determinants, life expectancy

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.001			
	(0.003)			
Hospital beds (per 1,000 people)	0.002			
	(0.012)			
Average governance quality		−0.003		0.002
		(0.068)		(0.054)
Average institutional quality			0.008	0.008
			(0.183)	(0.050)
Constant	0.933***	0.972***	0.953	0.952
	(0.105)	(0.214)	(2.061)	(1.119)
Sigma	0.048**	0.049*	0.049	0.049
	(0.020)	(0.026)	(0.051)	(0.038)
Observations	27	27	24	24
Number of efficient units	4	4	4	4
Log likelihood, initial truncated regression	47.919	47.554	41.28	41.282
Model significance, p-value	0.916	0.968	0.966	0.979
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 7: Simar-Wilson regression results of potential efficiency determinants, under-five mortality

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.001			
	(0.006)			
Hospital beds (per 1,000 people)	0.004			
	(0.043)			
Average governance quality		0.018		0.015
		(0.239)		(0.166)
Average institutional quality			−0.000	0.001
			(0.209)	(0.099)
Constant	1.003**	1.039	1.025	1.013*
	(0.417)	(1.175)	(1.333)	(0.542)
Sigma	0.018	0.018	0.015	0.013
	(0.019)	(0.037)	(0.036)	(0.019)
Observations	27	27	24	24
Number of efficient units	6	6	5	5
Log likelihood, initial truncated regression	84.93	85.001	77.871	78.419
Model significance, p-value	0.99	0.939	1	0.996
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 8: Simar-Wilson regression results of potential efficiency determinants, DALYs lost

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.011			
	(0.138)			
Hospital beds (per 1,000 people)	0.054			
	(0.929)			
Average governance quality		0.054		0.253
		(4.158)		(2.866)
Average institutional quality			0.697	0.674
			(4.544)	(2.426)
Constant	1.382	2.11	1.964	1.722
	(12.037)	(22.806)	(20.160)	(11.116)
Sigma	0.284	0.316	0.469	0.442
	(0.408)	(0.677)	(0.592)	(0.379)
Observations	27	27	24	24
Number of efficient units	4	4	4	4
Log likelihood, initial truncated regression	35.319	35.155	31.194	31.224
Model significance, p-value	0.996	0.99	0.878	0.962
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 9: Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance

	(1)	(2)	(3)
Out-of-pocket health expenditure (Perc.)	−0.033		
	(0.027)		
Hospital beds (per 1,000 people)	0.414		
	(0.256)		
Average governance quality		10.193***	0.363*
		(2.211)	-0.213
Average institutional quality			0.372*
			(0.211)
Constant	2.368	16.184***	0.289
	(1.548)	(6.275)	(0.329)
Sigma	0.170***	0.720***	0.080***
	(0.062)	(0.218)	(0.027)
Observations	26	26	23
Number of efficient units	7	7	7
Log likelihood, initial truncated regression	46.984	41.554	42.587
Model significance, p-value	0.183	0	0.172
Number of bootstrap repetitions	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 10: Simar-Wilson regression results of potential efficiency determinants, DPT immunization

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.002*			
	(0.001)			
Hospital beds (per 1,000 people)	0.01			
	(0.014)			
Average governance quality		0.066**		0.060**
		(0.030)		(0.025)
Average institutional quality			0.003	0.004
			(0.025)	(0.017)
Constant	0.993***	0.944***	0.931***	0.925***
	(0.064)	(0.021)	(0.067)	(0.046)
Sigma	0.052***	0.050***	0.055***	0.045***
	(0.012)	(0.011)	(0.015)	(0.009)
Observations	27	27	24	24
Number of efficient units	3	3	2	2
Log likelihood, initial truncated regression	43.868	44.812	38.752	42.222
Model significance, p-value	0.093	0.027	0.891	0.06
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 11: Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio poorest/richest

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.013			
	(0.063)			
Hospital beds (per 1,000 people)	0.266			
	(0.988)			
Average governance quality		0.633**		0.475
		(0.319)		(0.538)
Average institutional quality			0.447	0.111
			(2.173)	(0.170)
Constant	1.169	1.180***	0.14	0.839
	(2.842)	(0.311)	(5.846)	(1.010)
Sigma	0.264	0.181***	0.274	0.170**
	(0.199)	(0.061)	(0.336)	(0.083)
Observations	19	19	18	18
Number of efficient units	3	3	3	3
Log likelihood, initial truncated regression	13.362	15.635	12.897	15.405
Model significance, p-value	0.929	0.047	0.837	0.659
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 12: Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio rural/urban

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.008			
	(0.038)			
Hospital beds (per 1,000 people)	0.023			
	(0.281)			
Average governance quality		0.319		0.245
		(3.019)		(1.130)
Average institutional quality			0.168	0.116
			(2.561)	(0.410)
Constant	1.277	1.191	0.709	0.768
	(4.353)	(8.974)	(11.561)	(2.464)
Sigma	0.141	0.159	0.173	0.124
	(0.114)	(0.286)	(0.380)	(0.123)
Observations	21	21	19	19
Number of efficient units	5	5	5	5
Log likelihood, initial truncated regression	22.674	22.104	18.952	20.378
Model significance, p-value	0.903	0.916	0.948	0.957
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 13: Further Simar-Wilson regression results of potential efficiency determinants, life expectancy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	0.001														0.002
	(0.013)														(0.001)
Hospital beds (per 1,000 people)		−0.002													−0.011
		(0.11)													(0.01)
Quality of governance															
Government effectiveness			−0.003									−0.030			
			(0.42)									(0.04)			
Voice and accountability				−0.022								−0.067			
				(0.15)								(0.06)			
Rule of law					−0.006							−0.042			
					(0.03)							(0.08)			
Regulatory quality						0.008						0.063*			
						(0.03)						(0.03)			
Political stability and absence of violence/terrorism							0.003					0.038			
							(0.05)					(0.03)			
Control of corruption								0.006				0.039			
								(0.03)				(0.05)			
Average governance quality														−0.009	0.04
														(0.12)	(0.03)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									0.003				0.007	0.008	
									(0.39)				(0.02)	(0.04)	
Results-based management in the production of goods and services										−0.003			−0.017	−0.020	
										(0.19)			(0.03)	(0.09)	
Sectoral information systems											0.01		0.015	0.016	
											(0.03)		(0.02)	(0.02)	
Average institutional quality															0.01
															(0.02)
Constant	0.943	0.977***	0.972	0.975	0.970***	0.973***	0.973***	0.973***	0.963	0.98	0.953	0.980***	0.956***	0.959***	0.908***
	(1.84)	(0.25)	(2.00)	(1.31)	(0.06)	(0.07)	(0.20)	(0.08)	(2.70)	(2.39)	(1.52)	(0.05)	(0.09)	(0.28)	(0.08)
Sigma	0.048	0.049	0.049	0.047	0.049***	0.049***	0.049*	0.049***	0.05	0.05	0.049	0.039***	0.048***	0.048**	0.042***
	(0.06)	(0.03)	(0.07)	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.10)	(0.07)	(0.04)	(0.01)	(0.02)	(0.02)	(0.01)
Observations	27	27	27	27	27	27	27	27	24	24	24	27	24	24	24
Number of efficient units	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Log likelihood, initial truncated regression	47.894	47.577	47.559	47.991	47.582	47.607	47.557	47.586	41.242	41.243	41.416	50.805	41.62	41.657	42.999
Model significance, p-value	0.947	0.984	0.993	0.882	0.819	0.773	0.958	0.858	0.994	0.987	0.754	0.541	0.869	0.961	0.619
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 14: Further Simar-Wilson regression results of potential efficiency determinants, under-five mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	0.001														0
	(0.013)														(0.001)
Hospital beds (per 1,000 people)		0.002													−0.003
		(0.10)													(0.02)
Quality of governance															
Government effectiveness			0.015									−0.030			
			(0.22)									(0.04)			
Voice and accountability				0.014								−0.026			
				(0.33)								(0.05)			
Rule of law					0.015							0.001			
					(0.24)							(0.05)			
Regulatory quality						0.016						0.013			
						(0.24)						(0.01)			
Political stability and absence of violence/terrorism							0.009					0.003			
							(0.22)					(0.03)			
Control of corruption								0.02				0.043			
								(0.21)				(0.04)			
Average governance quality														0.011	0.021
														(0.03)	(0.05)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									0.005				0.007	0.005	
									(0.15)				(0.04)	(0.01)	
Results-based management in the production of goods and services										−0.006			−0.011	−0.007	
										(0.18)			(0.06)	(0.01)	
Sectoral information systems											0.001		0.004	0.003	
											(0.13)		(0.04)	(0.01)	
Average institutional quality															0.002
															(0.03)
Constant	1.018	1.05	1.044	1.042	1.044	1.032	1.05	1.03	1.007	1.035	1.023	1.024***	1.009***	1.006***	1.002***
	(1.28)	(1.43)	(1.39)	(1.40)	(1.32)	(1.15)	(1.54)	(0.77)	(1.26)	(1.46)	(1.21)	(0.05)	(0.26)	(0.07)	(0.15)
Sigma	0.019	0.021	0.019	0.019	0.018	0.016	0.02	0.015	0.014	0.014	0.015	0.011***	0.012	0.012**	0.011
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.03)	(0.04)	(0.04)	(0.04)	(0.00)	(0.01)	(0.01)	(0.01)
Observations	27	27	27	27	27	27	27	27	24	24	24	27	24	24	24
Number of efficient units	6	6	6	6	6	6	6	6	5	5	5	6	5	5	5
Log likelihood, initial truncated regression	84.84	84.628	84.833	84.755	84.95	85.169	84.71	85.443	77.962	78.01	77.875	87.148	78.393	78.743	79.032
Model significance, p-value	0.957	0.986	0.947	0.965	0.948	0.946	0.968	0.923	0.975	0.975	0.995	0.848	0.998	0.975	0.985
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 15: Further Simar-Wilson regression results of potential efficiency determinants, DALYs lost

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	0.009														0.017
	(0.199)														(0.034)
Hospital beds (per 1,000 people)		0.003													−0.077
		(1.39)													(0.36)
Quality of governance															
Government effectiveness			-0.116									-0.629			
			(4.28)									(0.51)			
Voice and accountability				-0.143								-0.269			
				(3.20)								(0.40)			
Rule of law					0.084							0.223			
					(3.49)							(0.64)			
Regulatory quality						0.02						0.265			
						(3.99)						(0.31)			
Political stability and absence of violence/terrorism							0.157					0.122			
							(3.19)					(0.32)			
Control of corruption								0.177				0.25			
								(3.66)				(0.55)			
Average governance quality														0.163	0.452
														(0.72)	(1.20)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									0.355				0.31	0.281	
									(2.94)				(1.57)	(0.61)	
Results-based management in the production of goods and services										0.598			0.043	0.107	
										(3.58)			(1.35)	(1.06)	
Sectoral information systems											-0.327		-0.096	-0.124	
											(2.98)		(1.09)	(0.53)	
Average institutional quality															0.334
															(0.63)
Constant	1.647	2.105	2.036	2.041	2.112	2.114	1.995	1.984	0.844	3.699	8.25	1.404**	0.991	0.926	0.691
	(19.94)	(21.25)	(22.90)	(20.99)	(19.83)	(21.90)	(20.08)	(20.42)	(15.03)	(23.17)	(26.29)	(0.64)	(5.45)	(2.35)	(3.17)
Sigma	0.292	0.318	0.309	0.305	0.313	0.318	0.297	0.296	0.303	0.573	0.725	0.157***	0.29	0.278*	0.277*
	(0.64)	(0.60)	(0.69)	(0.63)	(0.60)	(0.66)	(0.60)	(0.62)	(0.54)	(0.68)	(0.75)	(0.06)	(0.29)	(0.14)	(0.15)
Observations	27	27	27	27	27	27	27	27	24	24	24	27	24	24	24
Number of efficient units	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Log likelihood, initial truncated regression	35.269	35.149	35.185	35.209	35.169	35.15	35.242	35.256	31.56	31.094	31.021	37.155	31.606	31.67	31.672
Model significance, p-value	0.966	0.998	0.978	0.964	0.981	0.996	0.961	0.961	0.904	0.867	0.913	0.936	0.997	0.987	0.985
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 16: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Organization of healthcare delivery and financing							
Out-of-pocket health expenditure (Perc.)	−0.091						−0.008
	(0.07)						(0.01)
Hospital beds (per 1,000 people)							0.022
							(0.04)
Quality of governance							
Voice and accountability		11.171***					
		(2.65)					
Rule of law			7.369***				
			(1.57)				
Regulatory quality				6.304**			
				(2.49)			
Average governance quality						0.359**	0.076
						(0.14)	(0.12)
Quality of health system institutions							
Medium term sectoral vision in line with the government plan					9.027***	0.102*	
					(2.01)	(0.06)	
Results-based management in the production of goods and services						0.166	
						(0.10)	
Sectoral information systems						0.018	
						(0.09)	
Average institutional quality							0.203**
							(0.09)
Constant	6.004	36.686***	13.644***	54.419***	−12.788***	0.412	0.801***
	(4.18)	(11.92)	(4.03)	(14.16)	(3.72)	(0.28)	(0.29)
Sigma	0.235**	1.297***	0.564***	1.571***	0.787***	0.073***	0.059***
	(0.11)	(0.37)	(0.15)	(0.42)	(0.22)	(0.02)	(0.02)
Observations	26	26	26	26	23	23	23
Number of efficient units	7	7	7	7	7	7	7
Log likelihood, initial truncated regression	45.779	39.623	43.07	39.062	35.391	42.868	43.821
Model significance, p-value	0.186	0	0	0.011	0	0.114	0.031
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000

Table A 17: Further Simar-Wilson regression results of potential efficiency determinants, DPT immunization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	-0.003**														-0.0004
	(0.001)														(0.001)
Hospital beds (per 1,000 people)		0.023													0.004
		(0.02)													(0.01)
Quality of governance															
Government effectiveness			0.063**									0.025			
			(0.03)									(0.05)			
Voice and accountability				0.075***								0.139*			
				(0.03)								(0.07)			
Rule of law					0.056**							-0.103			
					(0.03)							(0.07)			
Regulatory quality						0.040*						-0.028			
						(0.02)						(0.03)			
Political stability and absence of violence/terrorism							0.046**					-0.035			
							(0.02)					(0.03)			
Control of corruption								0.064**				0.088*			
								(0.03)				(0.05)			
Average governance quality														0.060**	0.047*
														(0.02)	(0.03)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									-0.005				-0.004	-0.002	
									(0.02)				(0.02)	(0.02)	
Results-based management in the production of goods and services										0.001			-0.006	0.005	
										(0.02)			(0.03)	(0.02)	
Sectoral information systems											0.008		0.011	0.001	
											(0.02)		(0.02)	(0.01)	
Average institutional quality															0.004
															(0.02)
Constant	1.029***	0.897***	0.943***	0.914***	0.959***	0.942***	0.950***	0.949***	0.958***	0.938***	0.922***	0.862***	0.946***	0.932***	0.933***
	(0.06)	(0.05)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)	(0.03)	(0.07)	(0.06)	(0.04)	(0.04)	(0.07)	(0.06)	(0.07)
Sigma	0.053***	0.058***	0.050***	0.048***	0.051***	0.057***	0.054***	0.049***	0.055***	0.055***	0.055***	0.042***	0.055***	0.045***	0.044***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	27	27	27	27	27	27	27	27	24	24	24	27	24	24	24
Number of efficient units	3	3	3	3	3	3	3	3	2	2	2	3	2	2	2
Log likelihood, initial truncated regression	43.534	42.256	44.706	45.303	44.552	42.438	43.214	45.383	38.785	38.741	38.904	47.518	38.987	42.253	42.457
Model significance, p-value	0.035	0.202	0.016	0.005	0.026	0.098	0.047	0.029	0.781	0.971	0.594	0.021	0.92	0.156	0.138
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 18: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio poorest/richest

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	-0.025														-0.0002
	(0.224)														(0.006)
Hospital beds (per 1,000 people)		0.473													0.13
		(2.45)													(0.09)
Quality of governance															
Government effectiveness			0.487**									0.553**			
			(0.21)									(0.24)			
Voice and accountability				0.618								-0.227			
				(0.39)								(0.31)			
Rule of law					0.653							0.291			
					(1.55)							(0.28)			
Regulatory quality						0.516						-0.237*			
						(8.44)						(0.13)			
Political stability and absence of violence/terrorism							0.424					0.129			
							(2.08)					(0.11)			
Control of corruption								0.69				-0.092			
								(0.62)				(0.29)			
Average governance quality														0.310**	0.336**
														(0.12)	(0.17)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									0.214				0.211	0.097*	
									(0.53)				(0.28)	(0.05)	
Results-based management in the production of goods and services										0.6			0.135	0.101	
										(3.48)			(0.31)	(0.09)	
Sectoral information systems											0.004		-0.189	-0.118*	
											(5.06)		(0.46)	(0.07)	
Average institutional quality															0.134
															(0.09)
Constant	2.073	0.553	1.123***	0.929**	1.422	1.618	1.277	1.328	0.293	0.095	5.076	1.273***	0.325	0.654***	0.529
	(20.00)	(7.62)	(0.23)	(0.36)	(3.46)	(28.50)	(10.85)	(0.86)	(2.19)	(16.80)	(51.33)	(0.25)	(0.26)	(0.17)	(0.40)
Sigma	0.3	0.308	0.171***	0.185***	0.193	0.384	0.247	0.213**	0.2	0.331	0.893	0.130***	0.174***	0.119***	0.156***
	(0.54)	(0.44)	(0.06)	(0.07)	(0.13)	(0.87)	(0.34)	(0.10)	(0.16)	(0.58)	(1.48)	(0.03)	(0.07)	(0.03)	(0.03)
Observations	19	19	19	19	19	19	19	19	18	18	18	19	18	18	18
Number of efficient units	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Log likelihood, initial truncated regression	12.511	12.792	15.88	15.894	15.52	11.6	13.328	14.26	14.428	12.433	10.732	18.605	16.049	18.658	16.603
Model significance, p-value	0.913	0.847	0.02	0.117	0.673	0.951	0.838	0.268	0.686	0.863	0.999	0.008	0.439	0.001	0.007
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 19: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio rural/urban

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Organization of healthcare delivery and financing															
Out-of-pocket health expenditure (Perc.)	−0.009														-0.007
	(0.075)														(0.006)
Hospital beds (per 1,000 people)		0.127													-0.119
		(1.01)													(0.09)
Quality of governance															
Government effectiveness			0.225									-0.063			
			(4.31)									(0.15)			
Voice and accountability				0.027								-0.607***			
				(2.91)								(0.23)			
Rule of law					0.301							0.401**			
					(2.16)							(0.19)			
Regulatory quality						-0.101						-0.092			
						(3.11)						(0.08)			
Political stability and absence of violence/terrorism							0.176					0.212***			
							(0.79)					(0.08)			
Control of corruption								0.321				0.353*			
								(1.20)				(0.19)			
Average governance quality														0.22	0.127
														(0.92)	(0.16)
Quality of health system institutions															
Medium term sectoral vision in line with the government plan									0.128				0.127	0.089	
									(1.54)				(0.19)	(0.07)	
Results-based management in the production of goods and services										0.122			0.02	0.016	
										(2.53)			(0.18)	(0.35)	
Sectoral information systems											0.03		-0.023	-0.014	
											(1.68)		(0.13)	(0.17)	
Average institutional quality															0.094
															(0.09)
Constant	1.34	0.934	1.249	1.259	1.221	1.217	1.046	1.124	0.614	0.896	1.171	1.427***	0.613	0.699	1.193***
	(8.30)	(6.16)	(13.73)	(18.40)	(5.28)	(16.44)	(3.73)	(2.61)	(5.61)	(14.63)	(17.55)	(0.18)	(0.42)	(1.39)	(0.33)
Sigma	0.141	0.172	0.187	0.208	0.138	0.201	0.107	0.131	0.145	0.187	0.201	0.078***	0.144**	0.103	0.106***
	(0.22)	(0.27)	(0.42)	(0.55)	(0.19)	(0.51)	(0.12)	(0.12)	(0.26)	(0.46)	(0.54)	(0.02)	(0.06)	(0.07)	(0.03)
Observations	21	21	21	21	21	21	21	21	19	19	19	21	19	19	19
Number of efficient units	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Log likelihood, initial truncated regression	22.645	21.83	21.413	21.074	22.887	21.177	24.131	23.264	19.593	18.691	18.471	30.456	19.629	21.353	21.357
Model significance, p-value	0.91	0.899	0.958	0.993	0.889	0.974	0.824	0.789	0.934	0.962	0.986	0.082	0.905	0.68	0.292
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table A 20: DEA efficiency scores using total health expenditure per capita as input

Life expectancy				Under-five mortality			
Country	Input variables			Country	Input variables		
	Total exp.	+GDP	+ Pop. 65+		Total exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Belize	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Cuba	1.0000	1.0000	1.0000
Jamaica	0.9979	0.9979	1.0000	Haiti	1.0000	1.0000	1.0000
Ecuador	0.9908	0.9908	0.9908	Jamaica	1.0000	1.0000	1.0000
Costa Rica	0.9832	1.0000	1.0000	Nicaragua	1.0000	1.0000	1.0000
Peru	0.9813	0.9813	0.9817	Costa Rica	0.9993	1.0000	1.0000
Cuba	0.9773	0.9816	1.0000	Peru	0.9982	0.9982	0.9982
Honduras	0.9716	0.9775	0.9775	Honduras	0.9980	1.0000	1.0000
Panama	0.9703	0.9745	0.9745	El Salvador	0.9980	0.9997	1.0000
Dominican Republic	0.9679	0.9679	0.9682	Barbados	0.9975	0.9975	1.0000
Mexico	0.9646	0.9646	0.9646	Colombia	0.9969	0.9971	0.9971
Paraguay	0.9546	0.9587	0.9587	Uruguay	0.9965	0.9971	1.0000
Colombia	0.9524	0.9532	0.9532	Mexico	0.9965	0.9965	0.9965
El Salvador	0.9522	0.9526	0.9605	Venezuela, RB	0.9964	0.9964	0.9964
Barbados	0.9506	0.9506	1.0000	Argentina	0.9948	0.9950	0.9956
Uruguay	0.9472	0.9592	1.0000	Paraguay	0.9937	0.9965	0.9966
Guatemala	0.9430	0.9439	0.9439	Bahamas, The	0.9931	0.9931	0.9931
Venezuela, RB	0.9416	0.9416	0.9416	Brazil	0.9928	0.9934	0.9934
Argentina	0.9366	0.9393	0.9483	Ecuador	0.9925	0.9927	0.9927
Belize	0.9278	0.9278	0.9278	Panama	0.9922	0.9925	0.9925
Bahamas, The	0.9254	0.9254	0.9254	Guyana	0.9899	0.9899	0.9899
Brazil	0.9172	0.9305	0.9305	Suriname	0.9896	0.9896	0.9896
Guyana	0.9129	0.9129	0.9129	Trinidad and Tobago	0.9853	0.9853	0.9853
Bolivia	0.9094	0.9094	0.9184	Guatemala	0.9851	0.9875	0.9875
Suriname	0.9042	0.9042	0.9042	Dominican Republic	0.9841	0.9841	0.9841
Trinidad and Tobago	0.8664	0.8664	0.8664	Bolivia	0.9814	0.9814	0.9931

Notes: Column (1) displays scores for a DEA model with total health expenditures per capita as only input. Column (2) uses total expenditures and GDP per capita as inputs. Column (3) uses total expenditures, GDP per capita and share of population aged 65+.

Table A 20: DEA efficiency scores using total health expenditure per capita as input *(continued)*

DALYs lost				Skilled birth attendance			
Country	Input variables			Country	Input variables		
	Total exp.	+GDP	+ Pop. 65+		Total exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Peru	1.0000	1.0000	1.0000	Jamaica	1.0000	1.0000	1.0000
Costa Rica	0.9856	1.0000	1.0000	Trinidad and Tobago	1.0000	1.0000	1.0000
Colombia	0.9715	0.9763	0.9763	Colombia	0.9986	0.9999	0.9999
Dominican Republic	0.9624	0.9624	0.9624	Cuba	0.9977	1.0000	1.0000
Ecuador	0.9577	0.9646	0.9646	El Salvador	0.9959	1.0000	1.0000
Honduras	0.9560	0.9965	0.9965	Barbados	0.9941	0.9941	1.0000
Uruguay	0.9557	0.9667	1.0000	Uruguay	0.9892	0.9925	1.0000
Barbados	0.9542	0.9542	1.0000	Dominican Republic	0.9882	0.9882	0.9882
Mexico	0.9531	0.9531	0.9531	Costa Rica	0.9863	0.9903	0.9903
Belize	0.9515	0.9562	0.9562	Bahamas, The	0.9850	0.9858	0.9858
Cuba	0.9511	0.9548	0.9765	Brazil	0.9830	0.9862	0.9862
Panama	0.9384	0.9432	0.9432	Belize	0.9778	0.9831	0.9831
Paraguay	0.9383	0.9847	0.9847	Argentina	0.9759	0.9767	0.9781
Argentina	0.9304	0.9329	0.9402	Paraguay	0.9659	0.9932	0.9932
Venezuela, RB	0.9268	0.9268	0.9268	Venezuela, RB	0.9647	0.9647	0.9647
Jamaica	0.9248	0.9250	0.9445	Mexico	0.9639	0.9639	0.9639
Suriname	0.9229	0.9236	0.9236	Nicaragua	0.9433	1.0000	1.0000
Bahamas, The	0.8840	0.8840	0.8840	Ecuador	0.9285	0.9291	0.9291
Brazil	0.8735	0.8844	0.8844	Panama	0.9277	0.9289	0.9289
El Salvador	0.8707	0.8993	0.9149	Bolivia	0.9027	0.9221	0.9308
Guatemala	0.8598	0.8978	0.8978	Peru	0.8802	0.8802	0.8802
Bolivia	0.8346	0.8346	0.8426	Honduras	0.8602	0.9324	0.9324
Trinidad and Tobago	0.7836	0.7836	0.7836	Guatemala	0.6336	0.6532	0.6532
Guyana	0.7111	0.7111	0.7111	Suriname			

Notes: Column (1) displays scores for a DEA model with total health expenditures per capita as only input. Column (2) uses total expenditures and GDP per capita as inputs. Column (3) uses total expenditures, GDP per capita and share of population aged 65+.

Table A 20: DEA efficiency scores using total health expenditure per capita as input *(continued)*

DPT immunization				Skilled birth attendance ratio poorest/richest			
Country	Input variables			Country	Input variables		
	Total exp.	+GDP	+ Pop. 65+		Total exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Cuba	1.0000	1.0000	1.0000	Barbados	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Jamaica	0.9816	1.0000	1.0000
Bahamas, The	0.9819	0.9819	0.9819	Trinidad and Tobago	0.9773	0.9773	0.9773
Bolivia	0.9775	0.9775	1.0000	Costa Rica	0.9730	0.9760	0.9760
Brazil	0.9762	0.9762	0.9762	Argentina	0.9710	0.9710	0.9710
Belize	0.9729	0.9729	0.9729	Belize	0.9415	0.9741	0.9741
Uruguay	0.9631	0.9631	1.0000	El Salvador	0.9316	1.0000	1.0000
Chile	0.9476	0.9476	0.9500	Suriname	0.8803	0.8810	0.8810
Jamaica	0.9463	0.9463	0.9751	Colombia	0.8584	0.8609	0.8609
Argentina	0.9433	0.9433	0.9532	Ecuador	0.8261	0.8473	0.8473
Trinidad and Tobago	0.9382	0.9382	0.9382	Panama	0.7170	0.7179	0.7179
Barbados	0.9363	0.9363	0.9781	Peru	0.6898	0.7036	0.7036
El Salvador	0.9339	0.9339	0.9463	Bolivia	0.6682	0.7309	0.7285
Costa Rica	0.9234	0.9234	0.9234	Honduras	0.6332	0.9251	0.9251
Mexico	0.9220	0.9220	0.9220	Nicaragua	0.4932	0.7329	0.7323
Peru	0.9218	0.9218	0.9271	Guatemala	0.3923	0.4375	0.4375
Colombia	0.9128	0.9128	0.9128	Haiti	0.3559	0.5014	0.5014
Paraguay	0.9011	0.9011	0.9011	Bahamas, The			
Honduras	0.8895	0.8897	0.8897	Brazil			
Suriname	0.8756	0.8756	0.8756	Chile			
Dominican Republic	0.8729	0.8729	0.8769	Cuba			
Ecuador	0.8624	0.8624	0.8630	Mexico			
Guatemala	0.8484	0.8484	0.8484	Paraguay			
Venezuela, RB	0.8267	0.8267	0.8267	Uruguay			
Panama	0.8241	0.8241	0.8241	Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with total health expenditures per capita as only input. Column (2) uses total expenditures and GDP per capita as inputs. Column (3) uses total expenditures, GDP per capita and share of population aged 65+.

Table A 20: DEA efficiency scores using total health expenditure per capita as input *(continued)*

Skilled birth attendance ratio rural/urban				Pooled health expenditure share			
Country	Input variables			Country	Input variables		
	Total exp.	+GDP	+ Pop. 65+		Total exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Barbados	1.0000	1.0000	1.0000	Bolivia	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000	Colombia	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Cuba	1.0000	1.0000	1.0000
Jamaica	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Dominican Republic	0.9929	0.9929	0.9929	Suriname	1.0000	1.0000	1.0000
Cuba	0.9898	0.9898	0.9898	Belize	0.9706	0.9706	0.9706
Belize	0.9877	0.9977	0.9977	Dominican Republic	0.9430	0.9430	0.9449
Uruguay	0.9809	0.9833	1.0000	Jamaica	0.9160	0.9160	0.9382
El Salvador	0.9746	1.0000	1.0000	Uruguay	0.9102	0.9134	0.9481
Costa Rica	0.9617	0.9777	0.9777	Guyana	0.8799	0.8799	0.8799
Brazil	0.9457	0.9560	0.9560	El Salvador	0.8641	0.8687	0.8826
Suriname	0.8955	0.8982	0.8982	Panama	0.8550	0.8550	0.8550
Nicaragua	0.8876	1.0000	1.0000	Peru	0.8445	0.8445	0.8467
Colombia	0.8842	0.8925	0.8925	Costa Rica	0.8403	0.8609	0.8609
Mexico	0.8687	0.8697	0.8697	Nicaragua	0.8200	0.8307	0.8307
Ecuador	0.8618	0.8661	0.8661	Brazil	0.8195	0.8273	0.8273
Honduras	0.8125	0.9302	0.9302	Argentina	0.7972	0.7972	0.8089
Bolivia	0.7915	0.8192	0.8267	Barbados	0.7960	0.7960	0.8362
Panama	0.7717	0.7768	0.7768	Chile	0.7471	0.7471	0.7525
Peru	0.7647	0.7647	0.7647	Bahamas, The	0.7449	0.7449	0.7449
Guatemala	0.6710	0.7041	0.7041	Honduras	0.6836	0.7069	0.7069
Argentina				Trinidad and Tobago	0.6600	0.6600	0.6600
Bahamas, The				Ecuador	0.6462	0.6462	0.6474
Chile				Mexico	0.6261	0.6261	0.6261
Paraguay				Paraguay	0.6028	0.6203	0.6205
Trinidad and Tobago				Guatemala	0.5790	0.5854	0.5854
Venezuela, RB				Venezuela, RB	0.4670	0.4670	0.4670

Notes: Column (1) displays scores for a DEA model with total health expenditures per capita as only input. Column (2) uses total expenditures and GDP per capita as inputs. Column (3) uses total expenditures, GDP per capita and share of population aged 65+.

Table A 21: Simar-Wilson regression results of potential efficiency determinants using total health expenditure per capita as input, pooled health expenditure share (financial protection proxy)

	(1)	(2)	(3)
Average governance quality	0.117*		0.062
	(0.066)		(0.059)
Average institutional quality		0.013	0.014
		(0.062)	(0.057)
Constant	0.815***	0.780***	0.778***
	(0.051)	(0.161)	(0.146)
Sigma	0.140***	0.131***	0.126***
	(0.031)	(0.031)	(0.028)
Observations	27	24	24
Number of efficient units	5	3	3
Log likelihood, initial truncated regression	17.063	16.955	17.59
Model significance, p-value	0.077	0.827	0.569
Number of bootstrap repetitions	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 22: DEA efficiency scores using the input orientation

Life expectancy				Under-five mortality			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Ecuador	1.0000	1.0000	1.0000	Cuba	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Honduras	1.0000	1.0000	1.0000
Jamaica	0.8648	0.8673	1.0000	Jamaica	1.0000	1.0000	1.0000
Honduras	0.8574	0.8623	0.9927	Nicaragua	1.0000	1.0000	1.0000
Mexico	0.7459	0.7459	0.9633	Peru	0.9654	0.9654	0.9858
Costa Rica	0.7166	1.0000	1.0000	Belize	0.9075	0.9982	0.9982
Guatemala	0.7058	0.7058	0.9806	Mexico	0.8829	0.8829	0.9634
Paraguay	0.6482	0.6482	0.9814	Venezuela, RB	0.8463	0.8463	0.9590
Peru	0.6205	0.6205	0.9832	El Salvador	0.8243	0.9795	1.0000
Panama	0.5712	0.6789	0.9579	Costa Rica	0.8170	1.0000	1.0000
Dominican Republic	0.5711	0.5711	0.9796	Paraguay	0.7612	0.7612	0.9848
Guyana	0.5403	0.5403	0.9791	Guatemala	0.7549	0.7549	0.9828
Bolivia	0.5390	0.5390	0.9932	Guyana	0.7277	0.7277	0.9821
El Salvador	0.4661	0.4833	0.9927	Barbados	0.6839	0.7269	1.0000
Belize	0.4237	0.4237	0.9572	Ecuador	0.6373	0.6373	0.9810
Venezuela, RB	0.3963	0.3963	0.9574	Bolivia	0.6369	0.6369	0.9954
Barbados	0.3620	0.3744	1.0000	Dominican Republic	0.5412	0.5412	0.9796
Cuba	0.3459	0.7150	1.0000	Colombia	0.5217	0.7480	0.9593
Uruguay	0.3227	0.5357	1.0000	Uruguay	0.5197	0.7564	1.0000
Argentina	0.3189	0.3830	0.9705	Argentina	0.5101	0.5894	0.9705
Colombia	0.2913	0.3722	0.9580	Brazil	0.4210	0.6107	0.9473
Brazil	0.2131	0.2921	0.9473	Bahamas, The	0.4083	0.4648	0.9240
Suriname	0.1926	0.2427	0.9493	Panama	0.3525	0.4834	0.9469
Bahamas, The	0.1772	0.2107	0.9240	Suriname	0.2443	0.3052	0.9493
Trinidad and Tobago	0.1443	0.1443	0.9469	Trinidad and Tobago	0.2046	0.2046	0.9469

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 22: DEA efficiency scores using the input orientation *(continued)*

DALYs lost				Skilled birth attendance			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Peru	1.0000	1.0000	1.0000	Jamaica	1.0000	1.0000	1.0000
Honduras	0.9414	0.9569	0.9952	Nicaragua	1.0000	1.0000	1.0000
Paraguay	0.8670	0.8745	0.9930	Paraguay	1.0000	1.0000	1.0000
Ecuador	0.8489	0.8489	0.9924	Trinidad and Tobago	1.0000	1.0000	1.0000
Dominican Republic	0.8149	0.8149	0.9903	Dominican Republic	0.9955	0.9955	0.9955
Guatemala	0.7641	0.7641	0.9846	El Salvador	0.8971	1.0000	1.0000
Costa Rica	0.7418	1.0000	1.0000	Honduras	0.8711	0.8756	0.9927
Belize	0.6423	0.6877	0.9650	Belize	0.7975	0.8480	0.9610
Bolivia	0.6269	0.6269	0.9958	Bolivia	0.7870	0.7870	1.0000
Jamaica	0.5987	0.5987	1.0000	Ecuador	0.6669	0.6669	0.9811
Mexico	0.5984	0.5984	0.9677	Colombia	0.6619	0.9868	0.9868
Venezuela, RB	0.5493	0.5493	0.9627	Peru	0.6204	0.6204	0.9816
El Salvador	0.4880	0.5052	0.9945	Venezuela, RB	0.5785	0.5785	0.9574
Guyana	0.4737	0.4737	0.9791	Guatemala	0.5746	0.5746	0.9766
Colombia	0.4731	0.8410	0.9729	Mexico	0.5124	0.5124	0.9561
Barbados	0.4147	0.5782	1.0000	Barbados	0.4351	0.5331	1.0000
Uruguay	0.3854	0.7058	1.0000	Cuba	0.4140	1.0000	1.0000
Panama	0.3458	0.5952	0.9485	Brazil	0.3599	0.5387	0.9473
Suriname	0.3085	0.4859	0.9493	Costa Rica	0.3449	0.5995	0.9590
Argentina	0.2927	0.5090	0.9705	Argentina	0.2818	0.3954	0.9705
Brazil	0.2503	0.3917	0.9473	Uruguay	0.2489	0.5148	1.0000
Cuba	0.2442	0.5983	0.9784	Panama	0.2427	0.3780	0.9469
Bahamas, The	0.1686	0.2557	0.9240	Bahamas, The	0.2271	0.3049	0.9240
Trinidad and Tobago	0.1628	0.1628	0.9469	Suriname			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 22: DEA efficiency scores using the input orientation *(continued)*

DPT immunization				Skilled birth attendance ratio poorest/richest			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Cuba	1.0000	1.0000	1.0000	Barbados	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Guyana	0.8981	0.8981	0.9922	Haiti	1.0000	1.0000	1.0000
Bolivia	0.7917	0.7917	1.0000	Jamaica	0.8711	1.0000	1.0000
Honduras	0.7539	0.7618	0.9885	Honduras	0.7694	0.9411	0.9956
Guatemala	0.6184	0.6184	0.9789	Belize	0.7331	0.9058	0.9630
Paraguay	0.5892	0.5892	0.9810	El Salvador	0.7261	1.0000	1.0000
Peru	0.5430	0.5430	0.9829	Bolivia	0.6752	0.7791	0.9961
Belize	0.5233	0.5233	0.9649	Nicaragua	0.6691	0.7942	0.9895
Jamaica	0.5154	0.5154	1.0000	Ecuador	0.6588	0.6588	0.9802
Ecuador	0.4757	0.4757	0.9802	Peru	0.5772	0.5772	0.9816
Dominican Republic	0.4750	0.4750	0.9796	Guatemala	0.5306	0.5306	0.9766
El Salvador	0.4614	0.4786	0.9944	Colombia	0.3414	0.5527	0.9639
Mexico	0.3112	0.3112	0.9561	Costa Rica	0.3197	0.7511	0.9684
Venezuela, RB	0.2849	0.2849	0.9574	Trinidad and Tobago	0.2902	0.3126	0.9539
Colombia	0.2569	0.3297	0.9580	Suriname	0.2859	0.4624	0.9550
Barbados	0.2221	0.2286	1.0000	Argentina	0.2764	0.5106	0.9797
Brazil	0.2097	0.2876	0.9614	Panama	0.2142	0.3306	0.9524
Chile	0.2029	0.2029	0.9720	Bahamas, The			
Suriname	0.1853	0.2339	0.9493	Brazil			
Costa Rica	0.1785	0.2869	0.9567	Chile			
Trinidad and Tobago	0.1655	0.1655	0.9469	Cuba			
Argentina	0.1612	0.2051	0.9705	Mexico			
Panama	0.1574	0.1988	0.9469	Paraguay			
Uruguay	0.1352	0.2490	1.0000	Uruguay			
Bahamas, The	0.1308	0.1621	0.9492	Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 22: DEA efficiency scores using the input orientation *(continued)*

Skilled birth attendance ratio rural/urban			
Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)
Barbados	1.0000	1.0000	1.0000
Dominican Republic	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000
Jamaica	1.0000	1.0000	1.0000
Nicaragua	0.9457	1.0000	1.0000
Belize	0.8418	0.9705	0.9705
Honduras	0.8271	0.8772	0.9924
El Salvador	0.7963	1.0000	1.0000
Bolivia	0.6771	0.7035	0.9958
Ecuador	0.6250	0.6250	0.9802
Guatemala	0.6081	0.6081	0.9766
Peru	0.5390	0.5390	0.9816
Uruguay	0.3885	0.7678	1.0000
Mexico	0.3750	0.3750	0.9561
Costa Rica	0.3382	0.6869	0.9588
Brazil	0.3315	0.5522	0.9473
Cuba	0.3249	0.7785	0.9874
Colombia	0.3166	0.4911	0.9580
Suriname	0.2539	0.3975	0.9493
Panama	0.2032	0.2679	0.9469
Argentina			
Bahamas, The			
Chile			
Paraguay			
Trinidad and Tobago			
Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 23: Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance (input-oriented DEA efficiency scores)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	-0.001			
	(0.003)			
Hospital beds (per 1,000 people)	-0.046*			
	(0.026)			
Average governance quality		-0.146**		-0.149**
		(0.061)		(0.075)
Average institutional quality			0.118	0.05
			(0.083)	(0.068)
Constant	0.889***	0.730***	0.446**	0.607***
	(0.159)	(0.042)	(0.201)	(0.175)
Sigma	0.150***	0.140***	0.167***	0.141***
	(0.035)	(0.028)	(0.042)	(0.030)
Observations	26	26	23	23
Number of efficient units	7	7	7	7
Log likelihood, initial truncated regression	12.079	13.165	9.087	10.992
Model significance, p-value	0.169	0.017	0.155	0.03
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 24: Simar-Wilson regression results of potential efficiency determinants, DPT immunization (input-oriented DEA efficiency scores)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.002			
	(0.002)			
Hospital beds (per 1,000 people)	-0.045**			
	(0.021)			
Average governance quality		-0.135***		-0.158***
		(0.042)		(0.041)
Average institutional quality			-0.04	-0.047
			(0.046)	(0.037)
Constant	0.610***	0.579***	0.683***	0.698***
	(0.108)	(0.025)	(0.122)	(0.095)
Sigma	0.130***	0.125***	0.141***	0.107***
	(0.020)	(0.019)	(0.022)	(0.017)
Observations	27	27	24	24
Number of efficient units	3	3	2	2
Log likelihood, initial truncated regression	15.237	16.151	12.098	18.044
Model significance, p-value	0.023	0.001	0.39	0
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 25: Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio poorest/richest (input-oriented DEA efficiency scores)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.001			
	(0.003)			
Hospital beds (per 1,000 people)	-0.081**			
	(0.040)			
Average governance quality		-0.15		-0.141
		(0.128)		(0.146)
Average institutional quality			0.009	-0.008
			(0.104)	(0.098)
Constant	0.835***	0.706***	0.719***	0.726***
	(0.161)	(0.058)	(0.263)	(0.245)
Sigma	0.127***	0.153***	0.165***	0.157***
	(0.028)	(0.037)	(0.044)	(0.037)
Observations	19	19	18	18
Number of efficient units	4	4	4	4
Log likelihood, initial truncated regression	11.14	9.094	7.559	8.07
Model significance, p-value	0.045	0.241	0.933	0.63
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 26: DEA efficiency scores excluding Haiti, skilled birth attendance ratios

Skilled birth attendance ratio poorest/richest				Skilled birth attendance ratio rural/urban			
Country	Input variables			Country	Input variables		
	Pooled exp.	+GDP	+ Pop. 65+		Pooled exp.	+GDP	+ Pop. 65+
	(1)	(2)	(3)		(1)	(2)	(3)
Barbados	1.0000	1.0000	1.0000	Barbados	1.0000	1.0000	1.0000
Dominican Republic	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000	Guyana	1.0000	1.0000	1.0000
Trinidad and Tobago	0.9773	0.9773	0.9773	Jamaica	1.0000	1.0000	1.0000
Costa Rica	0.9730	0.9760	0.9760	Nicaragua	1.0000	1.0000	1.0000
Argentina	0.9710	0.9710	0.9710	Cuba	0.9898	0.9898	0.9898
Jamaica	0.9694	1.0000	1.0000	Uruguay	0.9809	0.9833	1.0000
El Salvador	0.9315	1.0000	1.0000	Belize	0.9782	0.9941	0.9941
Belize	0.9154	0.9703	0.9703	El Salvador	0.9764	1.0000	1.0000
Suriname	0.8793	0.8810	0.8810	Costa Rica	0.9617	0.9777	0.9777
Colombia	0.8576	0.8609	0.8609	Brazil	0.9457	0.9560	0.9560
Ecuador	0.8357	0.8553	0.8553	Suriname	0.8893	0.8982	0.8982
Panama	0.7170	0.7179	0.7179	Mexico	0.8845	0.8845	0.8845
Honduras	0.6981	1.0000	1.0000	Colombia	0.8791	0.8925	0.8925
Peru	0.6948	0.7114	0.7114	Ecuador	0.8774	0.8804	0.8804
Bolivia	0.6583	0.7417	0.7360	Honduras	0.8580	0.9302	0.9302
Nicaragua	0.5438	0.7750	0.7750	Bolivia	0.7878	0.8192	0.8267
Guatemala	0.4468	0.4468	0.4468	Peru	0.7750	0.7777	0.7777
Bahamas, The				Panama	0.7717	0.7768	0.7768
Brazil				Guatemala	0.7188	0.7188	0.7188
Chile				Argentina			
Cuba				Bahamas, The			
Mexico				Chile			
Paraguay				Paraguay			
Uruguay				Trinidad and Tobago			
Venezuela, RB				Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with pooled health expenditures per capita as only input. Column (2) uses pooled expenditures and GDP per capita as inputs. Column (3) uses pooled expenditures, GDP per capita and share of population aged 65+.

Table A 27: Simar-Wilson regression results of potential efficiency determinants using total health expenditure per capita as input, skilled birth attendance

	(1)	(2)
Out-of-pocket health expenditure (Perc.)	−0.053**	
	(0.026)	
Hospital beds (per 1,000 people)	0.766***	
	(0.273)	
Average governance quality		1.411
		(1.095)
Average institutional quality		1.103
		-0.906
Constant	3.297**	−0.085
	(1.401)	(1.199)
Sigma	0.226***	0.214**
	(0.065)	(0.091)
Observations	26	23
Number of efficient units	5	5
Log likelihood, initial truncated regression	51.115	43.489
Model significance, p-value	0.015	0.406
Number of bootstrap repetitions	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 28: Simar-Wilson regression results of potential efficiency determinants using total health expenditure per capita as input, DPT immunization

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.002*			
	(0.001)			
Hospital beds (per 1,000 people)	0.007			
	(0.012)			
Average governance quality		0.061***		0.056***
		(0.023)		(0.021)
Average institutional quality			0.006	0.008
			(0.021)	(0.015)
Constant	0.985***	0.934***	0.914***	0.906***
	(0.057)	(0.017)	(0.054)	(0.039)
Sigma	0.050***	0.046***	0.051***	0.040***
	(0.011)	(0.010)	(0.011)	(0.007)
Observations	27	27	24	24
Number of efficient units	4	4	3	3
Log likelihood, initial truncated regression	41.598	43.107	37.043	41.234
Model significance, p-value	0.095	0.009	0.772	0.025
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 29: Simar-Wilson regression results of potential efficiency determinants using total health expenditure per capita as input, skilled birth attendance ratio poorest/richest

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.015			
	(0.057)			
Hospital beds (per 1,000 people)	0.282			
	(0.690)			
Average governance quality		0.678**		0.526*
		(0.306)		(0.283)
Average institutional quality			0.496	0.108
			(2.762)	(0.099)
Constant	1.224	1.201***	0.086	0.870**
	(7.303)	(0.283)	(5.719)	(0.376)
Sigma	0.272	0.187***	0.299	0.177***
	(0.206)	(0.058)	(0.376)	(0.055)
Observations	19	19	18	18
Number of efficient units	3	3	3	3
Log likelihood, initial truncated regression	13.114	15.394	12.342	15.084
Model significance, p-value	0.853	0.027	0.858	0.032
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 30: Simar-Wilson regression results of potential efficiency determinants using total health expenditure per capita as input, skilled birth attendance ratio rural/urban

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.011			
	(0.017)			
Hospital beds (per 1,000 people)	0.012			
	(0.216)			
Average governance quality		0.456		0.295
		(4.317)		(1.136)
Average institutional quality			0.266	0.156
			(2.966)	(0.508)
Constant	1.46	1.328	0.556	0.698
	(1.121)	(10.157)	(6.596)	(2.991)
Sigma	0.157*	0.186	0.2	0.132
	(0.083)	(0.342)	(0.396)	(0.132)
Observations	21	21	19	19
Number of efficient units	4	4	4	4
Log likelihood, initial truncated regression	24.133	23.426	20.403	22.088
Model significance, p-value	0.808	0.916	0.929	0.953
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 31: DEA efficiency scores using public health expenditure per capita as input

Life expectancy				Under-five mortality			
Country	Input variables			Country	Input variables		
	Public exp.	+GDP	+ Pop. +65		Public exp.	+GDP	+ Pop. +65
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Ecuador	1.0000	1.0000	1.0000	Cuba	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Nicaragua	0.9977	1.0000	1.0000	Honduras	1.0000	1.0000	1.0000
Jamaica	0.9845	0.9902	1.0000	Jamaica	1.0000	1.0000	1.0000
Cuba	0.9773	0.9816	1.0000	Nicaragua	1.0000	1.0000	1.0000
Costa Rica	0.9765	1.0000	1.0000	Ecuador	0.9988	0.9988	1.0000
Peru	0.9685	0.9737	0.9737	Belize	0.9983	0.9999	0.9999
Honduras	0.9645	0.9779	0.9779	Peru	0.9983	0.9983	0.9983
Mexico	0.9600	0.9617	0.9617	Costa Rica	0.9979	1.0000	1.0000
Dominican Republic	0.9597	0.9597	0.9597	Venezuela, RB	0.9975	0.9975	0.9975
Guatemala	0.9584	0.9593	0.9593	Paraguay	0.9974	0.9974	0.9974
Paraguay	0.9562	0.9649	0.9649	El Salvador	0.9968	0.9997	1.0000
Panama	0.9541	0.9695	0.9695	Uruguay	0.9966	0.9977	1.0000
Uruguay	0.9472	0.9592	1.0000	Mexico	0.9964	0.9964	0.9964
Venezuela, RB	0.9433	0.9433	0.9433	Bahamas, The	0.9949	0.9949	0.9949
Argentina	0.9366	0.9393	0.9479	Argentina	0.9945	0.9947	0.9951
El Salvador	0.9328	0.9512	0.9604	Barbados	0.9945	0.9956	1.0000
Barbados	0.9285	0.9392	0.9702	Brazil	0.9930	0.9955	0.9955
Bahamas, The	0.9254	0.9254	0.9254	Guatemala	0.9926	0.9926	0.9926
Brazil	0.9181	0.9374	0.9374	Colombia	0.9920	0.9965	0.9965
Colombia	0.9134	0.9484	0.9484	Panama	0.9898	0.9913	0.9913
Belize	0.9080	0.9184	0.9184	Suriname	0.9889	0.9895	0.9895
Suriname	0.8940	0.8996	0.8996	Trinidad and Tobago	0.9861	0.9861	0.9861
Bolivia	0.8922	0.9036	0.9094	Dominican Republic	0.9857	0.9857	0.9857
Guyana	0.8764	0.8858	0.8858	Guyana	0.9805	0.9805	0.9805
Trinidad and Tobago	0.8664	0.8664	0.8664	Bolivia	0.9785	0.9789	0.9828

Notes: Column (1) displays scores for a DEA model with public health expenditures per capita as only input. Column (2) uses public expenditures and GDP per capita as inputs. Column (3) uses public expenditures, GDP per capita and share of population aged 65+.

Table A 31: DEA efficiency scores using public health expenditure per capita as input *(continued)*

DALYs lost				Skilled birth attendance			
Country	Input variables			Country	Input variables		
	Public exp.	+GDP	+ Pop. +65		Public exp.	+GDP	+ Pop. +65
	(1)	(2)	(3)		(1)	(2)	(3)
Chile	1.0000	1.0000	1.0000	Chile	1.0000	1.0000	1.0000
Ecuador	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Ecuador	1.0000	1.0000	1.0000
Peru	1.0000	1.0000	1.0000	Haiti	1.0000	1.0000	1.0000
Nicaragua	0.9790	1.0000	1.0000	Jamaica	1.0000	1.0000	1.0000
Costa Rica	0.9786	1.0000	1.0000	Nicaragua	1.0000	1.0000	1.0000
Dominican Republic	0.9723	0.9723	0.9723	Trinidad and Tobago	1.0000	1.0000	1.0000
Paraguay	0.9628	0.9847	0.9847	Paraguay	0.9982	1.0000	1.0000
Uruguay	0.9557	0.9667	1.0000	Cuba	0.9977	1.0000	1.0000
Mexico	0.9523	0.9527	0.9527	Guyana	0.9976	1.0000	1.0000
Cuba	0.9511	0.9548	0.9765	El Salvador	0.9948	1.0000	1.0000
Honduras	0.9473	0.9965	0.9965	Colombia	0.9943	0.9999	0.9999
Venezuela, RB	0.9359	0.9359	0.9359	Barbados	0.9910	0.9937	1.0000
Belize	0.9311	0.9562	0.9562	Uruguay	0.9885	0.9926	1.0000
Barbados	0.9309	0.9414	0.9721	Bahamas, The	0.9850	0.9858	0.9858
Colombia	0.9305	0.9734	0.9734	Costa Rica	0.9840	0.9903	0.9903
Argentina	0.9304	0.9329	0.9402	Brazil	0.9832	0.9863	0.9863
Guatemala	0.9250	0.9331	0.9331	Argentina	0.9747	0.9767	0.9778
Jamaica	0.9220	0.9250	0.9446	Belize	0.9700	0.9755	0.9755
Panama	0.9219	0.9355	0.9355	Venezuela, RB	0.9657	0.9657	0.9657
Suriname	0.9166	0.9230	0.9230	Mexico	0.9638	0.9638	0.9638
Bahamas, The	0.8840	0.8840	0.8840	Panama	0.9250	0.9289	0.9289
Brazil	0.8755	0.8969	0.8969	Honduras	0.9006	0.9324	0.9324
El Salvador	0.8610	0.8993	0.9155	Bolivia	0.8946	0.9221	0.9302
Bolivia	0.7839	0.8199	0.8270	Peru	0.8802	0.8802	0.8802
Trinidad and Tobago	0.7836	0.7836	0.7836	Guatemala	0.7159	0.7159	0.7159
Guyana	0.6290	0.6520	0.6520	Suriname			

Notes: Column (1) displays scores for a DEA model with public health expenditures per capita as only input. Column (2) uses public expenditures and GDP per capita as inputs. Column (3) uses public expenditures, GDP per capita and share of population aged 65+.

Table A 31: DEA efficiency scores using public health expenditure per capita as input *(continued)*

DPT immunization				Skilled birth attendance ratio poorest/richest			
Country	Input variables			Country	Input variables		
	Public exp.	+GDP	+ Pop. +65		Public exp.	+GDP	+ Pop. +65
	(1)	(2)	(3)		(1)	(2)	(3)
Cuba	1.0000	1.0000	1.0000	Barbados	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000	Dominican Republic	1.0000	1.0000	1.0000
Nicaragua	1.0000	1.0000	1.0000	Ecuador	1.0000	1.0000	1.0000
Bahamas, The	0.9852	0.9852	0.9852	Haiti	1.0000	1.0000	1.0000
Guyana	0.9816	0.9816	0.9816	Trinidad and Tobago	0.9771	0.9771	0.9771
Brazil	0.9783	0.9783	0.9794	Costa Rica	0.9729	0.9759	0.9759
Bolivia	0.9774	0.9774	0.9907	Argentina	0.9710	0.9710	0.9710
Belize	0.9731	0.9731	0.9731	Jamaica	0.9694	1.0000	1.0000
Uruguay	0.9647	0.9647	1.0000	El Salvador	0.9311	1.0000	1.0000
Chile	0.9497	0.9497	0.9663	Belize	0.9151	0.9765	0.9765
Jamaica	0.9467	0.9467	1.0000	Guyana	0.8799	1.0000	1.0000
Argentina	0.9447	0.9447	0.9611	Suriname	0.8632	0.8632	0.8632
Trinidad and Tobago	0.9406	0.9406	0.9426	Colombia	0.8589	0.8623	0.8623
Barbados	0.9371	0.9371	0.9826	Honduras	0.7450	1.0000	1.0000
El Salvador	0.9342	0.9342	0.9503	Panama	0.7197	0.7206	0.7206
Costa Rica	0.9243	0.9243	0.9243	Peru	0.6527	0.6706	0.6706
Mexico	0.9235	0.9235	0.9235	Bolivia	0.6497	0.8175	0.8197
Peru	0.9222	0.9222	0.9322	Nicaragua	0.5509	0.7564	0.7558
Colombia	0.9131	0.9131	0.9131	Guatemala	0.5092	0.5451	0.5451
Paraguay	0.9019	0.9019	0.9038	Bahamas, The			
Honduras	0.8898	0.8898	0.8898	Brazil			
Suriname	0.8767	0.8767	0.8801	Chile			
Dominican Republic	0.8733	0.8733	0.8850	Cuba			
Ecuador	0.8632	0.8632	0.8773	Mexico			
Guatemala	0.8507	0.8507	0.8507	Paraguay			
Venezuela, RB	0.8279	0.8279	0.8279	Uruguay			
Panama	0.8248	0.8248	0.8248	Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with public health expenditures per capita as only input. Column (2) uses public expenditures and GDP per capita as inputs. Column (3) uses public expenditures, GDP per capita and share of population aged 65+.

Table A 31: DEA efficiency scores using public health expenditure per capita as input *(continued)*

Skilled birth attendance ratio rural/urban			
Country	Input variables		
	Public exp.	+GDP	+ Pop. +65
	(1)	(2)	(3)
Barbados	1.0000	1.0000	1.0000
Dominican Republic	1.0000	1.0000	1.0000
Guyana	1.0000	1.0000	1.0000
Haiti	1.0000	1.0000	1.0000
Jamaica	1.0000	1.0000	1.0000
Cuba	0.9901	0.9901	0.9901
Uruguay	0.9809	0.9833	1.0000
Belize	0.9765	0.9938	0.9938
El Salvador	0.9733	1.0000	1.0000
Costa Rica	0.9614	0.9776	0.9776
Brazil	0.9557	0.9560	0.9560
Ecuador	0.9476	0.9476	0.9537
Nicaragua	0.9392	1.0000	1.0000
Mexico	0.8827	0.8827	0.8827
Suriname	0.8815	0.8815	0.8815
Colombia	0.8750	0.8889	0.8889
Honduras	0.8715	0.9417	0.9417
Panama	0.7725	0.7777	0.7777
Bolivia	0.7722	0.8074	0.8143
Guatemala	0.7669	0.7669	0.7671
Peru	0.7392	0.7392	0.7392
Argentina			
Bahamas, The			
Chile			
Paraguay			
Trinidad and Tobago			
Venezuela, RB			

Notes: Column (1) displays scores for a DEA model with public health expenditures per capita as only input. Column (2) uses public expenditures and GDP per capita as inputs. Column (3) uses public expenditures, GDP per capita and share of population aged 65+.

Table A 32: Simar-Wilson regression results of potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance

	(1)	(2)
Out-of-pocket health expenditure (Perc.)	-0.023	
	(0.023)	
Hospital beds (per 1,000 people)	0.759***	
	(0.288)	
Average governance quality		3.029**
		(1.356)
Average institutional quality		1.692*
		(0.880)
Constant	2.108*	0.395
	(1.230)	(1.149)
Sigma	0.203***	0.313***
	(0.064)	(0.101)
Observations	26	23
Number of efficient units	7	7
Log likelihood, initial truncated regression	47.79	39.031
Model significance, p-value	0.031	0.072
Number of bootstrap repetitions	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 33: Simar-Wilson regression results of potential efficiency determinants using public health expenditure per capita as input, DPT immunization

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	–0.002*			
	(0.001)			
Hospital beds (per 1,000 people)	0.009			
	(0.015)			
Average governance quality		0.067**		0.059**
		(0.029)		(0.025)
Average institutional quality			0.004	0.005
			(0.025)	(0.019)
Constant	1.000***	0.946***	0.931***	0.926***
	(0.068)	(0.020)	(0.068)	(0.049)
Sigma	0.053***	0.051***	0.056***	0.046***
	(0.012)	(0.011)	(0.015)	(0.010)
Observations	27	27	24	24
Number of efficient units	3	3	2	2
Log likelihood, initial truncated regression	43.871	44.785	38.863	42.183
Model significance, p-value	0.103	0.021	0.88	0.06
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 34: Simar-Wilson regression results of potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance ratio poorest/richest

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.013			
	(0.084)			
Hospital beds (per 1,000 people)	0.239			
	(1.272)			
Average governance quality		1.142		1.124
		(5.473)		(2.384)
Average institutional quality			3.148	0.253
			(6.958)	(0.381)
Constant	1.355	1.513	−1.436	0.856
	(8.186)	(7.558)	(24.911)	(4.197)
Sigma	0.267	0.231	0.864	0.223
	(0.288)	(0.279)	(0.885)	(0.150)
Observations	19	19	18	18
Number of efficient units	4	4	4	4
Log likelihood, initial truncated regression	15.66	16.536	14.028	16.494
Model significance, p-value	0.961	0.835	0.651	0.563
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 35: Simar-Wilson regression results of potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance ratio rural/urban

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.007			
	(0.068)			
Hospital beds (per 1,000 people)	0.060			
	(1.089)			
Average governance quality		0.327		0.249
		(4.567)		(2.261)
Average institutional quality			0.185	0.145
			(2.967)	(1.143)
Constant	1.330	1.354	0.796	0.812
	(4.866)	(15.144)	(13.374)	(4.869)
Sigma	0.185	0.202	0.202	0.162
	(0.201)	(0.464)	(0.481)	(0.185)
Observations	21	21	19	19
Number of efficient units	5	5	5	5
Log likelihood, initial truncated regression	22.352	22.065	19.433	20.053
Model significance, p-value	0.977	0.943	0.95	0.991
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 36: Comparison of DEA efficiency scores and country rankings using the 'naïve' and bias-corrected estimation approaches, life expectancy

	Efficiency scores			Efficiency rankings	
Country	Naïve (original)	Bias-corrected	Bias	Naïve (original)	Bias-corrected
CHL	1.000	0.973	0.027	1	3
ECU	1.000	0.980	0.020	1	1
HTI	1.000	0.941	0.059	1	12
NIC	1.000	0.958	0.042	1	6
JAM	0.994	0.975	0.019	5	2
MEX	0.983	0.963	0.020	6	4
PER	0.982	0.962	0.020	7	5
HND	0.978	0.948	0.030	8	10
CUB	0.977	0.958	0.020	9	7
CRI	0.977	0.953	0.024	10	8
DOM	0.968	0.949	0.019	11	9
PRY	0.967	0.947	0.021	12	11
VEN	0.959	0.940	0.019	13	13
PAN	0.955	0.930	0.025	14	16
GTM	0.955	0.931	0.023	15	15
SLV	0.950	0.932	0.018	16	14
URY	0.947	0.927	0.020	17	17
BRB	0.939	0.917	0.022	18	18
ARG	0.937	0.916	0.021	19	19
COL	0.936	0.916	0.020	20	20
BHS	0.925	0.906	0.019	21	21
BLZ	0.921	0.903	0.018	22	22
BRA	0.913	0.889	0.024	23	23
BOL	0.905	0.883	0.022	24	24
GUY	0.889	0.863	0.027	25	25
SUR	0.880	0.858	0.022	26	26
TTO	0.866	0.847	0.020	27	27

Table A 37: Sample averages for selected indicators (enlarged sample)

Country	Country code	Life expectancy at birth (years)	Life expectancy at age 60 (years)	Under-five mortality (per 1,000)	Skilled birth attendance (%)	Skilled birth attendance: ratio poorest/richest	Pooled health expenditure per capita (USD)	GDP per capita (USD)	Smoking prevalence (%)	Average governance quality index
Argentina	ARG	75.9	21.5	13.3	97.5	0.97	896.24	17,818.80	27.9	-0.28
Australia	AUS	82.1	25.0	4.1	100.0	1.00	2,918.06	40,767.79	17.7	1.60
Austria	AUT	81.1	24.0	3.9	100.0	1.00	3,485.63	42,974.85	37.8	1.62
Belgium	BEL	80.5	23.5	4.3	100.0	1.00	2,897.32	40,689.27	25.2	1.29
Bahamas, The	BHS	75.0	21.0	12.8	98.5		1,189.76	24,218.97		1.04
Belize	BLZ	70.0	21.0	17.5	96.2	0.91	289.96	7,907.28		-0.11
Bolivia	BOL	67.7	19.0	41.5	84.4	0.58	193.06	5,137.10	27.8	-0.60
Brazil	BRA	74.0	21.5	16.2	98.1		731.47	13,459.06	17.8	-0.02
Barbados	BRB	75.3	23.0	13.7	99.0	1.00	640.61	15,746.56	7.2	1.16
Botswana	BWA	64.2	18.0	47.3			649.73	12,884.25		0.67
Canada	CAN	81.7	25.0	5.2	99.9	1.00	3,500.02	41,017.11	18.4	1.61
Switzerland	CHE	82.8	25.0	4.2	100.0	1.00	3,545.95	53,930.09	25.5	1.72
Chile	CHL	81.0	24.0	8.4	99.8		717.53	18,614.64	40.6	1.16
China	CHN	75.5	19.0	12.5	99.8		211.71	7,891.74	26.2	-0.53
Cameroon	CMR	54.8	16.5	94.2	64.1	0.19	34.25	2,564.39	14.7	-0.87
Colombia	COL	73.7	24.5	16.9	99.2	0.86	527.77	10,422.95	12.9	-0.42
Costa Rica	CRI	79.1	23.0	10.0	98.4	0.97	778.53	12,261.65	15.4	0.53
Cuba	CUB	79.2	22.0	5.7	99.8		1,628.68	17,449.71	37.3	-0.59
Czech Republic	CZE	78.1	21.5	3.7	100.0	1.00	1,543.66	28,129.87	33.9	0.88
Germany	DEU	80.8	24.0	3.9	100.0	1.00	3,446.81	40,197.33	31.7	1.47
Denmark	DNK	80.2	23.0	3.7	100.0	1.00	3,528.58	44,311.75	22.2	1.86
Dominican Republic	DOM	73.2	22.0	32.1	98.0	1.00	262.07	10,451.26	15.2	-0.36
Ecuador	ECU	75.5	22.0	23.0	92.1	0.82	255.80	9,107.74	9.8	-0.84
Spain	ESP	82.8	25.0	4.3	100.0	1.00	2,263.89	33,953.61	32.0	0.85
Estonia	EST	76.7	21.5	3.5	100.0	1.00	944.73	24,087.69	35.4	1.03
Finland	FIN	80.8	24.0	2.6	100.0	1.00	2,513.57	40,426.75	23.5	1.85
France	FRA	82.2	25.0	4.3	100.0	1.00	3,464.70	37,018.99	29.2	1.25
United Kingdom	GBR	81.0	24.0	4.6	100.0	1.00	2,886.34	37,118.64	22.2	1.42
Ghana	GHA	61.1	17.0	66.6	71.1	0.44	110.77	2,845.96	6.1	0.08
Greece	GRC	81.0	24.0	4.7	100.0	1.00	1,882.61	31,422.24	45.4	0.57
Guatemala	GTM	71.4	21.0	31.1	62.8	0.39	190.49	6,620.69		-0.59
Guyana	GUY	66.3	15.0	40.6	92.4	0.74	171.44	5,407.04		-0.40
Honduras	HND	72.9	22.0	21.9	82.9	0.61	171.00	4,297.14	21.5	-0.59
Haiti	HTI	62.2	17.0	73.1	37.3	0.13	59.35	1,575.17	11.8	-1.14
Hungary	HUN	75.3	20.0	6.2	100.0	1.00	1,155.68	22,760.50	31.7	0.81
Indonesia	IDN	68.6	18.0	29.4	83.1	0.63	108.29	7,790.32	36.3	-0.52

Table A 37: Sample averages for selected indicators (enlarged sample) *(continued)*

Country	Country code	Life expectancy at birth (years)	Life expectancy at age 60 (years)	Under-five mortality (per 1,000)	Skilled birth attendance (%)	Skilled birth attendance: ratio poorest/richest	Pooled health expenditure per capita (USD)	GDP per capita (USD)	Smoking prevalence (%)	Average governance quality index
India	IND	67.5	17.0	52.3		0.25	57.34	3,879.39	13.7	-0.23
Ireland	IRL	80.9	24.0	3.8	100.0	1.00	3,092.34	47,210.98	25.0	1.53
Iceland	ISL	82.3	24.5	2.1	100.0	1.00	2,915.47	40,819.12	19.6	1.62
Israel	ISR	81.9	24.5	4.2	100.0	1.00	1,476.50	28,645.82	31.1	0.56
Italy	ITA	82.5	25.0	3.7	100.0	1.00	2,447.94	36,854.61	24.8	0.56
Jamaica	JAM	75.4	21.0	16.7	99.1	0.96	280.39	8,765.88	18.0	-0.02
Japan	JPN	83.2	26.0	3.0	100.0	1.00	2,458.38	34,351.44	25.1	1.20
Korea, Rep.	KOR	81.5	24.0	3.7	100.0	1.00	1,151.94	28,520.74	29.0	0.73
Sri Lanka	LKA	74.6	20.0	10.2		0.98	135.43	7,738.43	15.0	-0.41
Luxembourg	LUX	81.6	25.0	2.1	100.0	1.00	5,620.41	91,960.83	25.6	1.68
Mexico	MEX	76.4	21.5	14.6	96.0		444.65	15,500.45	16.8	-0.16
Nigeria	NGA	52.3	16.0	116.9	43.4	0.10	93.87	4,714.11	8.2	-1.12
Nicaragua	NIC	74.4	21.0	23.6	88.0	0.42	158.98	4,007.26		-0.58
Netherlands	NLD	81.2	24.0	4.0	100.0	1.00	4,075.04	46,175.82	27.7	1.64
Norway	NOR	81.6	24.0	2.8	100.0	1.00	4,367.87	64,373.93	27.6	1.67
New Zealand	NZL	81.2	25.0	5.9	100.0	1.00	2,635.58	32,514.83		1.74
Panama	PAN	77.3	23.5	18.1	92.5	0.72	709.58	14,346.50	8.7	0.10
Peru	PER	74.2	23.0	18.4	87.2	0.65	253.82	8,984.13	6.9	-0.32
Poland	POL	76.9	21.0	5.3	100.0	1.00	923.33	19,923.76	32.1	0.63
Portugal	PRT	80.6	24.0	3.7	100.0	1.00	1,962.94	27,375.68	23.6	1.00
Paraguay	PRY	72.7	21.0	21.9	95.8		224.46	6,720.16	21.4	-0.72
Russian Federation	RUS	70.2	17.0	10.4			714.38	22,600.96	41.8	-0.73
El Salvador	SLV	72.4	22.0	18.0	98.8	0.93	305.94	7,464.21		-0.13
Suriname	SUR	70.9	23.0	22.7		0.86	677.57	13,649.03		-0.12
Slovak Republic	SVK	76.3	21.0	7.7	100.0	1.00	1,351.12	23,428.42	30.0	0.76
Slovenia	SVN	80.2	23.0	2.8	100.0	1.00	2,072.66	29,072.64	22.1	0.97
Sweden	SWE	81.9	24.0	3.0	100.0	1.00	2,989.16	42,803.33	24.2	1.74
Thailand	THA	74.2	21.0	13.1	99.6	0.98	558.40	12,712.33	22.9	-0.30
Trinidad and Tobago	TTO	70.2	18.0	21.6	100.0	0.98	866.55	30,362.27		0.11
Turkey	TUR	74.8	21.0	15.5	97.4	0.91	705.19	16,219.42	29.7	-0.04
Uruguay	URY	76.8	22.0	11.1	98.9		1,109.70	15,221.37	28.2	0.76
United States	USA	78.8	23.0	6.9	100.0	1.00	6,781.93	49,984.98	19.7	1.26
Venezuela, RB	VEN	74.0	23.0	15.7	96.0		393.87	16,999.37		-1.20
Vietnam	VNM	75.4	22.0	22.9	93.4	0.73	110.68	4,085.05	24.9	-0.54
South Africa	ZAF	56.3	16.5	44.6			816.40	11,991.71	20.3	0.31

Table A 38: Average efficiency scores by output indicator and country (enlarged sample)

	Average efficiency scores by output indicator								Efficiency across all DEA models		Counting low and high performers across models			
Country	Life expectancy at birth	Life expectancy at age 60	Under-five mortality	DALYs lost	Skilled birth attendance	DPT immunization	Skilled birth attendance ratio poorest/richest	Skilled birth attendance ratio rural/urban	Average efficiency	Ranking	Lowest to 25th	From 25 to 75th	75th to highest	Number of DEA models
Argentina	**0.940**	**0.873**	**0.992**	**0.924**	**0.975**	**0.937**	**0.971**		**0.945**	**45**	**5**	**16**	**0**	**21**
Australia	0.987	0.962	0.998	0.976	1.000	0.929	1.000	0.984	0.979	16	0	9	15	24
Austria	0.975	0.923	0.998	0.952	1.000	0.954	1.000	0.986	0.973	27	0	16	8	24
Bahamas, The	**0.919**	**0.840**	**0.991**	**0.856**	**0.985**	**0.978**			**0.928**	**53**	**11**	**7**	**0**	**18**
Barbados	**0.952**	**0.957**	**0.993**	**0.948**	**0.991**	**0.932**	**1.000**	**1.000**	**0.971**	**29**	**0**	**17**	**7**	**24**
Belgium	0.969	0.904	0.998	0.950	1.000	0.998	1.000	0.986	0.976	24	0	12	12	24
Belize	**0.909**	**0.907**	**0.992**	**0.910**	**0.964**	**0.964**	**0.925**	**0.964**	**0.942**	**47**	**8**	**16**	**0**	**24**
Bolivia	**0.891**	**0.846**	**0.974**	**0.768**	**0.877**	**0.973**	**0.675**	**0.752**	**0.845**	**67**	**21**	**3**	**0**	**24**
Botswana	0.808	0.732	0.960	0.497		0.960		0.897	0.809	68	15	3	0	18
Brazil	**0.925**	**0.872**	**0.991**	**0.878**	**0.982**	**0.970**		**0.949**	**0.938**	**49**	**10**	**11**	**0**	**21**
Cameroon	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	0	0	24	24
Canada	0.982	0.962	0.997	0.963	0.999	0.919	1.000	0.984	0.976	23	3	13	8	24
Chile	**1.000**	**0.982**	**0.997**	**0.998**	**0.999**	**0.941**			**0.986**	**10**	**0**	**9**	**9**	**18**
China	0.993	0.844	0.998	1.000	1.000	1.000		1.000	0.976	22	3	2	16	21
Colombia	**0.939**	**1.000**	**0.991**	**0.950**	**0.994**	**0.905**	**0.861**	**0.876**	**0.939**	**48**	**12**	**9**	**3**	**24**
Costa Rica	**0.992**	**0.935**	**0.997**	**0.990**	**0.985**	**0.917**	**0.975**	**0.967**	**0.970**	**31**	**3**	**16**	**5**	**24**
Cuba	**0.981**	**0.885**	**0.999**	**0.935**	**0.998**	**0.996**		**0.990**	**0.969**	**32**	**0**	**13**	**8**	**21**
Czech Republic	0.952	0.852	0.999	0.944	1.000	1.000	1.000	0.984	0.967	36	3	8	13	24
Denmark	0.964	0.885	0.999	0.944	1.000	0.941	1.000	0.985	0.965	37	0	15	9	24
Dominican Republic	**0.953**	**0.955**	**0.977**	**0.932**	**0.981**	**0.865**	**1.000**	**0.978**	**0.955**	**42**	**8**	**13**	**3**	**24**
Ecuador	**0.984**	**0.956**	**0.986**	**0.936**	**0.923**	**0.855**	**0.831**	**0.854**	**0.916**	**54**	**15**	**8**	**1**	**24**
El Salvador	**0.940**	**0.952**	**0.992**	**0.852**	**0.994**	**0.926**	**0.954**	**0.969**	**0.947**	**44**	**6**	**17**	**1**	**24**
Estonia	0.962	0.894	1.000	0.944	1.000	0.962	1.000	0.989	0.969	33	2	7	15	24
Finland	0.972	0.923	1.000	0.951	1.000	0.994	1.000	0.986	0.978	18	0	11	13	24
France	0.988	0.962	0.998	0.960	1.000	0.996	1.000	0.986	0.986	11	0	8	16	24
Germany	0.972	0.923	0.998	0.958	1.000	0.973	1.000	0.988	0.977	21	0	15	9	24
Ghana	0.861	0.838	0.971	0.703	0.920	0.986	0.852	0.864	0.875	63	16	2	6	24
Greece	0.986	0.946	0.998	0.973	1.000	1.000	1.000	0.987	0.986	9	0	9	15	24
Guatemala	**0.937**	**0.931**	**0.981**	**0.851**	**0.641**	**0.842**	**0.420**	**0.674**	**0.785**	**69**	**20**	**4**	**0**	**24**
Guyana	**0.873**	**0.670**	**0.974**	**0.613**	**0.961**	**0.976**	**0.849**	**0.949**	**0.858**	**66**	**19**	**5**	**0**	**24**
Haiti	**0.973**	**0.976**	**0.992**	**0.909**	**0.835**	**0.900**	**0.416**	**0.876**	**0.860**	**65**	**9**	**1**	**14**	**24**
Honduras	**0.963**	**0.991**	**0.996**	**0.932**	**0.874**	**0.886**	**0.755**	**0.827**	**0.903**	**57**	**13**	**6**	**5**	**24**
Hungary	0.938	0.817	0.998	0.895	1.000	1.000	1.000	0.987	0.954	43	7	5	12	24
Iceland	0.990	0.942	1.000	0.982	1.000	0.923	1.000	0.983	0.978	19	3	5	16	24
India	1.000	0.938	1.000	1.000		0.949	0.679	0.823	0.913	55	6	6	9	21
Indonesia	0.914	0.825	0.995	0.915	0.899	0.862	0.819	0.925	0.894	59	19	5	0	24
Ireland	0.974	0.923	0.998	0.957	1.000	0.964	1.000	0.983	0.975	25	0	16	8	24
Israel	0.999	0.971	0.999	0.999	1.000	0.949	1.000	0.983	0.987	6	0	6	18	24
Italy	0.992	0.962	0.999	0.985	1.000	0.967	1.000	0.988	0.987	7	0	5	19	24
Jamaica	**0.983**	**0.918**	**0.993**	**0.891**	**0.993**	**0.937**	**0.979**	**0.983**	**0.960**	**40**	**3**	**20**	**1**	**24**
Japan	1.000	1.000	1.000	1.000	1.000	0.982	1.000	0.989	0.996	2	0	2	22	24
Korea, Rep.	1.000	0.961	1.000	1.000	1.000	0.998	1.000	0.983	0.993	3	0	3	21	24
Luxembourg	0.981	0.962	1.000	0.965	1.000	1.000	1.000	0.984	0.986	8	0	6	18	24
Mexico	**0.974**	**0.894**	**0.993**	**0.952**	**0.961**	**0.915**		**0.876**	**0.938**	**50**	**9**	**12**	**0**	**21**
Netherlands	0.977	0.923	0.998	0.964	1.000	0.974	1.000	0.985	0.977	20	0	16	8	24
New Zealand	0.979	0.964	0.997	0.969	1.000	0.939	1.000	0.983	0.979	17	0	12	12	24
Nicaragua	**0.988**	**0.954**	**0.995**	**0.943**	**0.942**	**0.997**	**0.541**	**0.869**	**0.904**	**56**	**10**	**7**	**7**	**24**
Nigeria	0.717	0.770	0.912	0.235	0.499	0.519	0.156	0.503	0.539	71	24	0	0	24
Norway	0.981	0.923	0.999	0.954	1.000	0.952	1.000	0.984	0.974	26	0	15	9	24
Panama	**0.965**	**0.954**	**0.989**	**0.930**	**0.925**	**0.818**	**0.720**	**0.774**	**0.884**	**62**	**15**	**9**	**0**	**24**
Paraguay	**0.951**	**0.923**	**0.990**	**0.930**	**0.973**	**0.895**			**0.944**	**46**	**9**	**9**	**0**	**18**
Peru	**0.967**	**1.000**	**0.991**	**0.968**	**0.874**	**0.913**	**0.657**	**0.727**	**0.887**	**61**	**14**	**6**	**4**	**24**
Poland	0.957	0.862	0.999	0.945	1.000	0.996	1.000	0.984	0.968	34	2	9	13	24
Portugal	0.982	0.944	0.999	0.973	1.000	0.990	1.000	0.987	0.984	13	0	10	14	24
Russian Federation	0.881	0.707	0.995	0.775		0.987			0.869	64	9	5	1	15
Slovak Republic	0.934	0.835	0.996	0.911	1.000	0.988	1.000	0.983	0.956	41	6	9	9	24
Slovenia	0.972	0.896	1.000	0.950	1.000	0.964	1.000	0.985	0.971	30	0	13	11	24
South Africa	0.707	0.670	0.962	0.418		0.695			0.690	70	15	0	0	15
Spain	0.998	0.967	0.998	0.989	1.000	0.978	1.000	0.986	0.989	5	0	7	17	24
Sri Lanka	0.988	0.905	1.000	0.995		1.000	1.000	1.000	0.984	14	0	4	17	21
Suriname	**0.888**	**0.934**	**0.984**	**0.902**		**0.869**	**0.862**	**0.869**	**0.901**	**58**	**18**	**3**	**0**	**21**
Sweden	0.984	0.923	0.999	0.969	1.000	0.990	1.000	0.986	0.981	15	0	10	14	24
Switzerland	0.995	0.962	0.998	0.977	1.000	0.972	1.000	0.985	0.986	12	0	8	16	24
Thailand	0.938	0.866	0.994	0.920	0.997	1.000	0.987	0.990	0.962	38	5	14	5	24
Trinidad and Tobago	**0.865**	**0.727**	**0.983**	**0.771**	**1.000**	**0.933**	**0.977**		**0.894**	**60**	**12**	**6**	**3**	**21**
Turkey	0.929	0.852	0.991	0.906	0.975	0.978	0.912	0.919	0.933	52	19	5	0	24
United Kingdom	0.974	0.923	0.998	0.945	1.000	0.962	1.000	0.985	0.973	28	0	16	8	24
United States	0.948	0.885	0.995	0.916	1.000	0.958	1.000	0.983	0.961	39	1	15	8	24
Uruguay	**0.967**	**0.907**	**0.996**	**0.961**	**0.993**	**0.963**		**0.988**	**0.968**	**35**	**0**	**16**	**5**	**21**
Venezuela, RB	**0.948**	**0.968**	**0.992**	**0.922**	**0.961**	**0.820**			**0.935**	**51**	**6**	**9**	**3**	**18**
Vietnam	1.000	1.000	1.000	1.000	1.000	0.945	0.976	1.000	0.990	4	0	4	20	24

(light grey)	Below 25th percentile
(dark grey)	Above 75th percentile

Table A 39: Average efficiency scores and country rankings for selected DEA models (enlarged sample)

	Efficiency across 7 DEA models (excludes life expectancy at age 60)		Efficiency across 5 DEA models (excludes all skilled birth attendance indicators)	
Country	Average efficiency (1)	Ranking (2)	Average efficiency (3)	Ranking (4)
Argentina	**0.957**	**43**	**0.933**	**52**
Australia	0.982	26	0.970	18
Austria	0.981	30	0.960	31
Bahamas, The	**0.946**	**49**	**0.917**	**60**
Barbados	**0.974**	**39**	**0.956**	**37**
Belgium	0.986	18	0.964	28
Belize	**0.947**	**48**	**0.936**	**50**
Bolivia	**0.844**	**66**	**0.890**	**64**
Botswana	0.824	68	0.791	69
Brazil	**0.949**	**45**	**0.927**	**59**
Cameroon	1.000	1	1.000	1
Canada	0.978	34	0.965	27
Chile	**0.987**	**16**	**0.984**	**6**
China	0.998	2	0.967	24
Colombia	**0.931**	**52**	**0.957**	**35**
Costa Rica	**0.975**	**37**	**0.966**	**25**
Cuba	**0.983**	**21**	**0.959**	**33**
Czech Republic	0.983	23	0.950	42
Denmark	0.976	35	0.946	43
Dominican Republic	**0.955**	**44**	**0.936**	**51**
Ecuador	**0.910**	**55**	**0.943**	**47**
El Salvador	**0.947**	**47**	**0.932**	**54**
Estonia	0.980	32	0.952	39
Finland	0.986	17	0.968	20
France	0.990	13	0.981	10
Germany	0.984	20	0.965	26
Ghana	0.880	63	0.872	65
Greece	0.992	7	0.981	12
Guatemala	**0.764**	**69**	**0.909**	**62**
Guyana	**0.885**	**62**	**0.821**	**68**
Haiti	**0.843**	**67**	**0.950**	**41**
Honduras	**0.891**	**61**	**0.954**	**38**
Hungary	0.974	38	0.930	58
Iceland	0.983	24	0.967	22
India	0.908	57	0.977	15
Indonesia	0.904	58	0.902	63
Ireland	0.982	25	0.963	29
Israel	0.990	11	0.983	7
Italy	0.990	8	0.981	9
Jamaica	**0.966**	**42**	**0.945**	**45**
Japan	0.996	5	0.996	2
Korea, Rep.	0.997	4	0.992	3
Luxembourg	0.990	10	0.982	8
Mexico	**0.945**	**50**	**0.946**	**44**
Netherlands	0.985	19	0.967	23
New Zealand	0.981	29	0.970	19
Nicaragua	**0.896**	**59**	**0.975**	**16**
Nigeria	0.506	71	0.631	71
Norway	0.981	28	0.962	30
Panama	**0.875**	**64**	**0.931**	**56**
Paraguay	**0.948**	**46**	**0.938**	**49**
Peru	**0.871**	**65**	**0.968**	**21**
Poland	0.983	22	0.952	40
Portugal	0.990	9	0.978	13
Russian Federation	0.909	56	0.869	66
Slovak Republic	0.973	40	0.933	53
Slovenia	0.982	27	0.956	36
South Africa	0.695	70	0.690	70
Spain	0.993	6	0.986	5
Sri Lanka	0.997	3	0.978	14
Suriname	**0.896**	**60**	**0.915**	**61**
Sweden	0.990	12	0.973	17
Switzerland	0.990	14	0.981	11
Thailand	0.975	36	0.944	46
Trinidad and Tobago	**0.921**	**54**	**0.856**	**67**
Turkey	0.944	51	0.931	55
United Kingdom	0.980	31	0.960	32
United States	0.971	41	0.940	48
Uruguay	**0.978**	**33**	**0.959**	**34**
Venezuela, RB	**0.929**	**53**	**0.930**	**57**
Vietnam	0.989	15	0.989	4

(light grey)	Below 25th percentile
(dark grey)	Above 75th percentile

Table A 40: DEA efficiency scores using smoking prevalence as additional input (enlarged sample)

Life expectancy at birth		Life expectancy at age 60		Under-five mortality		DALYs lost	
Country	Efficiency score	Country	Efficiency score	Country	Efficiency score	Country	Efficiency score
Cameroon	1.0000	**Barbados**	**1.0000**	Cameroon	1.0000	Cameroon	1.0000
Chile	**1.0000**	Cameroon	1.0000	**Chile**	**1.0000**	**Chile**	**1.0000**
China	1.0000	**Chile**	**1.0000**	China	1.0000	China	1.0000
Costa Rica	**1.0000**	**Colombia**	**1.0000**	**Cuba**	**1.0000**	**Costa Rica**	**1.0000**
Cuba	**1.0000**	Estonia	1.0000	Estonia	1.0000	Estonia	1.0000
Estonia	1.0000	Greece	1.0000	Finland	1.0000	Greece	1.0000
Greece	1.0000	**Haiti**	**1.0000**	Greece	1.0000	**Haiti**	**1.0000**
Haiti	**1.0000**	Indonesia	1.0000	**Haiti**	**1.0000**	India	1.0000
India	1.0000	Japan	1.0000	**Honduras**	**1.0000**	Indonesia	1.0000
Indonesia	1.0000	Vietnam	1.0000	Iceland	1.0000	Israel	1.0000
Japan	1.0000	**Honduras**	**0.9962**	India	1.0000	Japan	1.0000
Spain	1.0000	Spain	0.9883	Indonesia	1.0000	Korea, Rep.	1.0000
Uruguay	**1.0000**	Israel	0.9825	Japan	1.0000	Spain	1.0000
Vietnam	1.0000	France	0.9776	Luxembourg	1.0000	**Uruguay**	**1.0000**
Korea, Rep.	0.9993	Korea, Rep.	0.9721	Russian Federation	1.0000	Vietnam	1.0000
Israel	0.9991	Austria	0.9705	Slovenia	1.0000	Sri Lanka	0.9966
Switzerland	0.9957	Luxembourg	0.9645	Sri Lanka	1.0000	Italy	0.9853
Italy	0.9917	Switzerland	0.9640	**Uruguay**	**1.0000**	Iceland	0.9815
Sri Lanka	0.9912	**Ecuador**	**0.9620**	Vietnam	1.0000	Portugal	0.9803
France	0.9910	Italy	0.9618	Poland	0.9999	Austria	0.9802
Jamaica	**0.9904**	Australia	0.9615	Austria	0.9999	Switzerland	0.9779
Iceland	0.9904	Canada	0.9615	Czech Republic	0.9997	Australia	0.9763
Portugal	0.9899	**Dominican Republic**	**0.9604**	Norway	0.9997	Germany	0.9732
Austria	0.9892	**Uruguay**	**0.9568**	Korea, Rep.	0.9997	**Cuba**	**0.9724**
Australia	0.9872	Portugal	0.9561	Sweden	0.9997	**Barbados**	**0.9697**
Sweden	0.9844	**Panama**	**0.9537**	Germany	0.9995	Netherlands	0.9696
Ecuador	**0.9843**	Germany	0.9476	Portugal	0.9995	Sweden	0.9691
Norway	0.9827	Iceland	0.9423	Italy	0.9992	France	0.9686
Canada	0.9820	India	0.9413	Israel	0.9990	Poland	0.9681
Luxembourg	0.9818	**Cuba**	**0.9405**	Spain	0.9989	Luxembourg	0.9667
Germany	0.9799	**Costa Rica**	**0.9403**	Denmark	0.9987	Canada	0.9628
Netherlands	0.9787	**Jamaica**	**0.9397**	Netherlands	0.9987	Norway	0.9593
Poland	0.9782	Netherlands	0.9333	Ireland	0.9987	Ireland	0.9576
Barbados	**0.9772**	Norway	0.9330	France	0.9987	**Colombia**	**0.9553**
United Kingdom	0.9739	**Paraguay**	**0.9263**	Belgium	0.9985	Slovenia	0.9545
Mexico	**0.9738**	Ireland	0.9239	Switzerland	0.9984	**Mexico**	**0.9524**
Ireland	0.9737	Finland	0.9231	**Costa Rica**	**0.9982**	Czech Republic	0.9523
Slovenia	0.9732	Sweden	0.9231	Australia	0.9981	Belgium	0.9513
Finland	0.9717	United Kingdom	0.9231	United Kingdom	0.9979	Finland	0.9508
Panama	**0.9704**	Sri Lanka	0.9098	Hungary	0.9978	United Kingdom	0.9445
Belgium	0.9688	Belgium	0.9053	Canada	0.9971	Denmark	0.9436
Hungary	0.9668	**Mexico**	**0.8987**	Slovak Republic	0.9960	**Honduras**	**0.9419**
Honduras	**0.9650**	Slovenia	0.8960	United States	0.9953	**Paraguay**	**0.9364**
Denmark	0.9642	Poland	0.8929	Thailand	0.9949	**Ecuador**	**0.9355**
Dominican Republic	**0.9534**	Thailand	0.8919	**Jamaica**	**0.9944**	**Panama**	**0.9354**
Czech Republic	0.9523	**Argentina**	**0.8877**	**Barbados**	**0.9932**	**Dominican Republic**	**0.9318**
Paraguay	**0.9514**	Denmark	0.8846	**Mexico**	**0.9930**	**Argentina**	**0.9313**
United States	0.9476	United States	0.8846	**Paraguay**	**0.9927**	Hungary	0.9307
Argentina	**0.9459**	**Bolivia**	**0.8799**	**Argentina**	**0.9926**	Thailand	0.9234
Colombia	**0.9436**	**Brazil**	**0.8759**	**Colombia**	**0.9920**	Slovak Republic	0.9192
Thailand	0.9429	Ghana	0.8704	Turkey	0.9917	United States	0.9161
Slovak Republic	0.9340	Turkey	0.8657	**Brazil**	**0.9915**	Turkey	0.9096
Turkey	0.9315	Czech Republic	0.8640	**Panama**	**0.9892**	**Jamaica**	**0.8922**
Brazil	**0.9313**	Hungary	0.8602	**Ecuador**	**0.9865**	**Brazil**	**0.8846**
Bolivia	**0.9184**	China	0.8590	**Bolivia**	**0.9825**	**Bolivia**	**0.8095**
Russian Federation	0.9059	Slovak Republic	0.8450	Ghana	0.9801	Russian Federation	0.7995
Ghana	0.8864	Nigeria	0.7696	**Dominican Republic**	**0.9768**	Ghana	0.7605
Nigeria	0.7169	Russian Federation	0.7403	South Africa	0.9634	South Africa	0.4231
South Africa	0.7141	South Africa	0.6808	Nigeria	0.9125	Nigeria	0.2349
Bahamas, The		**Bahamas, The**		**Bahamas, The**		**Bahamas, The**	
Belize		**Belize**		**Belize**		**Belize**	
Botswana		Botswana		Botswana		Botswana	
El Salvador		**El Salvador**		**El Salvador**		**El Salvador**	
Guatemala		**Guatemala**		**Guatemala**		**Guatemala**	
Guyana		**Guyana**		**Guyana**		**Guyana**	
New Zealand		New Zealand		New Zealand		New Zealand	
Nicaragua		**Nicaragua**		**Nicaragua**		**Nicaragua**	
Peru		**Peru**		**Peru**		**Peru**	
Suriname		**Suriname**		**Suriname**		**Suriname**	
Trinidad and Tobago		**Trinidad and Tobago**		**Trinidad and Tobago**		**Trinidad and Tobago**	
Venezuela, RB		**Venezuela, RB**		**Venezuela, RB**		**Venezuela, RB**	

Note: Estimated efficiency scores for a DEA model with four inputs: pooled health expenditure per capita, GDP per capita, share of population aged 65+ and smoking prevalence in the general population.

Table A 40: DEA efficiency scores using smoking prevalence as additional input (enlarged sample) *(continued)*

Skilled birth attendance		DPT immunization		Skilled birth attendance ratio poorest/richest		Skilled birth attendance ratio rural/urban	
Country	Efficiency score	Country	Efficiency score	Country	Efficiency score	Country	Efficiency score
Australia	1.0000	**Bolivia**	**1.0000**	Australia	1.0000	**Barbados**	**1.0000**
Austria	1.0000	Cameroon	1.0000	Austria	1.0000	Cameroon	1.0000
Belgium	1.0000	**Chile**	**1.0000**	**Barbados**	**1.0000**	China	1.0000
Cameroon	1.0000	China	1.0000	Belgium	1.0000	**Cuba**	**1.0000**
Chile	**1.0000**	**Cuba**	**1.0000**	Cameroon	1.0000	Estonia	1.0000
China	1.0000	Czech Republic	1.0000	Canada	1.0000	Greece	1.0000
Cuba	**1.0000**	Estonia	1.0000	Czech Republic	1.0000	**Haiti**	**1.0000**
Czech Republic	1.0000	Ghana	1.0000	Denmark	1.0000	Indonesia	1.0000
Denmark	1.0000	Greece	1.0000	**Dominican Republic**	**1.0000**	Japan	1.0000
Estonia	1.0000	**Haiti**	**1.0000**	Estonia	1.0000	Sri Lanka	1.0000
Finland	1.0000	Hungary	1.0000	Finland	1.0000	**Uruguay**	**1.0000**
France	1.0000	Indonesia	1.0000	France	1.0000	Vietnam	1.0000
Germany	1.0000	Japan	1.0000	Germany	1.0000	Germany	0.9990
Ghana	1.0000	Luxembourg	1.0000	Ghana	1.0000	Poland	0.9978
Greece	1.0000	Russian Federation	1.0000	Greece	1.0000	Italy	0.9977
Haiti	**1.0000**	Sri Lanka	1.0000	Hungary	1.0000	Hungary	0.9974
Hungary	1.0000	Thailand	1.0000	Iceland	1.0000	Austria	0.9963
Iceland	1.0000	Vietnam	1.0000	Indonesia	1.0000	Thailand	0.9961
Indonesia	1.0000	Belgium	0.9980	Ireland	1.0000	Portugal	0.9953
Ireland	1.0000	Korea, Rep.	0.9980	Israel	1.0000	Spain	0.9946
Israel	1.0000	France	0.9960	Italy	1.0000	Sweden	0.9943
Italy	1.0000	Poland	0.9960	**Jamaica**	**1.0000**	France	0.9939
Japan	1.0000	Finland	0.9939	Japan	1.0000	Belgium	0.9936
Korea, Rep.	1.0000	Portugal	0.9937	Korea, Rep.	1.0000	Czech Republic	0.9934
Luxembourg	1.0000	Sweden	0.9899	Luxembourg	1.0000	Switzerland	0.9926
Netherlands	1.0000	Slovak Republic	0.9879	Netherlands	1.0000	Finland	0.9924
Norway	1.0000	Germany	0.9808	Norway	1.0000	Korea, Rep.	0.9924
Poland	1.0000	Spain	0.9778	Poland	1.0000	Slovenia	0.9917
Portugal	1.0000	Turkey	0.9778	Portugal	1.0000	Netherlands	0.9915
Slovak Republic	1.0000	**Uruguay**	**0.9750**	Slovak Republic	1.0000	United Kingdom	0.9915
Slovenia	1.0000	Italy	0.9748	Slovenia	1.0000	Norway	0.9914
Spain	1.0000	Netherlands	0.9737	Spain	1.0000	Denmark	0.9914
Sweden	1.0000	Switzerland	0.9717	Sri Lanka	1.0000	Israel	0.9906
Switzerland	1.0000	**Brazil**	**0.9697**	Sweden	1.0000	Slovak Republic	0.9906
United Kingdom	1.0000	Ireland	0.9636	Switzerland	1.0000	Luxembourg	0.9903
United States	1.0000	Slovenia	0.9636	Thailand	1.0000	Ireland	0.9887
Uruguay	**1.0000**	United Kingdom	0.9616	United Kingdom	1.0000	Canada	0.9876
Vietnam	1.0000	United States	0.9576	United States	1.0000	United States	0.9874
Canada	0.9990	India	0.9543	Vietnam	1.0000	Australia	0.9871
Thailand	0.9972	Austria	0.9535	**Costa Rica**	**0.9763**	Iceland	0.9870
Colombia	**0.9937**	Norway	0.9515	**Argentina**	**0.9720**	**Jamaica**	**0.9840**
Jamaica	**0.9928**	Israel	0.9495	Turkey	0.9568	**Dominican Republic**	**0.9785**
Barbados	**0.9909**	Denmark	0.9414	**Colombia**	**0.8620**	**Costa Rica**	**0.9698**
Costa Rica	**0.9853**	**Argentina**	**0.9374**	**Ecuador**	**0.8331**	**Brazil**	**0.9530**
Brazil	**0.9820**	**Jamaica**	**0.9374**	**Honduras**	**0.8219**	Ghana	0.9490
Dominican Republic	**0.9813**	**Barbados**	**0.9359**	**Bolivia**	**0.7729**	Turkey	0.9331
Paraguay	**0.9794**	**Honduras**	**0.9332**	**Panama**	**0.7206**	**Colombia**	**0.8781**
Argentina	**0.9749**	Australia	0.9293	India	0.6780	**Mexico**	**0.8769**
Turkey	0.9746	Iceland	0.9232	**Haiti**	**0.4577**	**Ecuador**	**0.8538**
Mexico	**0.9613**	Canada	0.9192	Nigeria	0.1579	**Honduras**	**0.8471**
Bolivia	**0.9300**	**Costa Rica**	**0.9172**	**Bahamas, The**		India	0.8249
Panama	**0.9254**	**Mexico**	**0.9152**	**Belize**		**Bolivia**	**0.8007**
Ecuador	**0.9227**	**Colombia**	**0.9051**	Botswana		**Panama**	**0.7752**
Honduras	**0.8847**	**Paraguay**	**0.9046**	**Brazil**		Nigeria	0.5029
Nigeria	0.4993	**Dominican Republic**	**0.8646**	**Chile**		**Argentina**	
Bahamas, The		**Ecuador**	**0.8545**	China		**Bahamas, The**	
Belize		**Panama**	**0.8182**	**Cuba**		**Belize**	
Botswana		South Africa	0.6950	**El Salvador**		Botswana	
El Salvador		Nigeria	0.5214	**Guatemala**		**Chile**	
Guatemala		**Bahamas, The**		**Guyana**		**El Salvador**	
Guyana		**Belize**		**Mexico**		**Guatemala**	
India		Botswana		New Zealand		**Guyana**	
New Zealand		**El Salvador**		**Nicaragua**		New Zealand	
Nicaragua		**Guatemala**		**Paraguay**		**Nicaragua**	
Peru		**Guyana**		**Peru**		**Paraguay**	
Russian Federation		New Zealand		Russian Federation		**Peru**	
South Africa		**Nicaragua**		South Africa		Russian Federation	
Sri Lanka		**Peru**		**Suriname**		South Africa	
Suriname		**Suriname**		**Trinidad and Tobago**		**Suriname**	
Trinidad and Tobago		**Trinidad and Tobago**		**Uruguay**		**Trinidad and Tobago**	
Venezuela, RB		**Venezuela, RB**		**Venezuela, RB**		**Venezuela, RB**	

Note: Estimated efficiency scores for a DEA model with four inputs: pooled health expenditure per capita, GDP per capita, share of population aged 65+ and smoking prevalence in the general population.

Table A 41: Multi-output DEA efficiency scores (enlarged sample)

Multiple outputs Life expectancy at birth, DPT immunization and Skilled birth attendance ratio poorest/richest			
	Input variables		
Country	Pooled exp. (1)	+GDP (2)	+ Pop. +65 (3)
Australia	1.0000	1.0000	1.0000
Austria	1.0000	1.0000	1.0000
Barbados	**1.0000**	**1.0000**	**1.0000**
Belgium	1.0000	1.0000	1.0000
Cameroon	1.0000	1.0000	1.0000
Canada	1.0000	1.0000	1.0000
Costa Rica	**1.0000**	**1.0000**	**1.0000**
Czech Republic	1.0000	1.0000	1.0000
Denmark	1.0000	1.0000	1.0000
Dominican Republic	**1.0000**	**1.0000**	**1.0000**
Estonia	1.0000	1.0000	1.0000
Finland	1.0000	1.0000	1.0000
France	1.0000	1.0000	1.0000
Germany	1.0000	1.0000	1.0000
Greece	1.0000	1.0000	1.0000
Hungary	1.0000	1.0000	1.0000
Iceland	1.0000	1.0000	1.0000
India	1.0000	1.0000	1.0000
Ireland	1.0000	1.0000	1.0000
Israel	1.0000	1.0000	1.0000
Italy	1.0000	1.0000	1.0000
Japan	1.0000	1.0000	1.0000
Korea, Rep.	1.0000	1.0000	1.0000
Luxembourg	1.0000	1.0000	1.0000
Netherlands	1.0000	1.0000	1.0000
New Zealand	1.0000	1.0000	1.0000
Norway	1.0000	1.0000	1.0000
Poland	1.0000	1.0000	1.0000
Portugal	1.0000	1.0000	1.0000
Slovak Republic	1.0000	1.0000	1.0000
Slovenia	1.0000	1.0000	1.0000
Spain	1.0000	1.0000	1.0000
Sri Lanka	1.0000	1.0000	1.0000
Sweden	1.0000	1.0000	1.0000
Switzerland	1.0000	1.0000	1.0000
Thailand	1.0000	1.0000	1.0000
United Kingdom	1.0000	1.0000	1.0000
United States	1.0000	1.0000	1.0000
Vietnam	1.0000	1.0000	1.0000
Jamaica	**0.9963**	**0.9963**	**1.0000**
Nicaragua	**0.9941**	**1.0000**	**1.0000**
Ecuador	**0.9935**	**0.9935**	**0.9935**
Panama	**0.9799**	**0.9810**	**0.9810**
Turkey	0.9778	0.9778	0.9778
Trinidad and Tobago	**0.9771**	**0.9771**	**0.9771**
Peru	**0.9761**	**0.9761**	**0.9761**
Guyana	**0.9717**	**1.0000**	**1.0000**
Argentina	**0.9710**	**0.9780**	**0.9780**
Bolivia	**0.9677**	**0.9747**	**0.9784**
Belize	**0.9636**	**0.9636**	**0.9636**
Honduras	**0.9633**	**0.9671**	**0.9671**
Ghana	0.9594	1.0000	1.0000
El Salvador	**0.9543**	**0.9684**	**0.9684**
Colombia	**0.9499**	**0.9530**	**0.9530**
Guatemala	**0.9407**	**0.9407**	**0.9407**
Indonesia	0.9205	0.9205	0.9205
Haiti	**0.9180**	**1.0000**	**1.0000**
Suriname	**0.9035**	**0.9071**	**0.9071**
Nigeria	0.7169	0.7169	0.7169
Bahamas, The			
Botswana			
Brazil			
Chile			
China			
Cuba			
Mexico			
Paraguay			
Russian Federation			
South Africa			
Uruguay			
Venezuela, RB			

Table A 42: Composite indicators of health system quality for the enlarged sample: construction, year and sources

Indicator	Year	Source	Definition
Medium term sectoral vision	2013	PRODEV (LAC); Government at a Glance online database (OECD)	Index ranges from 0 (worst) to 5 (best). Comparable figures have been constructed using the following indicators: (1) "Medium term sectoral vision in line with the government plan" for LAC countries, and (2) "Medium term expenditure frameworks" for OECD countries. The first indicator's original scale was from 0 to 5 and the second indicator's scale was from 0 to 1. Mexico has been used as a pivot for the rescaling of indicators because this country is included in both the LAC and OECD sources. Mexico has an indicator value of 0.56 in the OECD original scale and 4.2 in the LAC original scale, so the ratio between both values is 7.5. Based on this ratio, the values of the original indicators for all countries have been rescaled from 0 to 5 again to achieve comparability. Chile, the other country included in both data sources, has been used to check further for consistency and equivalence.
Setting and monitoring plans and objectives	2009 (OECD); 2013 (LAC)	PRODEV (LAC); Health Systems Characteristics Survey (OECD)	Index ranges from 0 (worst) to 5 (best). Comparable figures have been constructed using the following indicators: (1) Simple average of sub-indicators 1 and 2 of the "Results-based management in the production of goods and services" for LAC countries, and (2) "Setting and monitoring public health objectives" for OECD countries. The first indicator's original scale was from 0 to 5 and the second indicator's scale was from 0 to 6. Mexico has been used as pivot for the rescaling of indicators because this country is the only country included in both the LAC and OECD sources. Mexico has an indicator value of 0.72 in the OECD original scale and 3.5 in the LAC original scale, so the ratio between both values is 4.86. Based on this ratio, the values of the original indicators for all countries have been rescaled from 0 to 5 again to achieve comparability.

Table A 43: Potential efficiency determinants, life expectancy at birth (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				0.002
	(0.005)				(0.001)
Hospital beds (per 1,000 people)	0.023				−0.003
	(0.076)				(0.006)
Average governance quality		0.623		0.021	0.038*
		(2.323)		(0.020)	(0.022)
Medium term sectoral vision			0.027	0.016	0.019
			(0.017)	(0.014)	(0.012)
Setting and monitoring plans and objectives			0.008	0.003	0.003
			(0.013)	(0.011)	(0.012)
Constant	0.958	2.163	0.908***	0.932***	0.876***
	(1.059)	(6.931)	(0.036)	(0.043)	(0.047)
Sigma	0.079	0.265	0.046***	0.044***	0.041***
	(0.056)	(0.282)	(0.013)	(0.012)	(0.009)
Observations	66	71	46	46	45
Number of efficient units	4	5	2	2	2
Log likelihood, initial truncated regression	132.42	133.786	102.125	102.936	101.474
Model significance, p-value	0.94	0.789	0.264	0.275	0.198
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 44: Potential efficiency determinants, life expectancy at age 60 (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				0.003
	(0.002)				(0.003)
Hospital beds (per 1,000 people)	−0.003				−0.009
	(0.009)				(0.012)
Average governance quality		0.045*		0.021	0.055
		(0.027)		(0.050)	(0.044)
Medium term sectoral vision			0.012	0.002	0.013
			(0.036)	(0.071)	(0.029)
Setting and monitoring plans and objectives			0.006	0.001	0.001
			(0.107)	(0.031)	(0.019)
Constant	0.958***	0.943***	0.947***	0.968***	0.861***
	(0.075)	(0.049)	(0.317)	(0.253)	(0.112)
Sigma	0.099***	0.106***	0.099**	0.098***	0.093***
	(0.020)	(0.023)	(0.042)	(0.038)	(0.022)
Observations	66	71	46	46	45
Number of efficient units	5	5	3	3	3
Log likelihood, initial truncated regression	86.372	91.445	66.155	66.325	65.258
Model significance, p-value	0.875	0.094	0.917	0.949	0.828
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 45: Potential efficiency determinants, under-five mortality (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				
	(0.001)				
Hospital beds (per 1,000 people)	0.026				0.001
	(0.017)				(0.001)
Average governance quality		1.427***		0.009***	0.008**
		(0.349)		(0.003)	(0.004)
Medium term sectoral vision			0.010**	0.004*	0.003*
			(0.004)	(0.002)	(0.002)
Setting and monitoring plans and objectives			0.005	0.001	0.001
			(0.004)	(0.002)	(0.002)
Constant	0.946***	2.989***	0.973***	0.985***	0.980***
	(0.028)	(0.535)	(0.007)	(0.005)	(0.008)
Sigma	0.017***	0.124***	0.008***	0.006***	0.006***
	(0.006)	(0.030)	(0.002)	(0.001)	(0.001)
Observations	66	71	46	46	45
Number of efficient units	5	7	0	0	0
Log likelihood, initial truncated regression	260.101	255.629	198.121	205.154	201.502
Model significance, p-value	0.286	0	0.064	0.002	0.018
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 46: Potential efficiency determinants, DALYs lost (enlarged sample)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	0.087			0.002
	(0.098)			(0.003)
Hospital beds (per 1,000 people)	1.677*			−0.015
	(0.868)			(0.022)
Medium term sectoral vision		0.095	0.047	0.052
		(0.523)	(0.097)	(0.046)
Setting and monitoring plans and objectives		0.025	−0.000	−0.001
		(0.083)	(0.062)	(0.031)
Average governance quality			0.084	0.115
			(0.256)	(0.070)
Constant	5.416	0.811	0.901	0.866***
	(7.291)	(1.400)	(0.580)	(0.165)
Sigma	1.004***	0.121	0.109*	0.106***
	(0.383)	(0.105)	(0.059)	(0.029)
Observations	66	46	46	45
Number of efficient units	5	2	2	2
Log likelihood, initial truncated regression	91.712	75.751	77.122	75.074
Model significance, p-value	0.154	0.879	0.969	0.516
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 47: Potential efficiency determinants, skilled birth attendance (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.013				−0.012*
	(0.013)				(0.007)
Hospital beds (per 1,000 people)	0.387				0.108
	(0.261)				(0.094)
Average governance quality		2.27		0.912	0.206
		(1.636)		(0.555)	(0.196)
Medium term sectoral vision			1.980*	0.268	0.103
			(1.191)	(0.214)	(0.095)
Setting and monitoring plans and objectives			2.347	−0.867	−0.020
			(2.607)	(0.717)	(0.413)
Constant	1.257*	3.528	0.842	1.653***	1.328***
	(0.655)	(2.199)	(2.204)	(0.636)	(0.422)
Sigma	0.142***	0.301**	0.511***	0.151***	0.105***
	(0.054)	(0.125)	(0.158)	(0.048)	(0.027)
Observations	63	65	45	45	44
Number of efficient units	33	34	21	21	20
Log likelihood, initial truncated regression	67.994	62.502	49.633	54.932	58.597
Model significance, p-value	0.32	0.165	0.013	0.335	0.331
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 48: Potential efficiency determinants, DPT immunization (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.002**				−0.001
	(0.001)				(0.001)
Hospital beds (per 1,000 people)	0.017**				0.015*
	(0.007)				(0.008)
Average governance quality		0.624		0.040**	0.010
		(2.076)		(0.018)	(0.019)
Medium term sectoral vision			0.042**	0.021	0.014
			(0.017)	(0.014)	(0.013)
Setting and monitoring plans and objectives			0.008	−0.004	−0.002
			(0.013)	(0.011)	(0.010)
Constant	0.970***	1.817	0.850***	0.895***	0.900***
	(0.036)	(4.628)	(0.038)	(0.036)	(0.051)
Sigma	0.050***	0.255	0.057***	0.051***	0.047***
	(0.008)	(0.229)	(0.012)	(0.010)	(0.008)
Observations	66	71	46	46	45
Number of efficient units	7	8	1	1	1
Log likelihood, initial truncated regression	127.826	115.52	90.367	93.21	94.452
Model significance, p-value	0	0.764	0.027	0.018	0.019
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 49: Potential efficiency determinants, skilled birth attendance ratio poorest/richest (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.009				−0.002
	(0.038)				(0.005)
Hospital beds (per 1,000 people)	0.319				0.099
	(0.550)				(0.075)
Average governance quality		0.848***		0.468***	0.296*
		(0.304)		(0.178)	(0.161)
Medium term sectoral vision			0.290	0.134	0.090
			(0.336)	(0.087)	(0.079)
Setting and monitoring plans and objectives			0.113	−0.117	0.098
			(0.791)	(0.282)	(0.281)
Constant	0.934	1.291***	0.292	0.791***	0.625**
	(2.378)	(0.286)	(0.250)	(0.201)	(0.261)
Sigma	0.251*	0.217***	0.233***	0.150***	0.139***
	(0.135)	(0.060)	(0.085)	(0.036)	(0.030)
Observations	55	59	40	40	39
Number of efficient units	33	35	23	23	22
Log likelihood, initial truncated regression	19.275	20.343	13.75	17.108	18.606
Model significance, p-value	0.812	0.005	0.307	0.002	0.008
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 50: Potential efficiency determinants, skilled birth attendance ratio rural/urban (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.004				−0.003
	(0.004)				(0.003)
Hospital beds (per 1,000 people)	0.191*				0.043
	(0.105)				(0.040)
Average governance quality		0.552*		0.293**	0.169
		(0.286)		(0.133)	(0.107)
Medium term sectoral vision			0.228	0.001	0.003
			(0.302)	(0.042)	(0.043)
Setting and monitoring plans and objectives			0.232	0.020	0.028
			(0.340)	(0.064)	(0.071)
Constant	0.862***	1.261***	0.589	1.034***	1.025***
	(0.173)	(0.305)	(0.715)	(0.159)	(0.172)
Sigma	0.126***	0.146***	0.168*	0.099***	0.098***
	(0.036)	(0.043)	(0.092)	(0.025)	(0.024)
Observations	59	63	41	41	40
Number of efficient units	3	4	1	1	1
Log likelihood, initial truncated regression	129.019	128.895	80.916	89.95	88.691
Model significance, p-value	0.144	0.053	0.716	0.109	0.237
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 51: Average efficiency scores using public health expenditure per capita as input (enlarged sample)

	Average efficiency scores by output indicator								Efficiency across all DEA models		Counting low and high performers across models			
Country	Life expectancy at birth	Life expectancy at age 60	Under-five mortality	DALYs lost	Skilled birth attendance	DPT immunization	Skilled birth attendance ratio poorest/richest	Skilled birth attendance ratio rural/urban	Average efficiency	Ranking	Lowest to 25th	From 25 to 75th	75th to highest	Number of DEA models
Argentina	0.940	0.877	0.992	0.925	0.975	0.937	0.971		0.945	46	3	18	0	21
Australia	0.987	0.962	0.998	0.976	1.000	0.929	1.000	0.984	0.980	16	0	9	15	24
Austria	0.975	0.923	0.998	0.952	1.000	0.954	1.000	0.986	0.973	27	0	16	8	24
Bahamas, The	0.922	0.849	0.992	0.863	0.985	0.978			0.931	54	11	7	0	18
Barbados	0.947	0.957	0.993	0.945	0.991	0.930	1.000	1.000	0.970	30	0	17	7	24
Belgium	0.969	0.904	0.998	0.950	1.000	0.998	1.000	0.986	0.976	24	0	13	11	24
Belize	0.906	0.908	0.992	0.909	0.964	0.964	0.924	0.964	0.941	48	10	14	0	24
Bolivia	0.889	0.845	0.974	0.766	0.874	0.973	0.675	0.752	0.843	67	21	3	0	24
Botswana	0.808	0.736	0.960	0.497		0.960		0.899	0.810	68	15	3	0	18
Brazil	0.929	0.881	0.991	0.882	0.982	0.970		0.951	0.941	49	11	10	0	21
Cameroon	0.853	0.938	0.969	0.518	1.000	1.000	0.916	1.000	0.899	60	11	4	9	24
Canada	0.982	0.962	0.997	0.963	0.999	0.919	1.000	0.984	0.976	23	3	12	9	24
Chile	1.000	0.986	0.999	1.000	0.999	0.941			0.988	7	0	9	9	18
China	0.991	0.845	0.998	1.000	1.000	1.000		1.000	0.976	22	3	2	16	21
Colombia	0.933	1.000	0.991	0.946	0.994	0.905	0.861	0.876	0.938	50	11	10	3	24
Costa Rica	0.991	0.934	0.997	0.986	0.985	0.917	0.975	0.967	0.969	32	3	17	4	24
Cuba	0.980	0.884	0.999	0.934	0.998	0.996		0.990	0.969	33	1	12	8	21
Czech Republic	0.950	0.849	0.999	0.942	1.000	1.000	1.000	0.984	0.966	36	3	8	13	24
Denmark	0.964	0.885	0.999	0.944	1.000	0.941	1.000	0.985	0.965	37	1	15	8	24
Dominican Republic	0.951	0.962	0.977	0.932	0.981	0.865	1.000	0.979	0.956	42	8	10	6	24
Ecuador	0.990	0.977	0.987	0.950	0.934	0.855	0.833	0.856	0.923	56	15	4	5	24
El Salvador	0.937	0.950	0.992	0.850	0.994	0.926	0.954	0.969	0.946	45	7	17	0	24
Estonia	0.961	0.891	1.000	0.939	1.000	0.950	1.000	0.989	0.966	35	2	8	14	24
Finland	0.972	0.924	1.000	0.952	1.000	0.994	1.000	0.986	0.978	18	0	10	14	24
France	0.988	0.962	0.998	0.960	1.000	0.996	1.000	0.986	0.986	11	0	8	16	24
Germany	0.972	0.923	0.998	0.958	1.000	0.973	1.000	0.988	0.977	21	0	15	9	24
Ghana	0.861	0.838	0.970	0.703	0.920	0.984	0.842	0.862	0.872	64	17	1	6	24
Greece	0.985	0.947	0.998	0.972	1.000	1.000	1.000	0.987	0.986	10	0	10	14	24
Guatemala	0.937	0.936	0.981	0.853	0.643	0.842	0.420	0.674	0.786	69	20	4	0	24
Guyana	0.871	0.667	0.974	0.610	0.956	0.976	0.848	0.949	0.856	66	19	5	0	24
Haiti	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	0	0	24	24
Honduras	0.961	0.990	0.996	0.928	0.870	0.886	0.755	0.827	0.902	59	14	5	5	24
Hungary	0.938	0.816	0.998	0.899	1.000	1.000	1.000	0.987	0.955	44	7	5	12	24
Iceland	0.990	0.942	1.000	0.982	1.000	0.923	1.000	0.983	0.978	19	3	5	16	24
India	1.000	0.917	1.000	1.000		0.959	0.744	0.858	0.926	55	6	6	9	21
Indonesia	0.946	0.867	1.000	0.999	0.977	0.883	0.974	1.000	0.956	43	8	7	9	24
Ireland	0.974	0.923	0.998	0.957	1.000	0.964	1.000	0.983	0.975	25	0	16	8	24
Israel	1.000	0.976	0.999	0.999	1.000	0.949	1.000	0.983	0.988	6	0	6	18	24
Italy	0.992	0.962	0.999	0.985	1.000	0.967	1.000	0.988	0.987	8	0	6	18	24
Jamaica	0.982	0.921	0.993	0.892	0.993	0.937	0.979	0.984	0.960	40	3	18	3	24
Japan	1.000	1.000	1.000	1.000	1.000	0.982	1.000	0.989	0.996	2	0	2	22	24
Korea, Rep.	0.999	0.964	1.000	1.000	1.000	0.998	1.000	0.983	0.993	3	0	1	23	24
Luxembourg	0.981	0.962	1.000	0.965	1.000	1.000	1.000	0.984	0.986	9	0	6	18	24
Mexico	0.958	0.892	0.993	0.943	0.961	0.915		0.876	0.934	51	9	12	0	21
Netherlands	0.977	0.923	0.998	0.964	1.000	0.974	1.000	0.985	0.977	20	0	16	8	24
New Zealand	0.979	0.964	0.997	0.969	1.000	0.939	1.000	0.983	0.979	17	0	12	12	24
Nicaragua	0.986	0.953	0.995	0.940	0.938	0.997	0.540	0.869	0.902	58	10	8	6	24
Nigeria	0.705	0.746	0.907	0.225	0.484	0.515	0.141	0.478	0.525	71	24	0	0	24
Norway	0.981	0.923	0.999	0.954	1.000	0.952	1.000	0.984	0.974	26	0	15	9	24
Panama	0.964	0.953	0.989	0.926	0.925	0.818	0.720	0.774	0.884	63	15	9	0	24
Paraguay	0.950	0.925	0.990	0.930	0.973	0.895			0.944	47	9	9	0	18
Peru	0.960	1.000	0.991	0.967	0.874	0.913	0.656	0.727	0.886	62	14	6	4	24
Poland	0.955	0.861	1.000	0.941	1.000	0.996	1.000	0.984	0.967	34	2	8	14	24
Portugal	0.983	0.948	0.999	0.975	1.000	0.990	1.000	0.987	0.985	13	0	9	15	24
Russian Federation	0.874	0.702	0.995	0.766		0.982			0.864	65	9	6	0	15
Slovak Republic	0.933	0.838	0.996	0.912	1.000	0.988	1.000	0.983	0.956	41	6	9	9	24
Slovenia	0.973	0.902	1.000	0.952	1.000	0.964	1.000	0.985	0.972	29	0	13	11	24
South Africa	0.713	0.684	0.963	0.422		0.695			0.696	70	15	0	0	15
Spain	0.999	0.969	0.998	0.990	1.000	0.978	1.000	0.986	0.990	4	0	7	17	24
Sri Lanka	0.988	0.906	1.000	0.998		1.000	1.000	1.000	0.985	14	0	3	18	21
Suriname	0.894	0.961	0.985	0.908		0.869	0.863	0.874	0.908	57	17	3	1	21
Sweden	0.984	0.923	0.999	0.969	1.000	0.990	1.000	0.986	0.981	15	0	10	14	24
Switzerland	0.995	0.962	0.998	0.977	1.000	0.972	1.000	0.985	0.986	12	0	8	16	24
Thailand	0.932	0.865	0.995	0.916	0.997	1.000	0.987	0.990	0.960	39	5	14	5	24
Trinidad and Tobago	0.863	0.728	0.983	0.767	1.000	0.933	0.977		0.893	61	12	6	3	21
Turkey	0.927	0.853	0.991	0.903	0.975	0.978	0.912	0.919	0.932	53	21	3	0	24
United Kingdom	0.974	0.923	0.998	0.945	1.000	0.962	1.000	0.985	0.973	28	0	16	8	24
United States	0.948	0.885	0.995	0.916	1.000	0.958	1.000	0.983	0.961	38	2	14	8	24
Uruguay	0.967	0.913	0.996	0.965	0.993	0.963		0.988	0.969	31	0	16	5	21
Venezuela, RB	0.939	0.971	0.993	0.917	0.961	0.820			0.934	52	7	8	3	18
Vietnam	1.000	1.000	0.999	1.000	1.000	0.948	0.965	1.000	0.989	5	2	3	19	24

Below 25th percentile (light grey shading)
Above 75th percentile (dark grey shading)

Table A 52: Potential efficiency determinants using public health expenditure per capita as input, life expectancy at birth (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.001				0.002*
	(0.006)				(0.001)
Hospital beds (per 1,000 people)	0.016				−0.006
	(0.094)				(0.005)
Average governance quality		0.287		0.021	0.044**
		(1.352)		(0.015)	(0.017)
Medium term sectoral vision			0.034**	0.023*	0.030**
			(0.015)	(0.014)	(0.012)
Setting and monitoring plans and objectives			0.008	0.002	0.002
			(0.009)	(0.009)	(0.007)
Constant	0.999	1.341	0.878***	0.901***	0.845***
	(0.779)	(3.368)	(0.033)	(0.033)	(0.043)
Sigma	0.076	0.163	0.041***	0.039***	0.036***
	(0.054)	(0.163)	(0.009)	(0.008)	(0.006)
Observations	66	71	46	46	45
Number of efficient units	5	6	3	3	3
Log likelihood, initial truncated regression	126.638	129.495	100.742	102.001	101.484
Model significance, p-value	0.943	0.832	0.060	0.088	0.028
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 53: Potential efficiency determinants using public health expenditure per capita as input, life expectancy at age 60 (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				0.003
	(0.002)				(0.003)
Hospital beds (per 1,000 people)	−0.004				−0.013
	(0.009)				(0.013)
Average governance quality		0.049		0.023	0.067
		(0.039)		(0.046)	(0.047)
Medium term sectoral vision			0.026	0.016	0.034
			(0.133)	(0.041)	(0.034)
Setting and monitoring plans and objectives			0.005	0.001	−0.001
			(0.039)	(0.030)	(0.020)
Constant	0.961***	0.947***	0.917	0.937***	0.802***
	(0.077)	(0.107)	(1.012)	(0.148)	(0.116)
Sigma	0.101***	0.108***	0.104	0.103***	0.094***
	(0.022)	(0.026)	(0.069)	(0.035)	(0.022)
Observations	66	71	46	46	45
Number of efficient units	5	5	4	4	4
Log likelihood, initial truncated regression	87.154	92.131	64.965	65.142	64.445
Model significance, p-value	0.757	0.207	0.977	0.875	0.689
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 54: Potential efficiency determinants using public health expenditure per capita as input, under-five mortality (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				
	(0.001)				
Hospital beds (per 1,000 people)	0.031				0.001
	(0.019)				(0.001)
Average governance quality		0.614**		0.010***	0.012***
		(0.311)		(0.003)	(0.004)
Medium term sectoral vision			0.014**	0.007***	0.007***
			(0.006)	(0.002)	(0.002)
Setting and monitoring plans and objectives			0.005	−0.001	0.001
			(0.005)	(0.002)	(0.002)
Constant	0.959***	1.752***	0.962***	0.977***	0.970***
	(0.028)	(0.424)	(0.012)	(0.005)	(0.008)
Sigma	0.020***	0.077***	0.008***	0.006***	0.006***
	(0.007)	(0.026)	(0.002)	(0.001)	(0.001)
Observations	66	71	46	46	45
Number of efficient units	6	8	1	1	1
Log likelihood, initial truncated regression	254.219	251.418	198.143	208.17	204.866
Model significance, p-value	0.262	0.048	0.106	0.001	0.005
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 55: Potential efficiency determinants using public health expenditure per capita as input, DALYs lost (enlarged sample)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.358***			0.002
	(0.119)			(0.003)
Hospital beds (per 1,000 people)	4.821***			−0.020
	(0.891)			(0.028)
Average governance quality		0.113	0.077	0.091
		(0.599)	(0.069)	(0.079)
Medium term sectoral vision		0.025	0.003	0.003
		(0.186)	(0.046)	(0.055)
Setting and monitoring plans and objectives			0.072	0.120
			(0.080)	(0.098)
Constant	44.532***	0.725*	0.801***	0.749***
	(12.459)	(0.425)	(0.125)	(0.172)
Sigma	2.086***	0.113	0.105***	0.103***
	(0.455)	(0.082)	(0.038)	(0.034)
Observations	66	46	46	45
Number of efficient units	6	4	4	4
Log likelihood, initial truncated regression	86.228	72.551	73.703	71.88
Model significance, p-value	0.000	0.948	0.661	0.827
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 56: Potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance (enlarged sample)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)	−0.028			−0.006
	(0.019)			(0.007)
Hospital beds (per 1,000 people)	0.886***			0.140
	(0.317)			(0.124)
Average governance quality		3.823**	1.049*	0.411
		(1.664)	(0.576)	(0.315)
Medium term sectoral vision			0.365	0.141
			(0.236)	(0.138)
Setting and monitoring plans and objectives			0.523	0.590
			(0.891)	(0.666)
Constant	1.935*	5.404**	0.636	0.716
	(1.011)	(2.156)	(0.495)	(0.514)
Sigma	0.227***	0.387***	0.149***	0.118***
	(0.067)	(0.126)	(0.049)	(0.035)
Observations	63	65	45	44
Number of efficient units	34	35	22	21
Log likelihood, initial truncated regression	68.107	62.806	56.910	57.768
Model significance, p-value	0.019	0.022	0.290	0.471
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 57: Potential efficiency determinants using public health expenditure per capita as input, DPT immunization (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.002**				−0.001
	(0.001)				(0.001)
Hospital beds (per 1,000 people)	0.017**				0.014
	(0.007)				(0.009)
Average governance quality		0.802		0.044**	0.013
		(2.481)		(0.021)	(0.021)
Medium term sectoral vision			0.051**	0.029	0.018
			(0.023)	(0.018)	(0.016)
Setting and monitoring plans and objectives			0.009	−0.004	−0.002
			(0.014)	(0.012)	(0.011)
Constant	0.973***	2.072	0.829***	0.875***	0.887***
	(0.038)	(5.034)	(0.050)	(0.044)	(0.060)
Sigma	0.051***	0.289	0.060***	0.053***	0.049***
	(0.009)	(0.252)	(0.015)	(0.011)	(0.009)
Observations	66	71	46	46	45
Number of efficient units	8	9	2	2	2
Log likelihood, initial truncated regression	125.358	114.253	88.690	91.646	92.389
Model significance, p-value	0.003	0.747	0.073	0.038	0.057
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 58: Potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance ratio poorest/richest (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.004				0.001
	(0.054)				(0.006)
Hospital beds (per 1,000 people)	0.480				0.124
	(1.261)				(0.091)
Average governance quality		1.412		0.682**	0.513*
		(5.022)		(0.300)	(0.279)
Medium term sectoral vision			0.443	0.208*	0.141
			(2.626)	(0.116)	(0.109)
Setting and monitoring plans and objectives			0.259	0.088	0.308
			(5.315)	(0.512)	(0.437)
Constant	0.781	1.963	0.063	0.594*	0.305
	(8.187)	(10.371)	(5.860)	(0.319)	(0.421)
Sigma	0.304	0.343	0.306	0.169***	0.156***
	(0.279)	(0.370)	(0.274)	(0.045)	(0.036)
Observations	55	59	40	40	39
Number of efficient units	33	35	24	24	23
Log likelihood, initial truncated regression	21.461	20.320	13.342	17.190	18.173
Model significance, p-value	0.922	0.779	0.957	0.090	0.126
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 59: Potential efficiency determinants using public health expenditure per capita as input, skilled birth attendance ratio rural/urban (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.005				−0.002
	(0.004)				(0.003)
Hospital beds (per 1,000 people)	0.201*				0.018
	(0.108)				(0.036)
Average governance quality		0.647**		0.333*	0.261*
		(0.322)		(0.201)	(0.153)
Medium term sectoral vision			0.472	0.080	0.066
			(0.448)	(0.064)	(0.059)
Setting and monitoring plans and objectives			0.368	0.028	0.034
			(0.401)	(0.091)	(0.078)
Constant	0.876***	1.272***	−0.010	0.831***	0.862***
	(0.184)	(0.316)	(0.719)	(0.167)	(0.183)
Sigma	0.128***	0.147***	0.191**	0.102***	0.099***
	(0.037)	(0.042)	(0.081)	(0.031)	(0.025)
Observations	59	63	41	41	40
Number of efficient units	5	6	2	2	2
Log likelihood, initial truncated regression	127.248	128.808	82.456	92.025	89.246
Model significance, p-value	0.130	0.045	0.566	0.360	0.292
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 60: Further Simar-Wilson regression results of potential efficiency determinants, life expectancy at birth (enlarged sample)

	Full enlarged sample		LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Organization of healthcare delivery and financing							
Out-of-pocket health expenditure (Perc.)	0.002		0.001				0.001
	(0.001)		(0.001)				(0.001)
Hospital beds (per 1,000 people)			0.002				−0.004
			(0.010)				(0.010)
Quality of governance							
Government effectiveness		−0.079**					
		(0.040)					
Voice and accountability		−0.019					
		(0.048)					
Rule of law		0.016					
		(0.046)					
Regulatory quality		0.040					
		(0.024)					
Political stability and absence of violence/terrorism		0.001					
		(0.023)					
Control of corruption		0.049					
		(0.035)					
Average governance quality	0.035*			−0.010		−0.021	−0.001
	(0.020)			(0.024)		(0.022)	(0.028)
Quality of health system institutions							
Medium term sectoral vision	0.017	0.021			−0.009	−0.011	−0.005
	(0.012)	(0.013)			(0.023)	(0.021)	(0.021)
Setting and monitoring plans and objectives	0.003	0.001			0.081	0.108	0.074
	(0.009)	(0.008)			(0.089)	(0.093)	(0.090)
Constant	0.872***	0.926***	0.929***	0.958***	0.933***	0.918***	0.900***
	(0.048)	(0.042)	(0.054)	(0.044)	(0.049)	(0.048)	(0.059)
Sigma	0.041***	0.039***	0.045***	0.046***	0.044***	0.043***	0.041***
	(0.009)	(0.007)	(0.012)	(0.014)	(0.012)	(0.010)	(0.008)
Observations	46	46	27	27	24	24	24
Number of efficient units	2	2	1	1	1	1	1
Log likelihood, initial truncated regression	104.314	105.817	53.058	52.817	47.329	47.819	48.374
Model significance, p-value	0.109	0.146	0.734	0.689	0.640	0.628	0.627
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000

Table A 61: Further Simar-Wilson regression results of potential efficiency determinants, life expectancy at age 60 (enlarged sample)

	Full enlarged sample			LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Organization of healthcare delivery and financing								
Out-of-pocket health expenditure (Perc.)	0.001	0.003		0.004				0.004
	(0.002)	(0.003)		(0.046)				(0.010)
Hospital beds (per 1,000 people)				−0.005				−0.018
				(0.230)				(0.072)
Quality of governance								
Government effectiveness			−0.211**					
			(0.087)					
Voice and accountability			−0.085					
			(0.101)					
Rule of law			0.046					
			(0.101)					
Regulatory quality			0.061					
			(0.055)					
Political stability and absence of violence/terrorism			0.021					
			(0.055)					
Control of corruption			0.136**					
			(0.069)					
Average governance quality		0.048			−0.031		−0.083	−0.006
		(0.045)			(1.305)		(0.479)	(0.217)
Quality of health system institutions								
Medium term sectoral vision		0.006	0.019			−0.051	−0.064	−0.035
		(0.028)	(0.026)			(1.575)	(0.606)	(0.139)
Setting and monitoring plans and objectives		0.005	−0.002			0.316	0.469	0.269
		(0.019)	(0.014)			(5.002)	(2.628)	(0.604)
Constant	0.964***	0.846***	0.954***	0.916	1.062	1.075	0.996	0.947
	(0.099)	(0.120)	(0.095)	(4.730)	(8.761)	(8.710)	(1.280)	(0.602)
Sigma	0.114***	0.094***	0.079***	0.129	0.141	0.163	0.156	0.150**
	(0.029)	(0.022)	(0.015)	(0.143)	(0.272)	(0.273)	(0.097)	(0.061)
Observations	71	46	46	27	27	24	24	24
Number of efficient units	5	3	3	2	2	2	2	2
Log likelihood, initial truncated regression	89.457	67.068	70.331	36.120	35.463	31.372	31.584	31.790
Model significance, p-value	0.811	0.741	0.330	0.995	0.981	0.998	0.994	0.970
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000

Table A 62: Further Simar-Wilson regression results of potential efficiency determinants, under-five mortality (enlarged sample)

	Full enlarged sample		LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Organization of healthcare delivery and financing							
Out-of-pocket health expenditure (Perc.)							
Hospital beds (per 1,000 people)			0.002				−0.002
			(0.002)				(0.002)
Quality of governance							
Government effectiveness		−0.012**					
		(0.006)					
Voice and accountability		−0.007					
		(0.007)					
Rule of law		0.009					
		(0.007)					
Regulatory quality		0.008**					
		(0.004)					
Political stability and absence of violence/terrorism		0.004					
		(0.003)					
Control of corruption		0.005					
		(0.006)					
Average governance quality	0.010***			0.005		0.004	0.008*
	(0.004)			(0.004)		(0.003)	(0.004)
Quality of health system institutions							
Medium term sectoral vision	0.004**	0.005**			0.002	0.002	0.003
	(0.002)	(0.002)			(0.003)	(0.003)	(0.003)
Setting and monitoring plans and objectives	0.001	−0.001			0.006	−0.002	−0.009
	(0.002)	(0.002)			(0.012)	(0.012)	(0.013)
Constant	0.983***	0.988***	0.989***	0.993***	0.985***	0.988***	0.993***
	(0.007)	(0.006)	(0.009)	(0.005)	(0.007)	(0.006)	(0.009)
Sigma	0.006***	0.006***	0.008***	0.008***	0.007***	0.007***	0.006***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Observations	46	46	27	27	24	24	24
Number of efficient units	0	0	0	0	0	0	0
Log likelihood, initial truncated regression	205.253	209.574	100.509	100.800	91.125	92.191	92.931
Model significance, p-value	0.003	0.008	0.659	0.281	0.591	0.355	0.384
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000

Table A 63: Further Simar-Wilson regression results of potential efficiency determinants, DALYs lost (enlarged sample)

	Full enlarged sample		LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Organization of healthcare delivery and financing							
Out-of-pocket health expenditure (Perc.)	0.002		0.002				0.002
	(0.007)		(0.042)				(0.025)
Hospital beds (per 1,000 people)			0.020				−0.039
			(0.330)				(0.216)
Quality of governance							
Government effectiveness		−0.329***					
		(0.109)					
Voice and accountability		0.113					
		(0.108)					
Rule of law		0.021					
		(0.098)					
Regulatory quality		0.105*					
		(0.055)					
Political stability and absence of violence/terrorism		−0.020					
		(0.050)					
Control of corruption		0.174**					
		(0.082)					
Average governance quality	0.101			0.076		0.061	0.145
	(0.257)			(1.758)		(0.893)	(0.873)
Quality of health system institutions							
Medium term sectoral vision	0.049	0.061**			0.047	0.052	0.085
	(0.082)	(0.027)			(0.569)	(0.193)	(0.235)
Setting and monitoring plans and objectives	0.001	0.001			0.164	0.054	−0.146
	(0.059)	(0.017)			(1.046)	(1.231)	(2.462)
Constant	0.826**	0.776***	0.958	1.062	0.879	0.926	0.961
	(0.396)	(0.084)	(6.336)	(7.399)	(3.694)	(3.004)	(1.675)
Sigma	0.107**	0.078***	0.147	0.142	0.147	0.143	0.136
	(0.044)	(0.014)	(0.204)	(0.246)	(0.125)	(0.119)	(0.084)
Observations	46	46	27	27	24	24	24
Number of efficient units	2	2	0	0	0	0	0
Log likelihood, initial truncated regression	77.324	83.116	36.620	36.908	33.593	33.762	34.161
Model significance, p-value	0.882	0.081	0.998	0.965	0.965	0.994	0.968
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000

Table A 64: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance (enlarged sample)

	Full enlarged sample			LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Organization of healthcare delivery and financing								
Out-of-pocket health expenditure (Perc.)	−0.037	−0.015*		−0.018				−0.013*
	(0.026)	(0.008)		(0.020)				(0.008)
Hospital beds (per 1,000 people)				0.489				0.133
				(0.338)				(0.102)
Quality of governance								
Government effectiveness			0.190					
			(0.300)					
Voice and accountability			−0.165					
			(0.356)					
Rule of law			1.330**					
			(0.622)					
Regulatory quality			−0.367					
			(0.224)					
Political stability and absence of violence/terrorism			−0.007					
			(0.141)					
Control of corruption			−0.436					
			(0.437)					
Average governance quality		0.292			2.707		1.427	0.083
		(0.207)			(2.488)		(0.892)	(0.169)
Quality of health system institutions								
Medium term sectoral vision		0.151	−0.092			6.793***	0.495	0.065
		(0.118)	(0.114)			(1.918)	(0.598)	(0.089)
Setting and monitoring plans and objectives		−0.229	0.323			3.086	−1.988	0.259
		(0.401)	(0.399)			(4.783)	(1.962)	(0.424)
Constant	2.921*	1.651***	1.943***	1.450	4.559	1.576	2.240**	1.210***
	(1.650)	(0.477)	(0.535)	(1.051)	(4.979)	(4.978)	(1.095)	(0.416)
Sigma	0.174***	0.106***	0.117***	0.168**	0.361*	0.913***	0.188***	0.103***
	(0.065)	(0.029)	(0.029)	(0.069)	(0.201)	(0.209)	(0.062)	(0.027)
Observations	65	45	45	26	26	23	23	23
Number of efficient units	34	21	21	1	1	1	1	1
Log likelihood, initial truncated regression	64.929	58.172	59.408	54.963	51.371	43.513	48.417	51.685
Model significance, p-value	0.157	0.242	0.397	0.330	0.277	0.000	0.200	0.195
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000

Table A 65: Further Simar-Wilson regression results of potential efficiency determinants, DPT immunization (enlarged sample)

	Full enlarged sample			LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Organization of healthcare delivery and financing								
Out-of-pocket health expenditure (Perc.)	−0.028	−0.001		−0.002**				−0.001
	(0.110)	(0.001)		(0.001)				(0.001)
Hospital beds (per 1,000 people)				0.005				−0.002
				(0.012)				(0.012)
Quality of governance								
Government effectiveness			−0.005					
			(0.045)					
Voice and accountability			−0.056					
			(0.056)					
Rule of law			0.116**					
			(0.058)					
Regulatory quality			0.005					
			(0.031)					
Political stability and absence of violence/terrorism			0.027					
			(0.027)					
Control of corruption			−0.063					
			(0.044)					
Average governance quality		0.029			0.044		0.037	0.030
		(0.020)			(0.028)		(0.023)	(0.028)
Quality of health system institutions								
Medium term sectoral vision		0.020	0.014			−0.004	0.001	0.001
		(0.014)	(0.014)			(0.024)	(0.020)	(0.021)
Setting and monitoring plans and objectives		−0.005	−0.006			0.055	−0.005	−0.001
		(0.010)	(0.009)			(0.090)	(0.082)	(0.092)
Constant	2.754	0.936***	0.953***	1.002***	0.942***	0.904***	0.930***	0.962***
	(9.117)	(0.054)	(0.049)	(0.059)	(0.028)	(0.051)	(0.048)	(0.067)
Sigma	0.252	0.050***	0.048***	0.052***	0.058***	0.051***	0.048***	0.047***
	(0.244)	(0.009)	(0.008)	(0.010)	(0.013)	(0.010)	(0.009)	(0.008)
Observations	71	46	46	27	27	24	24	24
Number of efficient units	8	1	1	0	0	0	0	0
Log likelihood, initial truncated regression	114.269	93.736	95.185	48.535	46.639	41.767	43.272	43.594
Model significance, p-value	0.801	0.018	0.044	0.040	0.121	0.809	0.374	0.551
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000

Table A 66: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio poorest/richest (enlarged sample)

	Full enlarged sample			LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Organization of healthcare delivery and financing								
Out-of-pocket health expenditure (Perc.)	−0.026	−0.006		−0.011				−0.003
	(0.089)	(0.005)		(0.077)				(0.005)
Hospital beds (per 1,000 people)				0.244				0.122
				(0.803)				(0.077)
Quality of governance								
Government effectiveness			0.254					
			(0.206)					
Voice and accountability			0.372					
			(0.352)					
Rule of law			−0.156					
			(0.192)					
Regulatory quality			−0.168					
			(0.103)					
Political stability and absence of violence/terrorism			−0.035					
			(0.097)					
Control of corruption			0.005					
			(0.345)					
Average governance quality		0.343**			0.629***		0.482**	0.217
		(0.162)			(0.228)		(0.202)	(0.155)
Quality of health system institutions								
Medium term sectoral vision		0.125	0.083			0.290	0.139	0.058
		(0.082)	(0.061)			(1.288)	(0.095)	(0.076)
Setting and monitoring plans and objectives		−0.050	0.136			0.141	−0.147	0.337
		(0.282)	(0.328)			(2.077)	(0.388)	(0.329)
Constant	2.159	0.927***	0.471	0.982	1.111***	0.284	0.807***	0.514*
	(7.761)	(0.229)	(0.405)	(4.851)	(0.183)	(3.449)	(0.243)	(0.282)
Sigma	0.320	0.145***	0.099***	0.236	0.173***	0.236	0.154***	0.129***
	(0.224)	(0.033)	(0.019)	(0.165)	(0.047)	(0.192)	(0.039)	(0.027)
Observations	59	40	40	19	19	18	18	18
Number of efficient units	35	23	23	2	2	2	2	2
Log likelihood, initial truncated regression	16.838	17.794	21.262	12.826	15.169	12.263	15.547	17.524
Model significance, p-value	0.773	0.004	0.000	0.949	0.006	0.867	0.002	0.001
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000

Table A 67: Further Simar-Wilson regression results of potential efficiency determinants, skilled birth attendance ratio rural/urban (enlarged sample)

	Full enlarged sample			LAC-restricted sample				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Organization of healthcare delivery and financing								
Out-of-pocket health expenditure (Perc.)	−0.025	−0.004		−0.006				−0.007
	(0.029)	(0.003)		(0.012)				(0.004)
Hospital beds (per 1,000 people)				0.066				−0.024
				(0.140)				(0.084)
Quality of governance								
Government effectiveness			0.064					
			(0.135)					
Voice and accountability			−0.094					
			(0.161)					
Rule of law			0.337**					
			(0.169)					
Regulatory quality			−0.101					
			(0.094)					
Political stability and absence of violence/terrorism			0.104					
			(0.068)					
Control of corruption			−0.081					
			(0.132)					
Average governance quality		0.215**			0.250		0.213	0.063
		(0.103)			(1.541)		(0.157)	(0.129)
Quality of health system institutions								
Medium term sectoral vision		0.009	−0.026			−0.002	−0.004	−0.001
		(0.039)	(0.043)			(0.209)	(0.086)	(0.066)
Setting and monitoring plans and objectives		0.018	0.020			0.313	0.032	0.139
		(0.056)	(0.048)			(0.787)	(0.361)	(0.320)
Constant	2.268	1.126***	1.219***	1.073	1.082	0.846	1.026***	1.169***
	(2.017)	(0.164)	(0.196)	(0.890)	(4.198)	(0.552)	(0.250)	(0.284)
Sigma	0.180**	0.094***	0.091***	0.125**	0.139	0.148**	0.123***	0.108***
	(0.073)	(0.022)	(0.018)	(0.061)	(0.157)	(0.075)	(0.041)	(0.025)
Observations	63	41	41	21	21	19	19	19
Number of efficient units	4	1	1	1	1	1	1	1
Log likelihood, initial truncated regression	119.010	90.762	93.632	26.765	25.668	22.411	23.771	24.983
Model significance, p-value	0.382	0.065	0.167	0.804	0.871	0.762	0.474	0.278
Number of bootstrap repetitions	1000	1000	1000	1000	1000	1000	1000	1000

Table A 68: Average efficiency scores by output indicator and country, bias-corrected efficiency scores (enlarged sample)

	Average efficiency scores by output indicator								Efficiency across all DEA models		Counting low and high performers across models			
Country	Life expectancy at birth	Life expectancy at age 60	Under-five mortality	DALYs lost	Skilled birth attendance	DPT immunization	Skilled birth attendance ratio poorest/richest	Skilled birth attendance ratio rural/urban	Average efficiency	Ranking	Lowest to 25th	From 25 to 75th	75th to highest	Number of DEA models
Argentina	0.928	0.858	0.991	0.915	0.973	0.932	0.955		0.936	41	2	19	0	21
Australia	0.979	0.947	0.998	0.968	0.999	0.925	0.992	0.981	0.974	10	0	9	15	24
Austria	0.968	0.911	0.998	0.945	0.999	0.948	0.990	0.984	0.968	21	0	13	11	24
Bahamas, The	0.909	0.828	0.990	0.844	0.983	0.973			0.921	52	11	4	3	18
Barbados	0.938	0.925	0.992	0.933	0.987	0.920	0.967	0.989	0.956	32	1	20	3	24
Belgium	0.960	0.889	0.998	0.941	0.999	0.992	0.990	0.984	0.969	20	0	15	9	24
Belize	0.900	0.887	0.991	0.896	0.958	0.954	0.889	0.957	0.929	48	8	16	0	24
Bolivia	0.877	0.818	0.973	0.752	0.871	0.954	0.648	0.746	0.830	67	21	3	0	24
Botswana	0.800	0.714	0.959	0.493		0.954		0.892	0.802	68	15	3	0	18
Brazil	0.915	0.853	0.990	0.871	0.980	0.964		0.944	0.931	46	10	11	0	21
Cameroon	0.939	0.886	0.992	0.835	0.947	0.918	0.732	0.919	0.896	54	12	12	0	24
Canada	0.975	0.949	0.997	0.956	0.998	0.915	0.992	0.982	0.970	16	1	10	13	24
Chile	0.981	0.964	0.997	0.985	0.997	0.936			0.976	7	0	9	9	18
China	0.976	0.825	0.996	0.963	0.978	0.973		0.983	0.956	31	4	9	8	21
Colombia	0.930	0.961	0.991	0.941	0.991	0.899	0.841	0.871	0.928	49	10	11	3	24
Costa Rica	0.980	0.911	0.997	0.981	0.983	0.911	0.956	0.962	0.960	27	3	16	5	24
Cuba	0.970	0.867	0.998	0.924	0.996	0.989		0.984	0.961	25	0	13	8	21
Czech Republic	0.941	0.838	0.999	0.929	0.998	0.993	0.987	0.981	0.958	29	3	15	6	24
Denmark	0.957	0.873	0.998	0.937	0.999	0.937	0.991	0.983	0.960	28	0	12	12	24
Dominican Republic	0.945	0.934	0.976	0.918	0.977	0.856	0.965	0.973	0.943	37	6	16	2	24
Ecuador	0.975	0.935	0.986	0.920	0.918	0.846	0.803	0.848	0.904	53	15	3	6	24
El Salvador	0.929	0.925	0.991	0.838	0.989	0.914	0.913	0.962	0.933	44	6	18	0	24
Estonia	0.937	0.870	0.997	0.892	0.984	0.934	0.916	0.964	0.937	40	3	19	2	24
Finland	0.961	0.904	1.000	0.938	0.999	0.988	0.990	0.983	0.970	17	0	14	10	24
France	0.979	0.946	0.998	0.950	0.999	0.990	0.990	0.984	0.979	6	0	8	16	24
Germany	0.962	0.905	0.998	0.946	0.998	0.963	0.980	0.984	0.967	22	0	17	7	24
Ghana	0.839	0.796	0.969	0.678	0.907	0.944	0.800	0.850	0.848	64	15	9	0	24
Greece	0.973	0.924	0.998	0.955	0.997	0.986	0.977	0.982	0.974	9	0	16	8	24
Guatemala	0.927	0.908	0.980	0.834	0.637	0.829	0.401	0.668	0.773	69	20	4	0	24
Guyana	0.860	0.649	0.973	0.600	0.955	0.957	0.813	0.940	0.844	65	16	8	0	24
Haiti	0.924	0.885	0.986	0.789	0.802	0.841	0.611	0.822	0.832	66	14	10	0	24
Honduras	0.947	0.956	0.995	0.908	0.868	0.864	0.719	0.817	0.884	57	13	6	5	24
Hungary	0.923	0.805	0.996	0.877	0.996	0.981	0.969	0.980	0.941	39	7	15	2	24
Iceland	0.982	0.928	0.999	0.973	0.999	0.919	0.992	0.981	0.972	13	0	8	16	24
India	0.951	0.890	0.994	0.894		0.921	0.683	0.848	0.883	58	7	14	0	21
Indonesia	0.892	0.784	0.993	0.883	0.890	0.840	0.772	0.912	0.871	62	19	5	0	24
Ireland	0.966	0.911	0.998	0.950	0.999	0.960	0.992	0.981	0.970	18	0	13	11	24
Israel	0.990	0.958	0.998	0.983	0.999	0.945	0.989	0.979	0.980	5	0	10	14	24
Italy	0.977	0.934	0.998	0.966	0.997	0.955	0.976	0.982	0.973	11	0	14	10	24
Jamaica	0.971	0.892	0.992	0.873	0.987	0.923	0.933	0.975	0.943	36	4	19	1	24
Japan	0.972	0.953	0.997	0.945	0.986	0.954	0.916	0.965	0.961	26	2	14	8	24
Korea, Rep.	0.989	0.947	0.999	0.976	0.998	0.993	0.987	0.979	0.984	1	0	7	17	24
Luxembourg	0.975	0.951	1.000	0.960	0.999	0.996	0.992	0.982	0.982	2	0	0	24	24
Mexico	0.964	0.870	0.992	0.942	0.959	0.909		0.871	0.930	47	9	12	0	21
Netherlands	0.970	0.912	0.998	0.958	0.999	0.969	0.992	0.983	0.973	12	0	9	15	24
New Zealand	0.968	0.946	0.996	0.956	0.999	0.935	0.991	0.981	0.972	14	0	16	8	24
Nicaragua	0.968	0.916	0.993	0.916	0.934	0.962	0.508	0.855	0.882	59	10	14	0	24
Nigeria	0.698	0.732	0.910	0.226	0.494	0.506	0.147	0.495	0.526	71	24	0	0	24
Norway	0.974	0.912	0.999	0.948	0.999	0.947	0.992	0.983	0.969	19	0	9	15	24
Panama	0.954	0.934	0.988	0.923	0.924	0.813	0.708	0.770	0.877	60	15	8	1	24
Paraguay	0.941	0.901	0.989	0.914	0.967	0.883			0.933	43	7	11	0	18
Peru	0.957	0.977	0.990	0.952	0.869	0.904	0.634	0.723	0.876	61	14	5	5	24
Poland	0.945	0.844	0.999	0.933	0.997	0.986	0.979	0.977	0.957	30	3	15	6	24
Portugal	0.968	0.918	0.998	0.955	0.997	0.977	0.977	0.981	0.972	15	0	17	7	24
Russian Federation	0.866	0.692	0.994	0.762		0.974			0.857	63	9	3	3	15
Slovak Republic	0.923	0.822	0.995	0.901	0.998	0.982	0.987	0.979	0.948	35	6	15	3	24
Slovenia	0.961	0.877	0.999	0.938	0.999	0.957	0.987	0.982	0.963	24	0	20	4	24
South Africa	0.699	0.654	0.962	0.414		0.691			0.684	70	15	0	0	15
Spain	0.987	0.947	0.998	0.973	0.999	0.971	0.988	0.983	0.981	3	0	9	15	24
Sri Lanka	0.961	0.879	0.994	0.925		0.952	0.856	0.957	0.932	45	1	18	2	21
Suriname	0.879	0.913	0.984	0.895		0.864	0.846	0.864	0.892	55	13	8	0	21
Sweden	0.976	0.908	0.999	0.960	0.999	0.983	0.988	0.984	0.975	8	0	6	18	24
Switzerland	0.988	0.950	0.998	0.970	0.999	0.967	0.991	0.984	0.981	4	0	5	19	24
Thailand	0.927	0.840	0.994	0.910	0.995	0.993	0.965	0.984	0.951	34	5	13	6	24
Trinidad and Tobago	0.854	0.716	0.982	0.760	0.998	0.929	0.963		0.886	56	12	9	0	21
Turkey	0.917	0.836	0.990	0.898	0.973	0.972	0.896	0.912	0.924	51	12	11	1	24
United Kingdom	0.965	0.907	0.997	0.934	0.999	0.957	0.990	0.983	0.967	23	0	19	5	24
United States	0.941	0.875	0.995	0.911	0.999	0.954	0.992	0.981	0.956	33	0	16	8	24
Uruguay	0.942	0.879	0.993	0.894	0.975	0.943		0.961	0.941	38	2	18	1	21
Venezuela, RB	0.939	0.945	0.992	0.912	0.959	0.814			0.927	50	6	9	3	18
Vietnam	0.959	0.922	0.995	0.923	0.969	0.916	0.831	0.956	0.934	42	3	16	5	24

Below 25th percentile
Above 75th percentile

Table A 69: Potential efficiency determinants with bias-corrected efficiency scores, life expectancy at birth (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				0.001
	(0.001)				(0.001)
Hospital beds (per 1,000 people)	0.010*				0.001
	(0.005)				(0.003)
Average governance quality		0.099		0.017*	0.028***
		(0.352)		(0.009)	(0.010)
Medium term sectoral vision			0.019***	0.011	0.013*
			(0.007)	(0.008)	(0.007)
Setting and monitoring plans and objectives			0.006	0.001	0.003
			(0.005)	(0.006)	(0.005)
Constant	0.925***	1.044	0.896***	0.915***	0.867***
	(0.032)	(0.802)	(0.019)	(0.020)	(0.029)
Sigma	0.053***	0.103*	0.034***	0.033***	0.030***
	(0.010)	(0.053)	(0.005)	(0.005)	(0.004)
Observations	66	71	46	46	45
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	131.876	131.951	102.528	104.307	103.982
Model significance, p-value	0.179	0.78	0.011	0.006	0.004
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 70: Potential efficiency determinants with bias-corrected efficiency scores, life expectancy at age 60 (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.001				0.001
	(0.001)				(0.001)
Hospital beds (per 1,000 people)	0.001				−0.001
	(0.005)				(0.006)
Average governance quality		0.034**		0.015	0.028
		(0.015)		(0.020)	(0.024)
Medium term sectoral vision			0.012	0.005	0.008
			(0.015)	(0.018)	(0.017)
Setting and monitoring plans and objectives			0.005	0.002	0.002
			(0.012)	(0.011)	(0.011)
Constant	0.896***	0.890***	0.878***	0.893***	0.842***
	(0.040)	(0.017)	(0.044)	(0.050)	(0.068)
Sigma	0.081***	0.086***	0.073***	0.073***	0.072***
	(0.012)	(0.012)	(0.013)	(0.012)	(0.011)
Observations	66	71	46	46	45
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	89.529	94.252	67.91	68.181	66.761
Model significance, p-value	0.968	0.02	0.601	0.64	0.757
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 71: Potential efficiency determinants with bias-corrected efficiency scores, under-five mortality (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)					
Hospital beds (per 1,000 people)	0.016				0.001
	(0.013)				(0.001)
Average governance quality		0.913**		0.007***	0.007***
		(0.389)		(0.002)	(0.002)
Medium term sectoral vision			0.008***	0.004***	0.004***
			(0.002)	(0.001)	(0.001)
Setting and monitoring plans and objectives			0.003	0.001	0.001
			(0.002)	(0.001)	(0.001)
Constant	0.964***	2.285***	0.973***	0.982***	0.979***
	(0.019)	(0.676)	(0.005)	(0.004)	(0.005)
Sigma	0.015***	0.103***	0.007***	0.005***	0.005***
	(0.005)	(0.034)	(0.001)	(0.001)	(0.001)
Observations	66	71	46	46	45
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	273.054	278.946	195.161	202.915	198.706
Model significance, p-value	0.475	0.019	0.003	0	0
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 72: Potential efficiency determinants with bias-corrected efficiency scores, DALYs lost (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	0.002				0.002
	(0.013)				(0.002)
Hospital beds (per 1,000 people)	0.063				−0.002
	(0.196)				(0.008)
Average governance quality		2.200		0.046*	0.064**
		(5.947)		(0.027)	(0.032)
Medium term sectoral vision			0.069***	0.045**	0.048**
			(0.025)	(0.021)	(0.022)
Setting and monitoring plans and objectives			0.013	0.001	0.001
			(0.017)	(0.018)	(0.016)
Constant	0.947	4.851	0.757***	0.808***	0.747***
	(1.835)	(13.525)	(0.053)	(0.054)	(0.082)
Sigma	0.189	0.692	0.082***	0.077***	0.075***
	(0.135)	(0.602)	(0.017)	(0.015)	(0.013)
Observations	66	71	46	46	45
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	90.768	90.116	75.753	77.416	75.752
Model significance, p-value	0.949	0.711	0.013	0.013	0.033
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 73: Potential efficiency determinants with bias-corrected efficiency scores, skilled birth attendance (enlarged sample)

	(1)	(2)	(3)	(4)
Out-of-pocket health expenditure (Perc.)				−0.007*
				(0.004)
Hospital beds (per 1,000 people)				0.108**
				(0.043)
Average governance quality	1.024**		0.304**	0.115
	(0.449)		(0.121)	(0.086)
Medium term sectoral vision		0.245**	0.052	0.057
		(0.104)	(0.035)	(0.036)
Setting and monitoring plans and objectives		0.336*	0.088	0.179*
		(0.178)	(0.092)	(0.097)
Constant	1.838***	0.515***	0.956***	0.953***
	(0.496)	(0.125)	(0.131)	(0.178)
Sigma	0.134***	0.102***	0.066***	0.072***
	(0.034)	(0.027)	(0.014)	(0.014)
Observations	65	45	45	44
Number of efficient units	0	0	0	0
Log likelihood, initial truncated regression	196.276	131.236	145.411	147.919
Model significance, p-value	0.022	0.041	0.001	0.004
Number of bootstrap repetitions	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 74: Potential efficiency determinants with bias-corrected efficiency scores, DPT immunization (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.002***				−0.001
	(0.001)				(0.001)
Hospital beds (per 1,000 people)	0.015***				0.007
	(0.005)				(0.005)
Average governance quality		0.270		0.034***	0.016
		(1.106)		(0.013)	(0.014)
Medium term sectoral vision			0.040***	0.023**	0.018*
			(0.011)	(0.010)	(0.010)
Setting and monitoring plans and objectives			0.007	−0.003	−0.001
			(0.008)	(0.008)	(0.008)
Constant	0.948***	1.223	0.829***	0.867***	0.882***
	(0.025)	(2.605)	(0.028)	(0.027)	(0.041)
Sigma	0.046***	0.164	0.048***	0.043***	0.041***
	(0.007)	(0.139)	(0.008)	(0.006)	(0.006)
Observations	66	71	46	46	45
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	138.393	124.733	90.726	94.528	94.744
Model significance, p-value	0	0.807	0.001	0	0
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 75: Potential efficiency determinants with bias-corrected efficiency scores, skilled birth attendance ratio poorest/richest (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.009**				−0.004
	(0.004)				(0.004)
Hospital beds (per 1,000 people)	0.252**				0.030
	(0.124)				(0.036)
Average governance quality		0.671***		0.462***	0.352***
		(0.150)		(0.145)	(0.134)
Medium term sectoral vision			0.324**	0.042	0.040
			(0.131)	(0.056)	(0.056)
Setting and monitoring plans and objectives			0.339	0.088	0.103
			(0.219)	(0.103)	(0.109)
Constant	0.905***	1.117***	0.145	0.860***	0.901***
	(0.208)	(0.117)	(0.205)	(0.173)	(0.213)
Sigma	0.183***	0.150***	0.192***	0.130***	0.131***
	(0.048)	(0.024)	(0.055)	(0.024)	(0.025)
Observations	55	59	40	40	39
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	101.376	114.643	68.19	81.551	78.95
Model significance, p-value	0.048	0	0.042	0.001	0.007
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Table A 76: Potential efficiency determinants with bias-corrected efficiency scores, skilled birth attendance ratio rural/urban (enlarged sample)

	(1)	(2)	(3)	(4)	(5)
Out-of-pocket health expenditure (Perc.)	−0.002				−0.002
	(0.003)				(0.002)
Hospital beds (per 1,000 people)	0.145				0.013
	(0.103)				(0.020)
Average governance quality		0.487		0.215***	0.151**
		(0.361)		(0.076)	(0.075)
Medium term sectoral vision			0.174	0.018	0.018
			(0.119)	(0.033)	(0.031)
Setting and monitoring plans and objectives			0.139	0.012	0.016
			(0.160)	(0.043)	(0.044)
Constant	0.866***	1.232***	0.597***	0.931***	0.971***
	(0.159)	(0.437)	(0.135)	(0.098)	(0.122)
Sigma	0.124***	0.148***	0.135***	0.086***	0.085***
	(0.042)	(0.047)	(0.051)	(0.018)	(0.017)
Observations	59	63	41	41	40
Number of efficient units	0	0	0	0	0
Log likelihood, initial truncated regression	124.797	129.061	79.955	89.304	87.195
Model significance, p-value	0.294	0.177	0.343	0.015	0.057
Number of bootstrap repetitions	1000	1000	1000	1000	1000

Notes: Bootstrapped standard errors in parentheses (1,000 replications). Stars denote statistically significant coefficients at the 1% (***), 5% (**) and 10% (*) levels.

Figure A 1: Comparison of country average efficiency scores, life expectancy at birth

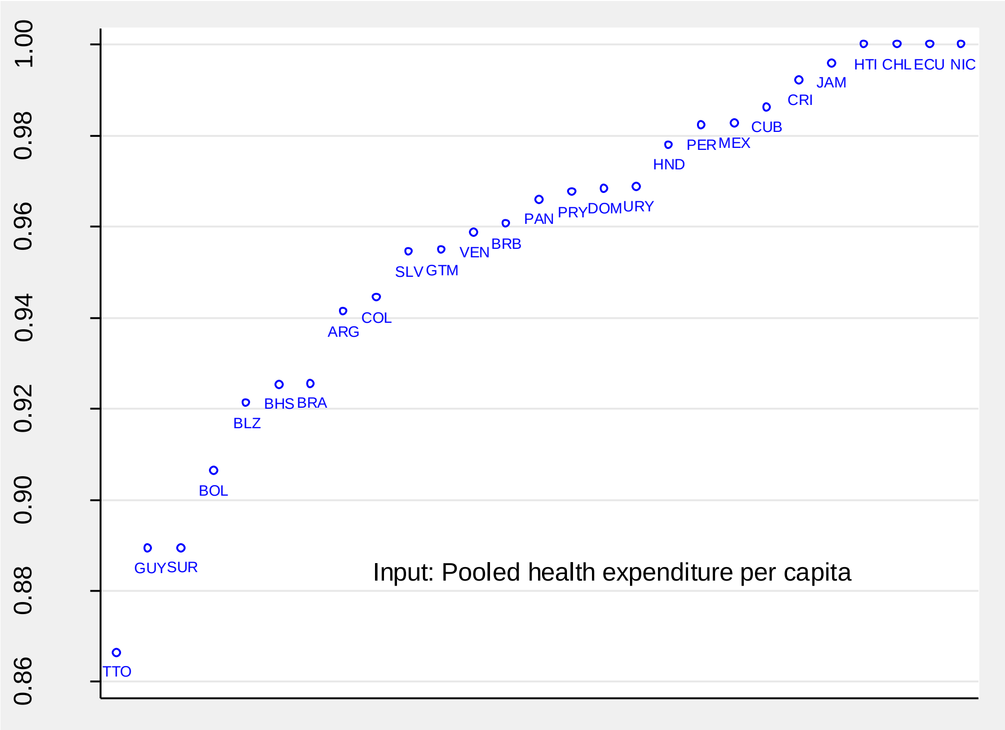


Figure A 2: Comparison of country average efficiency scores, under-five mortality rate

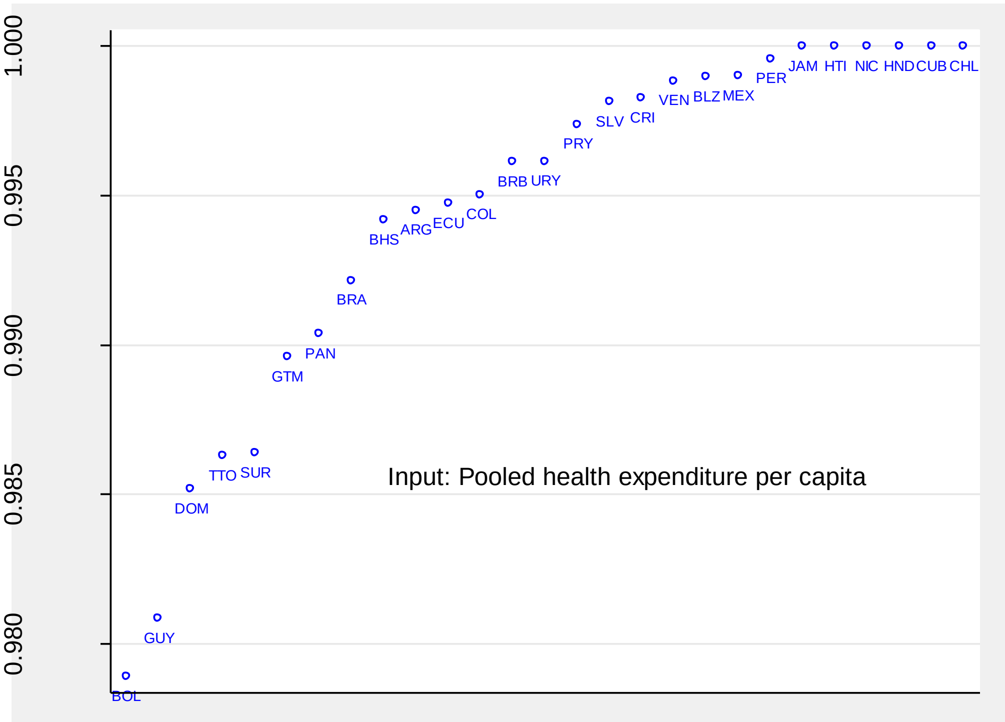


Figure A 3: Comparison of country average efficiency scores, DALYs lost

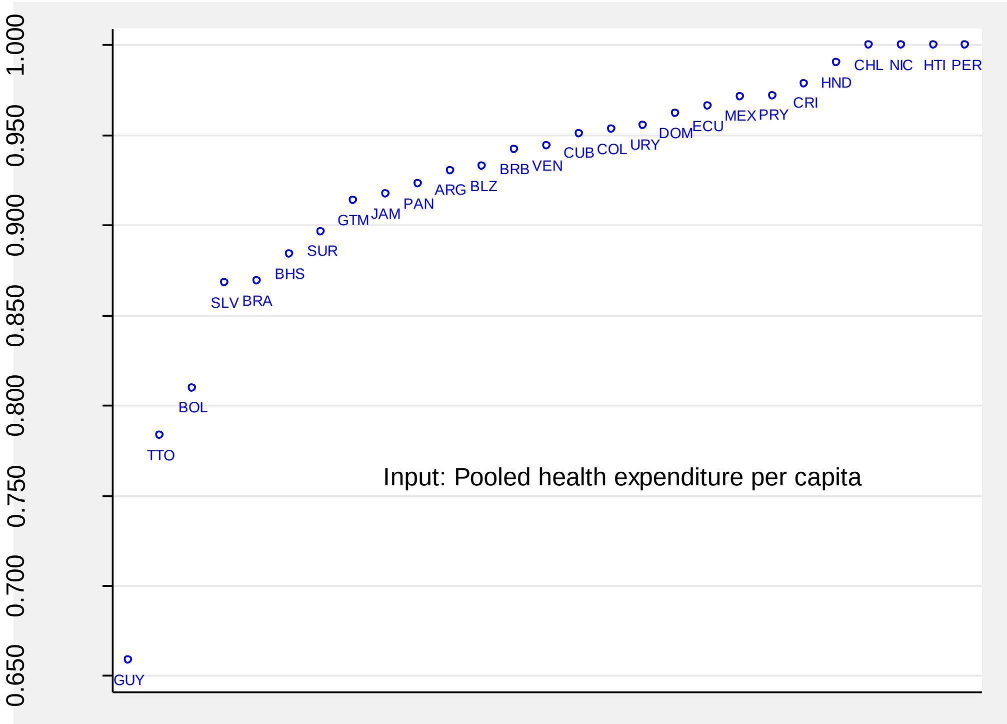


Figure A 4: Comparison of country average efficiency scores, skilled birth attendance rate

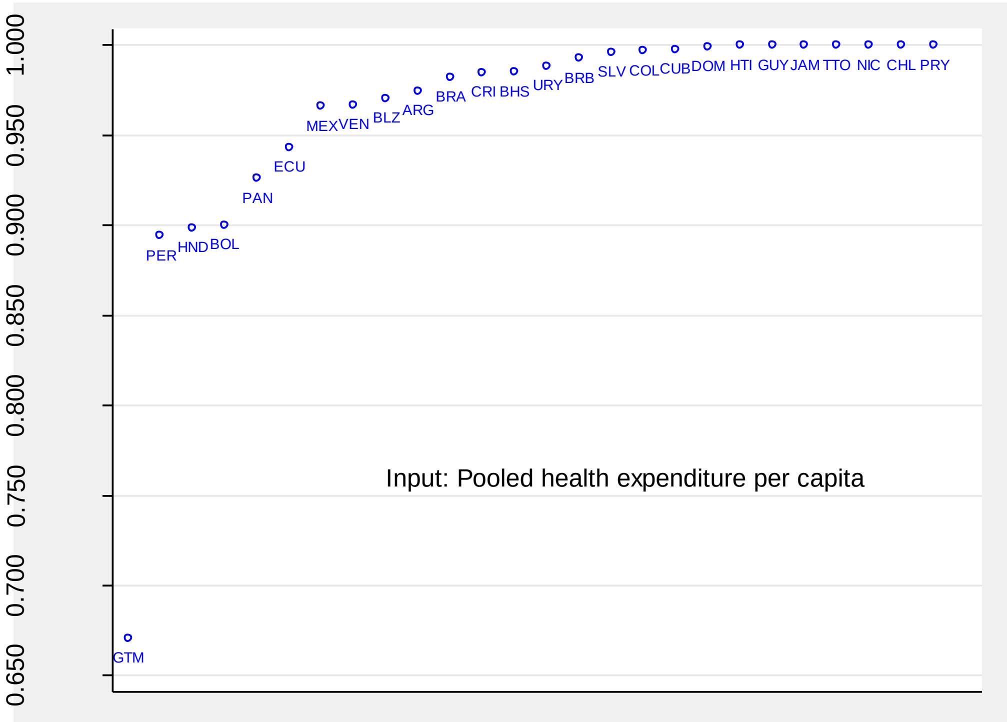


Figure A 5: Comparison of country average efficiency scores, DPT immunization rate

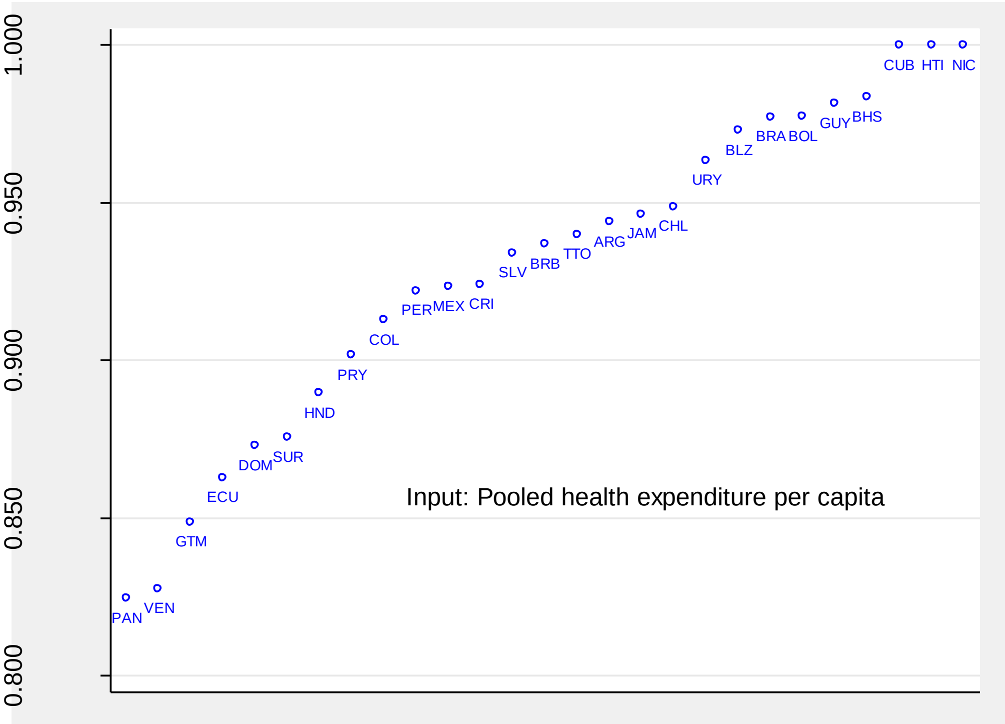


Figure A 6: Comparison of country average efficiency scores, skilled birth attendance ratio poorest/richest

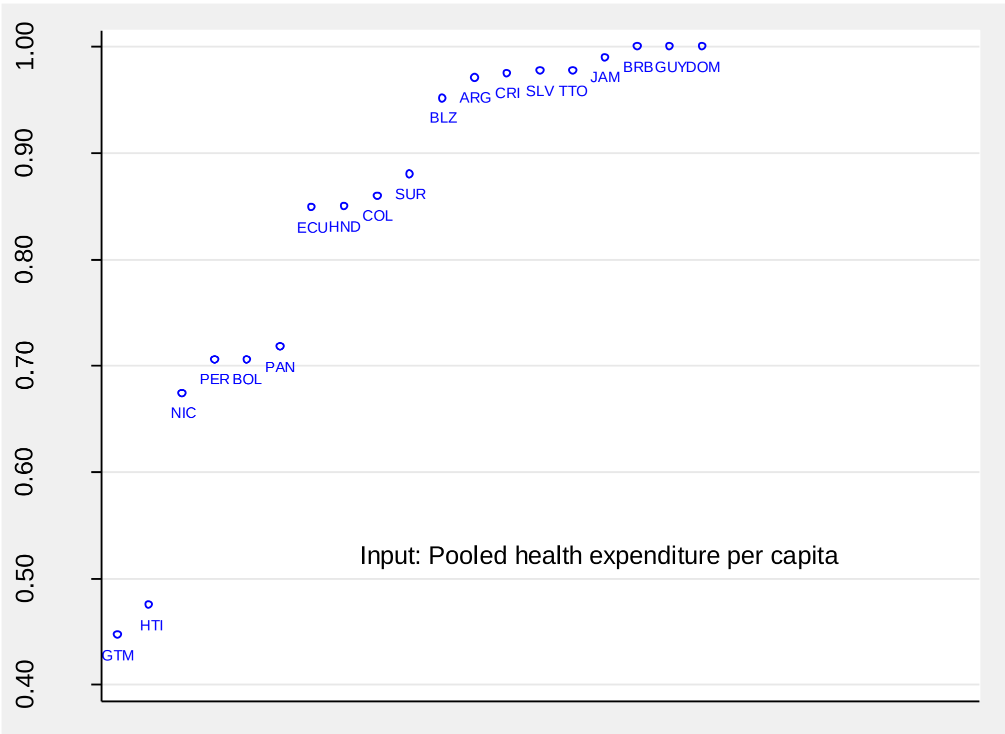


Figure A 7: Comparison of country average efficiency scores, skilled birth attendance ratio rural/urban

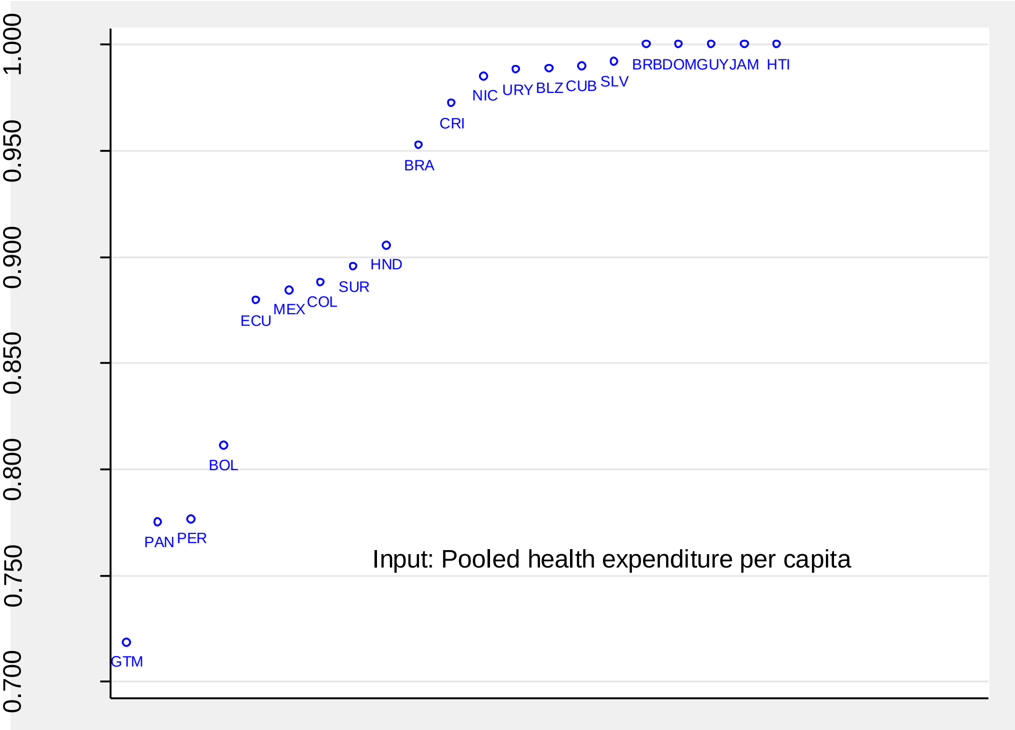


Figure A 8: Potential gains by country (average, minimum and maximum across three DEA models), life expectancy at birth

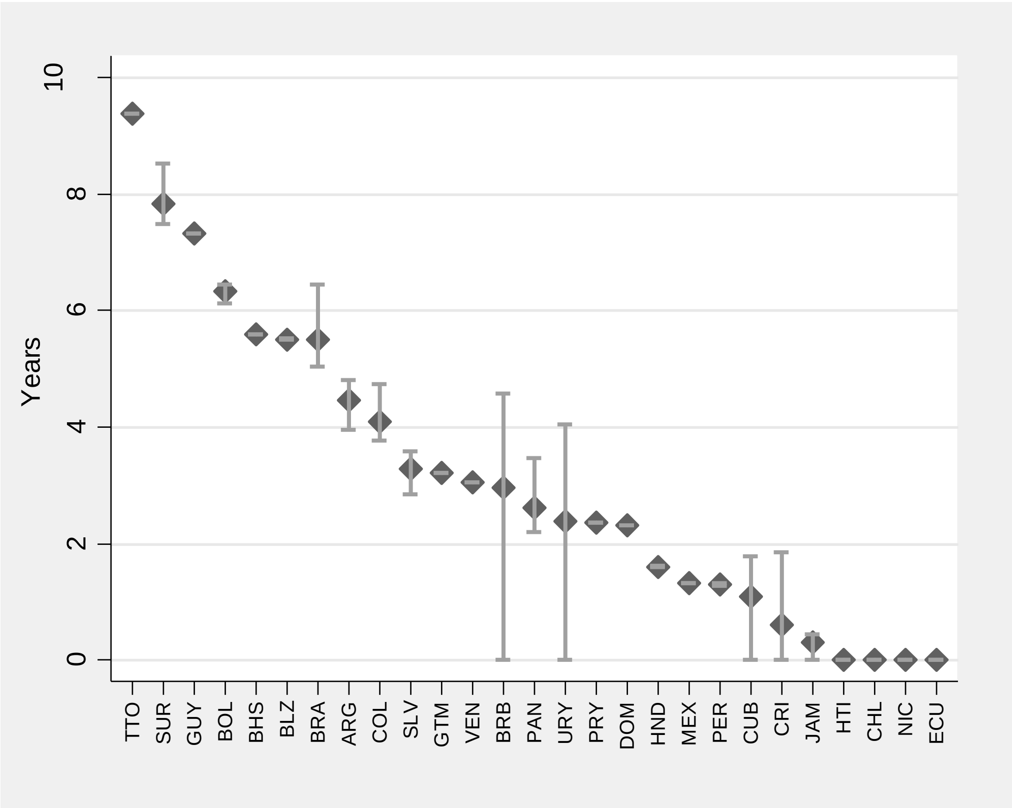


Figure A 9: Potential gains by country (average, minimum and maximum across three DEA models), under-five mortality rate

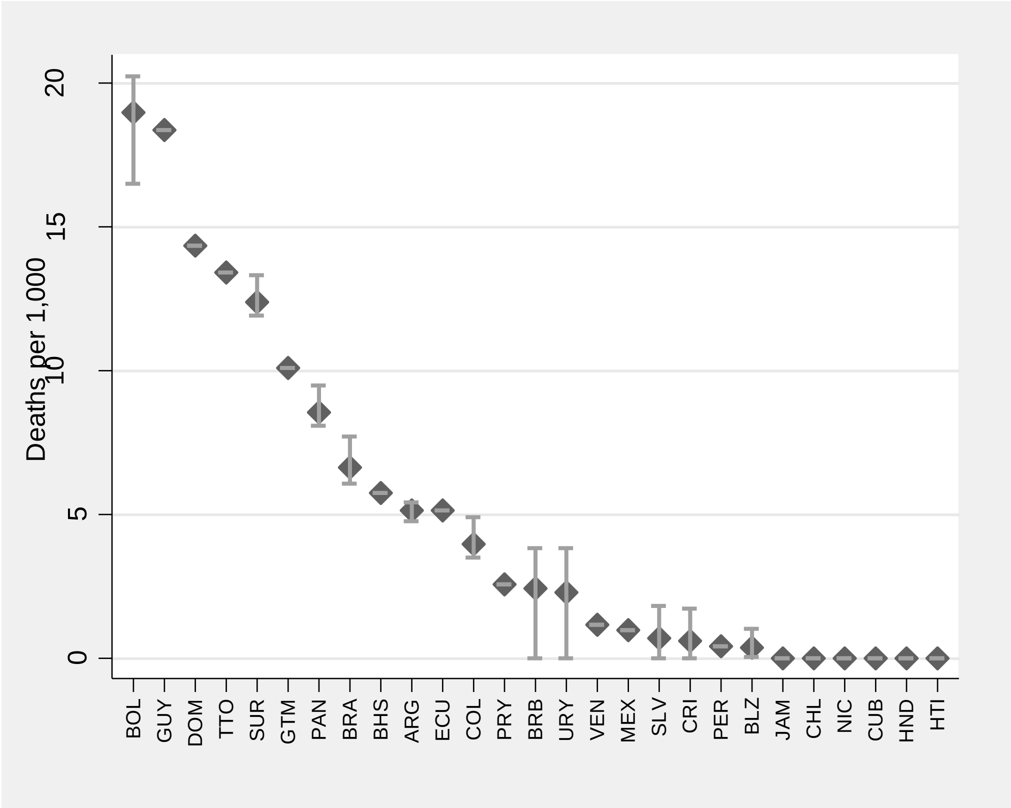


Figure A 10: Potential gains by country (average, minimum and maximum across three DEA models), DALYs lost

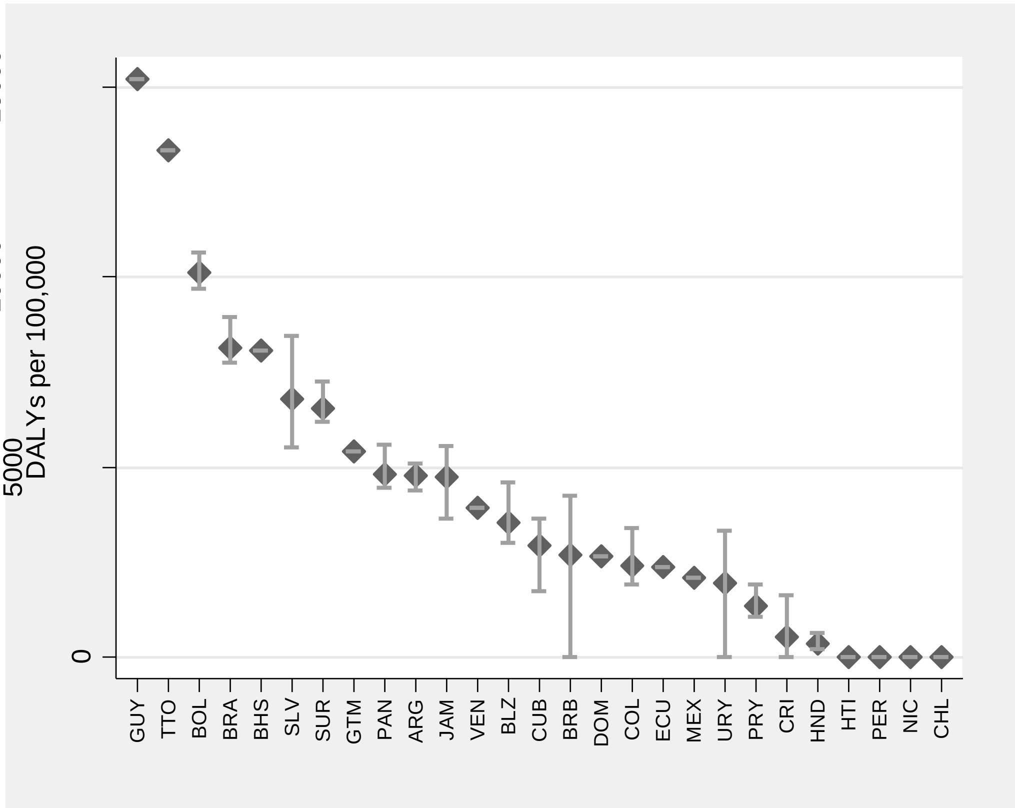


Figure A 11: Potential gains by country (average, minimum and maximum across three DEA models), skilled birth attendance rate

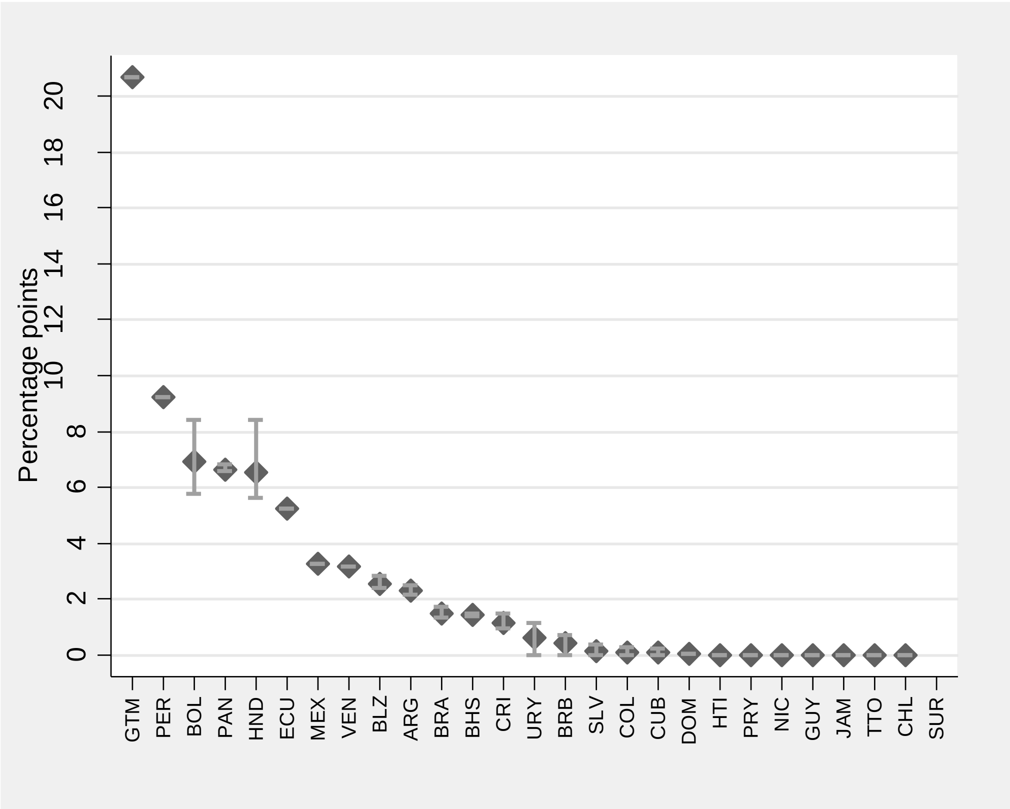


Figure A 12: Potential gains by country (average, minimum and maximum across three DEA models), DPT immunization rate

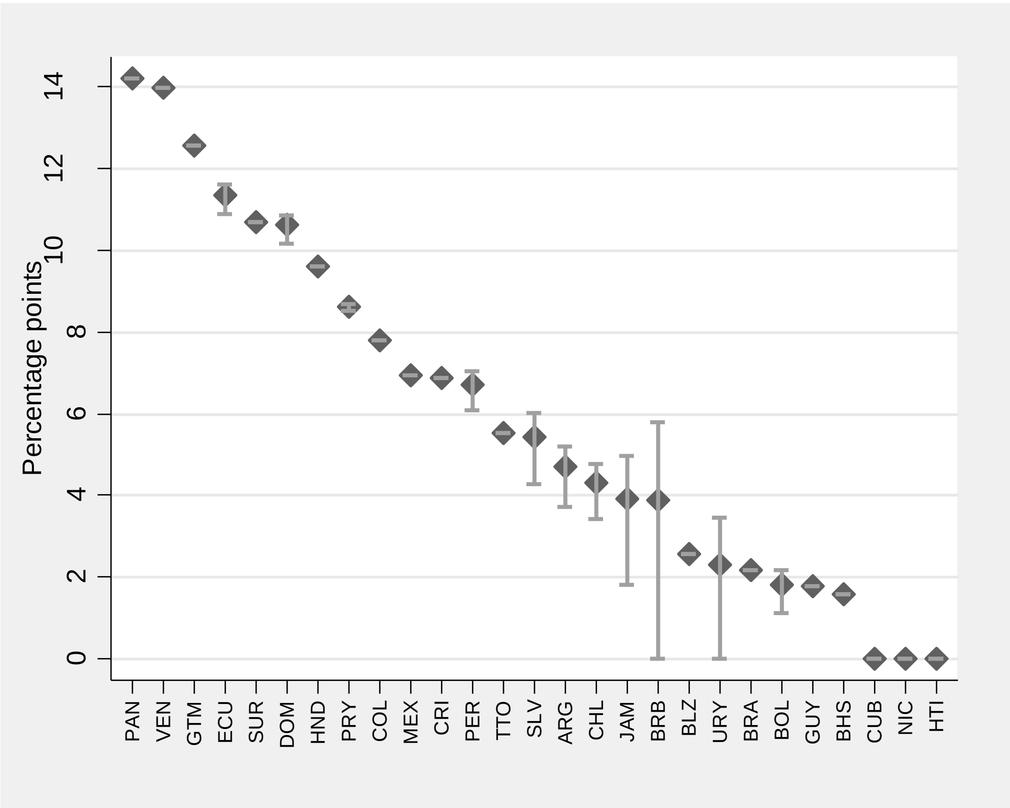


Figure A 13: Potential gains by country (average, minimum and maximum across three DEA models), skilled birth attendance ratio poorest/richest

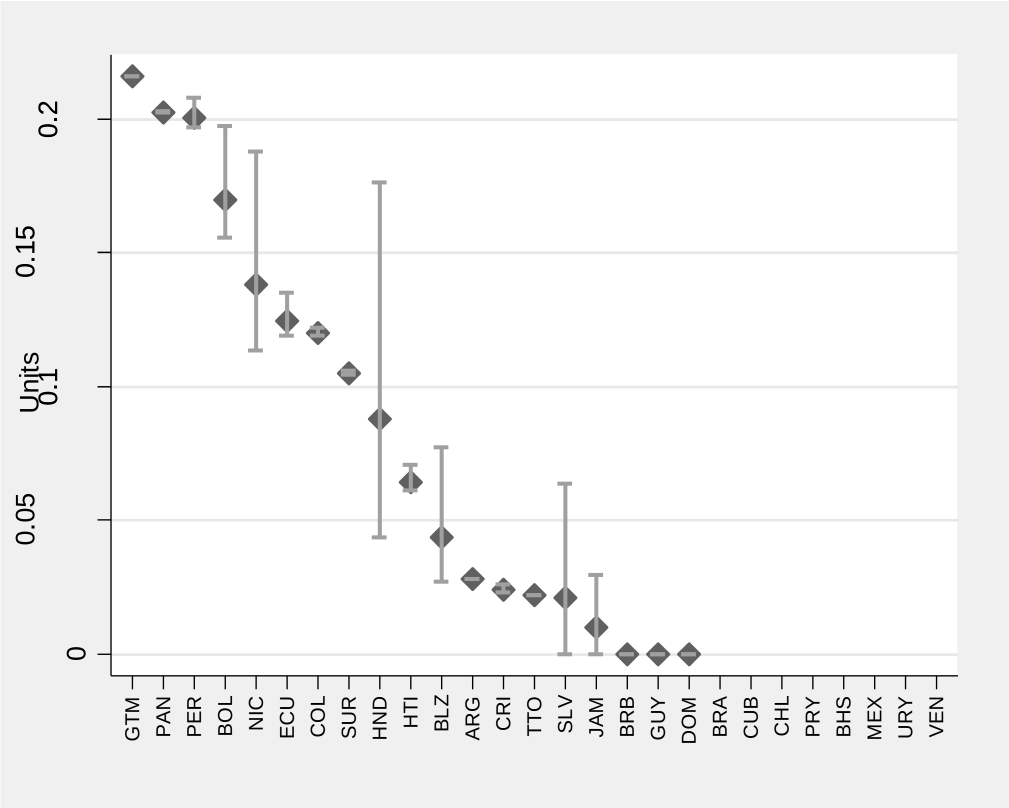


Figure A 14: Potential gains by country (average, minimum and maximum across three DEA models), skilled birth attendance ratio rural/urban

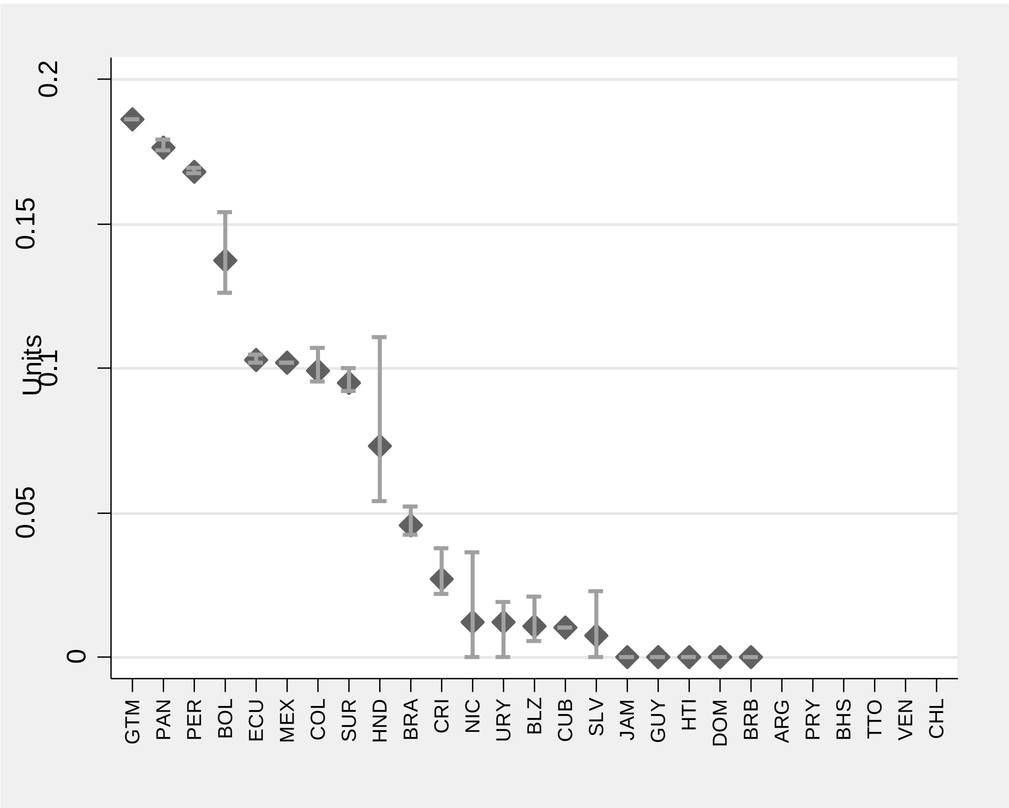
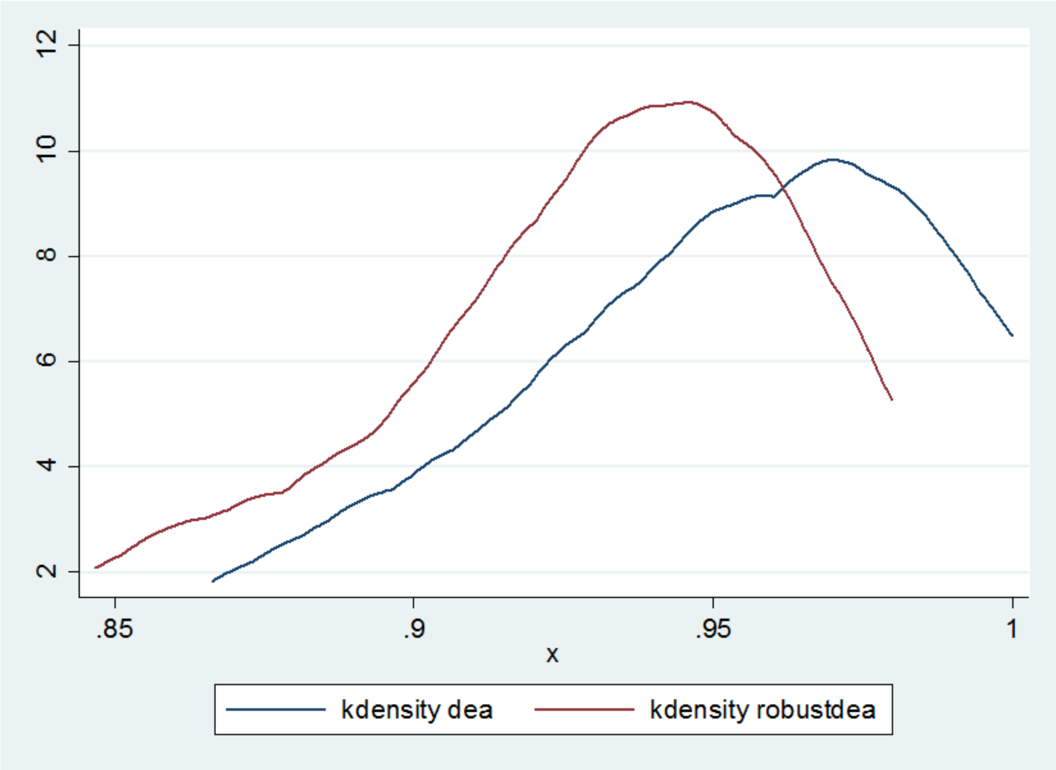
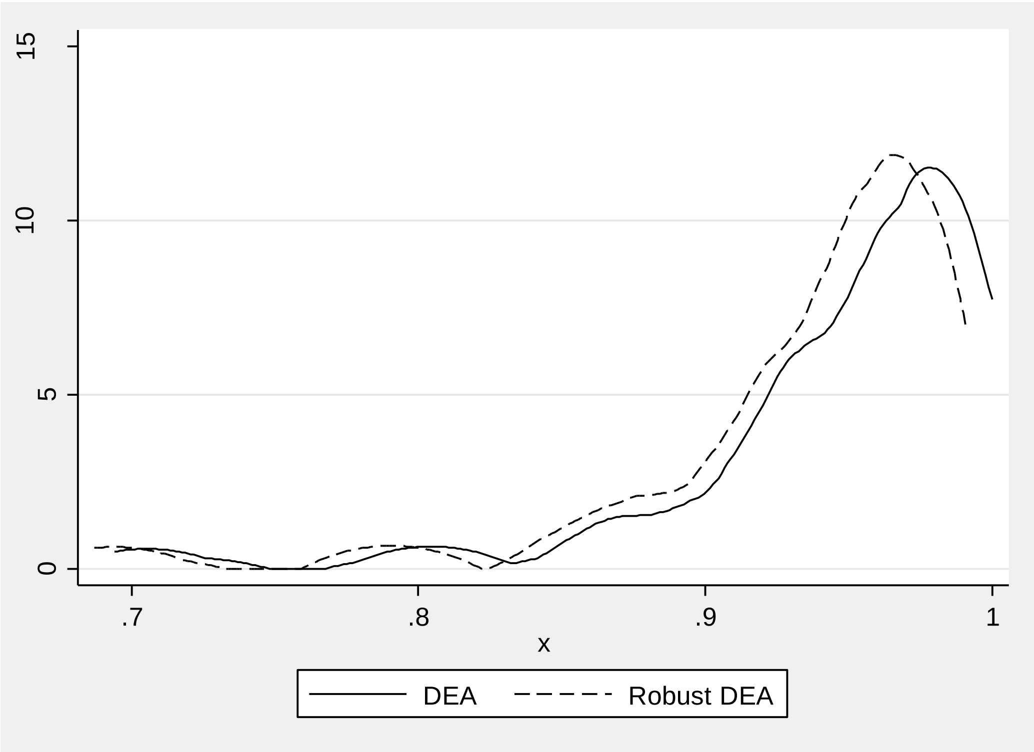


Figure A 15: Comparison of the distributions of DEA efficiency scores obtained from 'naïve' and bias-corrected estimation approaches, life expectancy at birth



Notes: "kdensity dea" = efficiency scores from 'naïve' approach. "kdensity robustdea" = efficiency scores from bias-corrected approach.

Figure A 16: Comparison of the distributions of DEA efficiency scores obtained from 'naïve' and bias-corrected estimation approaches, life expectancy at birth (enlarged sample)

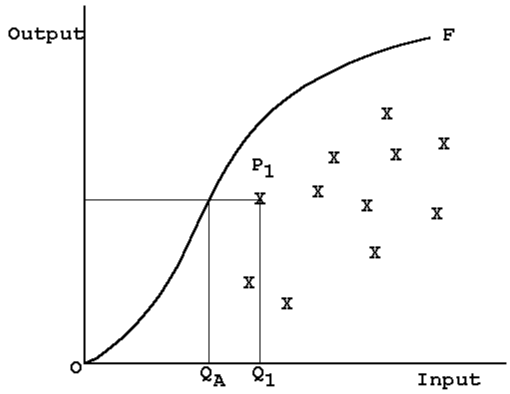


Notes: "DEA" = efficiency scores from 'naïve' approach. "Robust DEA" = efficiency scores from bias-corrected approach.

Annex B: The economic principles of DEA

Suppose there are a number of directly comparable organizations producing a single output, and that only one input is required to produce the output. Then we might observe a situation as shown in Figure B 1. The curve OF represents the production frontier, showing, for a given level of input, the maximum output that is technically feasible. All organizations (shown as crosses) must therefore in practice lie on or below this curve.

Figure B 1: Production frontier, one input one output



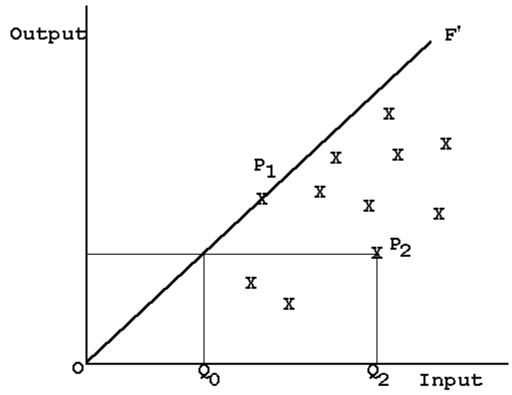
Clearly organization P_1 is not 100% efficient. At its chosen level of output, it should be possible for P_1 to reduce its inputs from OQ_1 to OQ_A. In his seminal paper, therefore, Farrell (1957) deems the ratio $E_1 = OQ_A/OQ_1$ to be a reasonable measure of technical efficiency. It takes no account of price data, so there is no way of telling if the chosen level of output is optimal in an allocative sense. The measure E_1 always lies between zero (no output) and one (total efficiency).

In practice the nature of the curve OF is rarely known. Practical considerations therefore demand some simplifying assumptions. The obvious first one is:

Assumption 1: There are constant returns to scale. That is, the curve OF is a straight line through the origin.

This means that we can easily identify the most efficient organization: it is that with the highest ratio of output to input. This is ratio analysis at its simplest. Figure B 2 reproduces Figure B 1 with the theoretical production frontier replaced by a linear production frontier OF'.

Figure B 2: Linear production frontier, one input one output



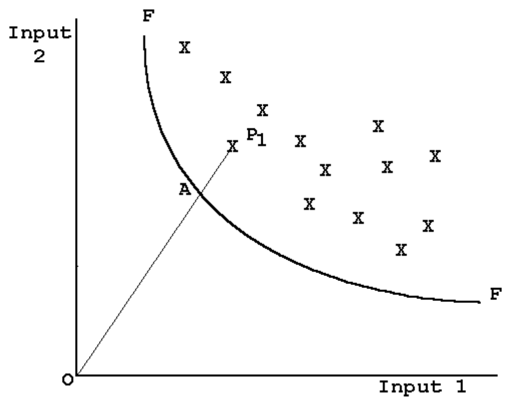
The problem of identifying the slope of OF' has been solved by employing:

Assumption 2: The production frontier is defined by the most efficient organization. That is, there is always at least one efficient organization that defines the frontier, all inefficient organizations lying below the frontier.

By this criterion, P_1 is now efficient. The technical efficiency of the inefficient organization P_2 is measured by the ratio $E_2 = OQ_0/OQ_2$, where the point Q_0 has been determined not by some 'ideal' efficiency (as in Figure B 1), but by the performance of another organization P_1 which appears to make better use of resources. In general, there is no way of knowing whether this empirical measure of efficiency overestimates or underestimates the true technical efficiency of an organization; that is, the measure of efficiency we should obtain if the curve OF were known.

Figure B 3 illustrates the case with two inputs, but still a single output. Because of the constant returns to scale assumption, we can represent in two dimensions the inputs required by each organization to produce a given level of output. All organizations therefore lie on the production frontier FF (if they are efficient) or above it (if they are inefficient). The curve FF is the usual isoquant of economic theory. A measure of the technical efficiency of P_1 analogous to the one input case is then OA/OP_1. This shows the extent to which each of the inputs could be reduced if P_1 were efficient, whilst retaining the same mix of inputs. Notice that the ratio is independent of the scales on which the inputs are measured.

Figure B 3: Production isoquant, two inputs



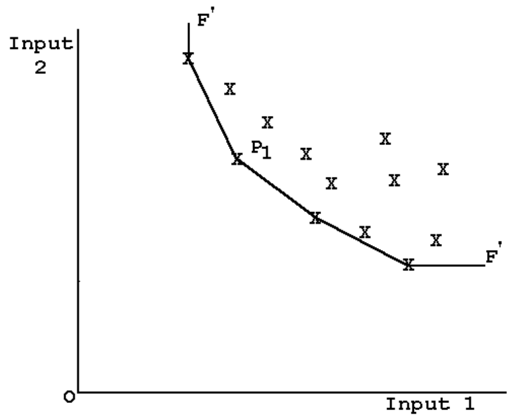
To make this notion empirically useful, the curve FF must once again be approximated with reference to the observed performance of organizations. Farrell's solution was to make the most conservative estimate of the frontier. This requires:

Assumption 3: The production frontier is convex to the origin, and has nowhere a positive slope. That is, along the frontier, reduced use of one input necessitates an increase (or certainly no decrease) in the use of the other input in order to maintain production.

Then the estimated frontier for the situation in Figure B 3 is defined by the curve F'F' in Figure B 4. This has the property that no segment has a positive slope, and no organization lies between it and the origin. The curve extends to infinity from the points with the lowest use of input per unit of output. Efficiency is now measured relative to this estimated isoquant, and P_1 is deemed efficient.

Figure B 4 shows the estimated isoquant for just one level of output. Because of the assumption of constant returns to scale, the complete production frontier (for all levels of output) is easily inferred. By including output as a third dimension, it is possible to envisage the production frontier as a series of planes, extending from the origin, and passing through the line segments making up F'F'. All observed organizations lie on or within this 'envelope' of planes. This argument can be readily extended to any number of inputs and a single output.

Figure B 4: Piecewise linear isoquant, two inputs



Farrell's method lay neglected for many years. However, a paper by Charnes, Cooper and Rhodes stimulated fresh interest in the approach. One development was the ability to handle multiple outputs as well as inputs, which turns out to be computationally (if not conceptually) relatively straightforward using mathematical programming techniques. If there are *m* inputs and *s* outputs, then the production frontier becomes a surface in *m*+*s* dimensional space. The efficiency of an organization is determined by the maximum distance it lies from that efficient surface - that is, the maximum extent to which it could improve all of its outputs - given that its existing level of inputs cannot be increased. Under the constant returns to scale assumption, this is equivalent to asking how much the organization's inputs could be reduced while maintaining existing output. The full mathematical formulation of the technique is known as data envelopment analysis (Charnes, Cooper and Rhodes 1978).

Since then the theory and practice of DEA has developed enormously (Emrouznejad et al. 2008), although the basic principles remain unchanged. Compared to statistical methods, DEA has some attractive features. It requires none of the restrictive assumptions required to undertake regression methods. It can handle multiple inputs and multiple outputs simultaneously, and it requires none of the stringent model testing that is required of statistical techniques. Furthermore, if the interest lies in multiple criteria (i.e. outputs) to assess the performance of organizations, DEA does not require the analyst to pre-define weights for these criteria – yet the method is flexible enough to accommodate alternative weighting schemes in the analysis if desired.

However, DEA also suffers from some drawbacks. It can be vulnerable to data errors, because the DEA 'best practice' frontier is composed of a small number of highly performing organizations, and the performance of all other units is judged in relation to that frontier. Little can be said about organizations on the best practice frontier, as they are used as the

basis for assessing the performance of all other organizations. Also, as more outputs (or more environmental – uncontrollable – factors) are included, an increasing number of organizations are likely to lie on the 'best practice' frontier, reducing the capacity to discriminate between organizations. This may be appropriate, but requires careful scrutiny. Finally, DEA measures technical efficiency and ignores allocative efficiency or overall cost-effectiveness. This means that an organization might be deemed efficient using DEA, but only if a zero weight is placed on an important output. This means that careful attention should be given to the 'slacks' on each input and output, as well as to the overall efficiency score.

Therefore, although DEA is a useful tool for exploring large and complex datasets and making preliminary comparisons, it is less well suited to testing hypotheses and drawing statistical inferences. Any DEA analysis should therefore examine a range of modelling perspectives in order to identify the sensitivity of judgments to different technical choices.