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The Efficiency of Government Expenditure: Experiences from Africa

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Abstract

This paper assesses the efficiency of government expenditure on education and health in 38 countries in Africa in 1984-95, both in relation to each other and compared with countries in Asia and the Western Hemisphere. The results show that, on average, countries in Africa are less efficient than countries in Asia and the Western Hemisphere; however, education and health spending in Africa became more efficient during that period. The assessment further suggests that improvements in educational attainment and health output in African countries require more than just higher budgetary allocations.

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SUMMARY

This paper attempts to provide a cross-country comparison of the efficiency of government expenditure on education and health in 38 countries in Africa during 1984-95 by using data on public sector inputs and outputs in education and health and Free Disposal Hull (FDH) analysis--a technique developed to empirically assess the efficiency of production in a market environment.

FDH analysis distinguishes between efficient and inefficient producers. All efficient producers are assumed to be on the production possibility frontier, which indicates the maximum output at a given level of input. The degree of inefficiency can be measured by the efficiency score, which measures the distance of the inefficient producer to the production possibility frontier.

The results of the FDH analysis reveal wide-ranging differences in the efficiency of government spending on education and health in Africa. On the basis of standards established by other countries in Africa, Asia, and Western Hemisphere in providing education and health services, The Gambia, Guinea, Ethiopia, and Lesotho score relatively well, while Botswana, Cameroon, Côte d'Ivoire, and Kenya do not. The results suggest that the productivity of government spending on education and health has improved over time in Africa, although the average level of efficiency has declined in comparison with Asia and the Western Hemisphere. The observed inefficiencies in countries in Africa seem unrelated to the level of private spending, but may be connected to the share of government wages in total spending. The results also indicate that the degree of inefficiency is higher at higher levels of per capita spending.

The central message of this paper is that increasing budgetary allocations for education and health may not be the only or most effective way to increase education and health output, and that more attention should be given to increasing the efficiency of expenditure.

I. Introduction

Governments provide a host of goods and services to their populations, to achieve various economic and social objectives. The efficiency with which these goods and services are provided is important, not only in the debate on the size of the government and the possible role of the private sector[1] but also in macroeconomic stabilization and economic growth. The purpose of this paper is to assess the efficiency of government spending on education and health in 38 countries in Africa, both in relation to each other and in comparison with countries in Asia and the Western Hemisphere. Besides ranking countries within Africa for their efficiency during a given time period and over time, this paper assesses changes in efficiency in the three regions.

Governments can be viewed as producers, engaged in the production of different outputs by combining labor with other inputs. For instance, governments finance teachers and books to reduce illiteracy, and pay for medical facilities and personnel to increase their populations' life expectancy. Governments that produce more of these outputs while spending less on inputs can be viewed as more efficient than governments that produce less outputs and use more inputs, other things being equal.

This paper shows that governments in some African countries are relatively inefficient in the provision of education and health services, both in relation to other African countries and to those in Asia and the Western Hemisphere. This implies that higher budgetary allocations to the social sectors in these countries will not necessarily translate into an improvement of their social outcomes, unless specific measures are implemented to correct the underlying inefficiency in spending.

This paper is structured as follows. Section II provides a selective overview of the literature on the efficiency of government expenditure and lays out the paper's methodology. Section III tests the statistical relationship between government spending and output indicators; it also provides an analysis of the efficiency of government spending of African countries relative to each other and to those in Asia and the Western Hemisphere, and over time. Section IV summarizes the results and the policy implications.

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[1]Using a regression that relates government consumption to the rate of economic growth, Karras (1996) estimates the optimal size of the government at an average of 23 percent of GDP. This study also finds that government services are overprovided in Africa, underprovided in Asia, and optimally provided elsewhere. Tanzi and Schuknecht (1997), on the other hand, find that the increase in public spending in many industrial countries since 1960 has been excessive in relation to its impact on social welfare, as measured by certain social and economic indicators.

II. MEASURING THE EFFICIENCY OF GOVERNMENT EXPENDITURES

Several approaches for measuring the efficiency of government expenditure have been proposed in the literature. In general, these approaches either do not allow for easy comparison of efficiency among countries or use proxies to gauge efficiency. The main advantage of the technique employed in this paper is that it allows for a direct measurement of the relative efficiency of government spending among countries.

A. Measuring the Efficiency of Government Expenditure: a Selective Overview

Studies of the efficiency of government spending have developed broadly along four lines. First, some studies have concentrated on gauging and enhancing efficiency in practical applications, often focusing on certain types of government spending in a specific country. Second, the efficiency of governments has been addressed in quantitative terms, using data on inputs of government spending but not on outputs. Third, some studies have assessed the efficiency of public spending using outputs but not inputs. Finally, other studies have looked at both inputs and outputs; these studies, however, have not made a consistent comparison of the efficiency of government spending among countries.

The issue of gauging and enhancing government efficiency continues to interest policymakers and researchers alike (Chu and Hemming, 1991; Chu and others, 1995). This interest received a boost with the initiation of wide-ranging institutional reforms by the Government of New Zealand in the late 1980s, aimed at improving the efficiency of the public sector (Scott, 1996). The central elements of these reforms were to separate policy formulation from policy implementation, create competition between government agencies and between government agencies and private firms, and develop output-oriented budgets using a wide array of output indicators. One reform objective was to transform government institutions to reflect the distinction between outputs—the goods or services produced by the government—and outcomes—the goals that the government wants to achieve with the outputs. Elements of this approach have been adopted by many countries, and the theory and practice of result-oriented public expenditure management has generated a wealth of information on how to control production processes within the government and how to enhance their efficiency (Oxley and others, 1990; and OECD, 1994).

Inefficiency in government spending has been assessed with the help of regression analysis, focusing on inputs. For example, a study of OECD member countries covering 20 years (Gerdtham and others, 1995) analyzed the efficiency of health care systems. They show that public-reimbursement health systems, which combine private provision with public financing, are associated with lower public health expenditures and higher efficiency than publicly managed and financed health care systems.[2] This is traced to the high incidence of

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[2]Gerdtham and others (1995) gauge efficiency by looking at factors associated with a high

(continued...)

relatively expensive in-patient care and the lack of a mechanism to restrain demand for specialized health care. Countries without ceilings on in-patient care were also found to have higher public health expenditure.

Another strand of literature has focused on differences in social indicators among countries (used as indicators of government outputs) after netting out the effect of economic development on these indicators. For example, a number of studies have found that when differences in income levels and rates of economic growth are taken into account, Sri Lanka's social indicators outperform those of Pakistan (Isenman, 1980; Sen, 1981; and Aturupane, Glewwe, and Isenman, 1994). Kakwani (1993) conjectures that this difference in performance reflects variation in the level and efficiency of public expenditure between Pakistan and Sri Lanka. However, these studies do not explicitly analyze the relationship between government spending and social indicators.

Instead of concentrating on either inputs or outputs, the analysis of efficiency should use information contained in both inputs and outputs, and address the question of whether the same level of output could be achieved with less input—or, equivalently, whether more output could be generated with the same level of input. Therefore, a final strand of quantitative analyses look at both inputs and outputs. Harbison and Hanushek (1992) give an overview of 96 studies of education production functions in developing countries, and 187 studies of education production functions in the United States, and investigate the relation between education inputs and outputs. Typically, the studies sampled by Harbison and Hanushek specify a functional form of the production function, and use data from different schools in a region or country to estimate the coefficients for a regression of the production function. The output of the education production process is usually measured by test scores, whereas input use is gauged by indicators, such as the pupil-teacher ratio, teacher education, teacher experience, teacher salary, expenditure per pupil, and the availability of facilities. It is found that in most studies of developing countries, teacher education, teacher experience, and the availability of facilities have a positive and significant impact on education output, and that the effect of expenditure per pupil is significant in half the studies; the pupil-teacher ratio and teacher salary have no discernable impact on education output.

Jimenez and Lockheed (1995) assess the relative efficiency of public and private education in several developing countries by taking into account both inputs and outputs. They compare for each country the ratio of test scores to the average cost per pupil. This ratio

[2](...continued)
degree of inefficiency, such as the share in total spending of in-patient care and specialized care.

measures the cost per pupil in the two education systems corrected for test score differences, and is in all cases lower for private education than for public education—in some instances, by a large margin.[3] However, this type of analysis only allows for establishing the efficiency of public education relative to that of private education within a country.

More recently, Tanzi and Schuknecht (1997) assess the incremental impact of public spending on social and economic indicators (for example, real growth and the mortality rate) in industrial countries. From a comparison of social indicators in countries with varying income levels, they conclude that higher public spending does not significantly improve social welfare.

B. Free Disposal Hull (FDH) Analysis

The FDH analysis method used in this paper has been developed to empirically assess the relative efficiency of production units in a market environment.[4] The contribution of this paper lies in applying FDH analysis to measuring efficiency of government spending in developing countries.[5] [6] FDH analysis consists of, first, establishing the production possibility frontier representing a combination of best-observed production results within the sample of observations (the "best practices"), and, second, measuring the relative inefficiency of producers inside the production possibility frontier by the distance from the frontier.

The major advantages of FDH analysis are that it imposes only weak restrictions on the production technology, while allowing for a comparison of efficiency levels among producers. The only assumption made is that inputs and/or outputs can be freely disposed of, so that it is possible with the same production technology to lower outputs while maintaining the level of inputs and to increase the inputs while maintaining outputs at the same level. This assumption guarantees the existence of a continuous FDH, or production possibility frontier, for any sample of production results. Thus, FDH analysis provides an intuitive tool that can be used to identify best practices in government spending and to assess how country governments are faring in comparison with these best practices.

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[3]In Thailand, for example, the cost per pupil of public education is almost seven times as high as in private education, taking into account the differences in test scores.

[4]FDH analysis was first proposed in a study of the relative efficiency of post office operations in Deprins, Simar, and Tulkens (1984). An excellent overview of the methodology can be found in Tulkens (1993); the issue of technological change and shifts in the production possibility frontier is dealt with in Tulkens and Vanden Eeckhaut (1995).

[5]Fakin and de Crombrugghe (1997) have applied the FDH analysis in assessing the efficiency of government spending in a study of Central European and OECD member countries.

[6]Throughout this paper, the term "producer" is meant to include governments.

FDH analysis shows that a producer is relatively inefficient if another producer uses less input to generate as much or more output. A producer is relatively efficient if there is no other producer that uses less input to generate as much or more output. In Figure 1, this is illustrated for the case of one input and one output. Producer *B* uses more input to produce less output than producer *A*, and is therefore relatively inefficient in comparison with producer *A*. Producer *C* is relatively efficient; there is no producer in the sample that has lower input as well as higher output. Producers *A* and *B* have lower input, but also lower output than producer *C*; producer *D* has higher input as well as higher output than producer *C*. By the same reasoning, producer *D* is also relatively efficient.

If a producer is engaged in the production of multiple outputs using more than one input, it becomes more difficult to establish relative efficiency. In FDH analysis, it is postulated that *a producer is relatively inefficient if he uses as much or more of all inputs to generate as much or less of all outputs than another producer, with at least one input being strictly higher, or one output strictly lower*. Producers that are not relatively inefficient are relatively efficient.

FDH analysis establishes the degree of efficiency in the following way. The first step is to identify the relatively efficient production results in the sample. In Figure 1, the relatively efficient production results are *A*, *C*, and *D*. Given that producer *A*'s production result is feasible and there is free disposal, all production results where at least as much input is used to generate the same level of output, or less, are also feasible. These relatively inefficient production possibilities are identified by the rectangular area to right and below producer *A*, which contains producer *B*. Similarly, the rectangular areas to the right and below producers *C* and *D* identify relatively inefficient production possibilities. If there is no observation in the rectangular area to the left and above an observed production result, the latter production result is among the relatively efficient production results in the sample of observations. The border of the set of production possibilities—that is, all the production results to the right of and below the relatively efficient observations—is given by the bold line connecting *A*, *C*, and *D* in Figure 1. This is the production possibility frontier, or FDH. Notice that free disposal is required to obtain a continuous production possibility frontier. In the absence of that assumption, it could not be inferred that all output combinations on the line connecting *A*, *C*, and *D* are feasible.

It should be noted that a producer can be relatively efficient, even though no producer is inefficient in relation to it (i.e., there is no producer in the rectangular area to the right of and below the relatively efficient producer). Such producers are assumed to be on the production possibility frontier. Producers that are efficient by default will here be called *independently efficient.*[7]

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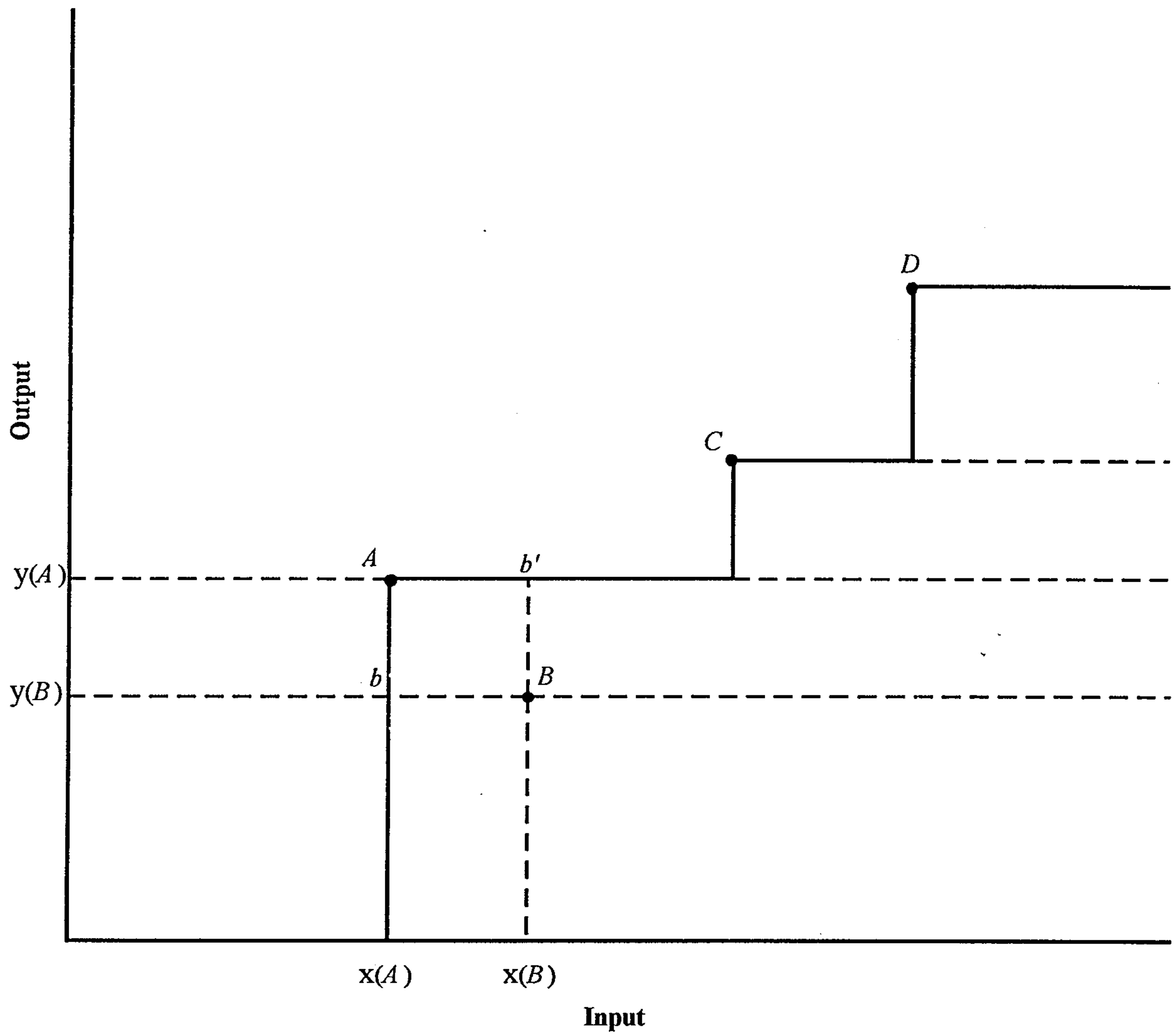
[7] Examples of independently efficient production results are producers *C* and *D* in Figure 1. Producer *A* is not independently efficient, as producer *B* is inefficient in relation to *A*.

Figure 1. Free Disposable Hull (FDH) Production Possibility Frontier



By applying the efficiency criterion described above, a distinction can be made between relatively efficient production results (production results on the production possibility frontier) and relatively inefficient production results (production results in the interior of the production possibility set). However, for a meaningful comparison of efficiency between producers, a more refined measure of efficiency is needed that enables a ranking of production results. This measure is the *efficiency score*, which represents the distance of individual production results to the production possibility frontier. This is the second and final step in establishing the degree of efficiency.

The calculation of a producer's efficiency score can be illustrated using the example in Figure 1. Producer *B* is the only relatively inefficient producer in the figure. FDH analysis suggests two alternative ways of measuring the distance of producer *B*'s production result from the production possibility frontier: from either the input side or from the output side. In input terms, the distance is given by the line *bB*, that is, the quotient of inputs used by producer *A* over inputs used by producer *B*, $x(A)/x(B)$. This measure of efficiency is referred to as the input efficiency score. For all observations in the interior of the production possibility set, the input efficiency score is smaller than 1. For all observations on the production possibility frontier (producers *A*, *C*, and *D*) the efficiency score is 1. The input efficiency score indicates the excess use of inputs by the inefficient producer, and therefore the extent to which this producer allocates its resources in an inefficient manner. On the output side, the efficiency score of producer *B* is given by the line *b'B*, that, is the output quotient $y(B)/y(A)$. This score indicates the loss of output relative to the most efficient producer with an equal or lower level of inputs. As in the case of the input efficiency score, the output efficiency score is smaller than 1 for observations in the interior of the production possibility set (producer *B*) and equal to 1 for observations on the production possibility frontier (producers *A*, *C*, and *D*).

In the one-input one-output case depicted in Figure 1, formulation of an efficiency score is relatively straightforward. In case of multiple inputs and outputs, derivation of an efficiency score is more complicated. If the efficiency score were to be calculated separately for each input and output, they would differ for every combination of inputs and outputs. The approach followed in FDH analysis to overcome this ambiguity in outcome and capture input and output efficiency by single measures is explained in Appendix I.

The FDH approach contrasts significantly with alternative approaches of production possibility frontiers in empirical studies.[8] Non-FDH techniques typically assume a convex

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[8]The approaches towards assessing production possibility frontiers can be distinguished into parametric and non-parametric techniques. In parametric techniques a functional form is postulated for the production possibility frontier, and then a set of parameters is selected that best fit the sample data. Non-parametric techniques include FDH analysis and Data Envelopment Analysis (DEA). The latter technique was developed by Charnes, Cooper, and Rhodes (1978), and assumes that the production possibility set is convex. Tulkens and
(continued...)

production technology and that linear combinations of best-observed production results lie on or below the production possibility frontier. This assumption lies at the heart, for example, of the Data Envelopment Analysis (DEA) approach. With DEA, the area under the straight line connecting producer *A* and *D* would become part of the production possibility set (Figure 2). Consequently, the status of producer *C* would change; rather than being a relatively efficient unit on the production possibility frontier as under FDH, producer *C* would now be viewed as relatively inefficient, with a production result in the interior of the production possibility set. If the production technology is also assumed to feature constant returns to scale (i.e., if the technology can be described by a Cobb-Douglas production function), the production possibility frontier would be a straight line through the origin. In this case, producer *A* would be the only producer on the production possibility frontier as it would have the highest observed output-input ratio, that is, the highest average productivity.

The example in Figure 2 illustrates that FDH singles out more observations as relatively efficient than DEA and parametric techniques, thereby reducing the informational value of FDH analysis. Another drawback of FDH analysis (as well as DEA) compared with parametric techniques is that correction for random factors unrelated to efficiency is not possible and therefore statistical noise is included in the measure of inefficiency.[9] On the other hand, both DEA and parametric techniques impose more restrictions on the production technology than FDH analysis. As noted above, DEA assumes convexity whereas parametric techniques impose a functional form for the production possibility frontier. Where these assumptions inaccurately capture the production processes underlying the observed production results, the efficiency results will be affected (Ferrier and Lovell, 1990).

The above discussion suggests that the choice between different techniques of estimating efficiency is a trade-off between imposing fewer restrictions on the production technology and obtaining relatively unambiguous results (Bauer, 1990). In the case of government spending on education and health, there is little a priori justification for making certain assumptions regarding convexity and economies of scale. This argues against the use of parametric techniques, and favors the use of the relatively parsimonious FDH analysis over

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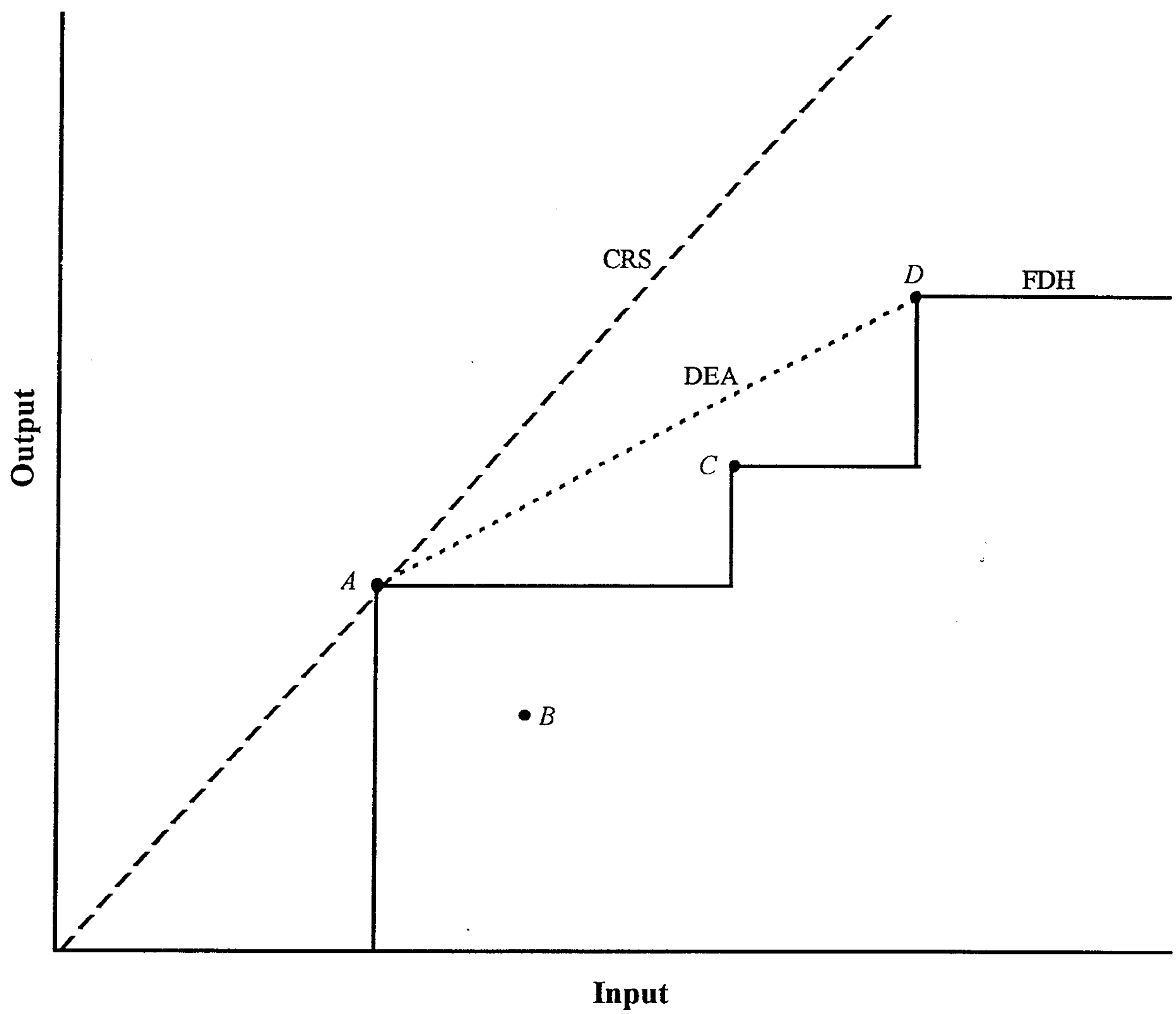
[8](...continued)
Vanden Eeckhaut (1995) provide a more comprehensive overview of the differences between FDH analysis and these alternative techniques.

[9] In the application of parametric techniques, stochastic methods can be used to correct for measurement and other random errors in the estimation of the production possibility frontier.

Figure 2. Alternative Production Possibility Frontiers: Free Disposable Hull (FDH), Data Envelopment Analysis (DEA), and Constant Returns to Scale (CRS)



DEA and parametric techniques. Moreover, as the subsequent analysis illustrates, meaningful results can be obtained in FDH analysis without imposing additional restrictions, particularly when the number of outputs included in the analysis is limited.[10]

In contrast with DEA and parametric techniques, FDH analysis has not yet been widely used in the empirical analysis of efficiency. An application to post offices in Belgium can be found in Deprins, Simar, and Tulkens (1984); FDH analyses of Belgian retail banking, courts, and urban transit are presented in Tulkens (1993). Lovell (1995) uses FDH analysis to establish the relative efficiency of 10 countries in Asia in engendering high economic growth, low inflation, low unemployment, and a favorable trade balance during 1970-88. He assumes one fixed input (the policymaker) and takes four proxies for the output of economic policy (economic growth, employment, the trade balance, and price stability). He finds that Taiwan and Japan outperform other countries, while the Philippines and Australia are at the bottom of the efficiency ranking.

Several studies have used FDH analysis to assess the efficiency of government spending, as this paper attempts to do. Vanden Eeckhaut, Tulkens, and Jamar (1993) have sought to establish relative efficiency of spending by municipalities in Belgium. They use the total population, length of roads maintained by the municipality, number of senior citizens, number of welfare recipients, number of registered crimes, and number of students enrolled in primary education as indicators of output. They compare results of FDH analysis with results from DEA, and conclude that the convexity assumption imposed by DEA distorts the results of efficiency analysis. Moreover, they find a relationship between the degree of efficiency and the political party that governs the municipality. Finally, Fakin and de Crombrugghe (1997) use FDH analysis to assess the efficiency of government spending in OECD member countries and countries in Central Europe. They use total aggregate government spending as input, and the number of patents, number of university entrants, the rates for infant mortality and life expectancy, the dependency ratio, and the number of telephone mainlines as outputs. They find that Belgium, Hungary, Italy, Poland, Slovenia, the Czech Republic, Greece, and Portugal are relatively inefficient, and that the inefficiencies are larger for transition countries than for OECD member countries.

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[10]Seiford and Thrall (1990, p. 28) offer a number of additional arguments against the use of parametric techniques for assessing efficiency, arguing that "a regression approach has a number of weaknesses: it only gives residuals; [forces a line] through [production results] usually not in the data set; does not readily yield a summary judgement on efficiency; its ability to identify sources of inefficiency is weak; is influenced by outliers; fits a function on the basis of average behavior." Moreover, Lewin and Lovell (1990, p. 3) note that nonparametric techniques are "geared toward the managerial implications of efficiency measurements, particularly in the public sector where output prices often cannot be specified."

III. EMPIRICAL RESULTS

FDH analysis is used in this paper to determine the relative efficiency of government spending on education and health. Per capita education and health spending by the government in Purchasing Power Parity (PPP) terms is taken as a measure of input.[11] Spending is measured in PPP terms [12] as it allows for a more accurate comparison of levels and quality of service among countries than conventional U.S. dollar measures and GDP shares. Output is measured by relevant social indicators: health output by life expectancy, infant mortality, and immunizations against measles and DPT;[13] and educational attainment by primary school enrollment, secondary school enrollment, and illiteracy.[14] The choice of indicators is determined by their appropriateness as measures (or close proxies) of education and health output and their availability in a wide range of countries over many years. It could be argued that some of these indicators, such as the illiteracy rate, actually measure the outcome of government spending rather than the output. However, in practice, the distinction between the concepts of output and outcome is somewhat imprecise, and although the selected variables may not directly measure output, they are indicative of the level of government output.

Before initiating an FDH analysis of the data for government spending on education and health, a regression analysis is done here to establish whether there is a statistically significant relationship between this expenditure and selected output indicators. The regression analysis is used as a test for the assumption that government spending on education

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[11]Per capita PPP public spending on education and health for the countries in the sample is calculated as the product of the respective shares of education and health spending in GDP in local currency, and GDP per capita expressed in PPP terms.

[12]Data on education and health spending are taken from IMF databases, whereas indicators of educational attainment and health output are from the World Bank database.

[13]Some caution needs to be exercised in the use of mortality indicators, because few developing countries report the cause of death and even when they do, the quality of information provided is poor. Furthermore, mortality indicators are typically derived from a common model that projects mortality for all age groups; hence, the mortality rates from the model may not necessarily reflect differences in underlying trends in health status among population groups. Finally, there is some interaction between education and health indicators; for instance, female education has a favorable impact on infant mortality.

[14]Performance in the education sector should be assessed in terms of access, completion of schooling, and achievement level. For the purposes of monitoring performance, two indicators are critical: net (age-specific) enrollment and the completion rate. However, the latter is not available for most countries, so the reliance in this paper is on (gross) enrollment rates in primary and secondary schools.

and health impacts on indicators of educational attainment and health output. The existence of a statistically significant relationship would provide the basis for the above-mentioned efficiency analysis of government spending (see also Vanden Eeckaut, Tulkens, and Jamar, 1993).

It should be noted, however, that government spending is not the only variable that impacts on indicators of education and health output. Private expenditures, including activities of NGOs, the general level of economic and social development, the manner in which government expenditure for education and health is targeted, and other factors such as the incidence of AIDS, also have a bearing on output indicators.

A. Regression Analysis

In a first set of regressions, indicators of educational attainment and health output are taken as dependent variables, with the level of education and health spending, respectively, as independent variables. These regressions are run in a log-linear form for 38 African countries, and for pooled data of 85 countries in Africa, Asia, and the Western Hemisphere (Appendix II lists the countries in the sample). Data on government spending and output indicators have been averaged over time periods because of the unavailability of annual data particularly for output indicators for many countries. The data for education spending are averaged over three periods (1984-87, 1988-91, and 1992-95); the data on health spending are averaged over two periods (1984-89 and 1990-95). The averages for these periods are treated as separate observations. Therefore, for education expenditure, a maximum of three observations are available for each country; and for health expenditure, a maximum of two observations.[15]

The regression results for Africa are presented in Table 1; for countries in Africa, Asia, and the Western Hemisphere, in Table 2, line (1). The results are obtained using robust OLS, which corrects standard errors for heteroscedasticity of unknown form using the White method. In all cases, the coefficients of education and health spending are statistically significant at the five percent confidence level and have the right signs. This suggests that government spending on education and health has a positive impact on social indicators.[16] A comparison of the size of the coefficients in Table 1 and Table 2 shows that they are larger for Africa in six cases (primary and secondary school enrollment, life expectancy, and

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[15]The regression results reported in this paper could also be used for efficiency analysis. For example, efficiency would be gauged by comparing the actual ratio of output to public spending with the fitted ratio of output to public spending. If the actual ratio is higher than the fitted ratio, the country could be seen as relatively efficient, whereas if the actual ratio is lower than the fitted ratio, the country would be classified as relatively inefficient. Although such a parametric analysis would be interesting, it is not undertaken here for reasons mentioned in the previous section.

[16]A similar conclusion is reached in Commander, Davoodi, and Lee (1996).

Table 1. Regression Results: Africa

$lnS = C + B_1\ lnG(o) + B_2\ lnE + B_3 lnH + e$

S: Social indicator
$G(o)$: Initial level of development given by per capita GDP in PPP
E: Average per capita spending on education in PPP
H: Average per capita spending on health in PPP

S	Regression	Intercept	*G(o)*	*E*	*H*	F Statistic	Adjusted R^2	Durbin Watson	Sample Size
Primary school enrollment	(1)	2.11		0.26		20.0	0.38	1.98	32
		(4.2) *		(4.7) *					
	(2)	1.76	0.17	0.16		10.7	0.38	1.92	32
		(3.3) *	(1.2) *	(1.6) **					
Secondary school enrollment	(1)	-1.79		0.55		48.5	0.60	2.15	33
		(-2.6) *		(7.4) *					
	(2)	-2.54	0.34	0.36		27.0	0.62	2.06	33
		(-3.8) *	(1.2)	(1.8) *					
Illiteracy	(1)	5.80		-0.24		17.9	0.33	2.06	36
		(11.8) *		(-4.2) *					
	(2)	5.69	0.06	-0.28		8.8	0.31	2.11	36
		(9.8) *	(0.6)	(-4.1) *					
Life expectancy	(1)	3.49			0.06	20.7	0.35	1.90	37
		(19.0) *			(2.7) *				
	(2)	3.22	0.07		0.03	12.7	0.39	2.15	37
		(17.1) *	(1.4) **		(0.7)				
Infant mortality	(1)	6.00			-0.21	19.3	0.34	1.84	37
		(9.5) *			(-2.4) *				
	(2)	7.32	-0.36		-0.04	15.6	0.45	1.84	37
		(9.7) *	(-2.3) *		(-0.5)				
Measles inoculation	(1)	2.81			0.15	8.2	0.18	1.50	35
		(6.8) *			(3.0) *				
	(2)	2.12	0.21		0.05	5.3	0.20	1.60	35
		(3.2) *	(1.2)		(0.5)				
DPT inoculation	(1)	2.53			0.17	5.6	0.12	1.50	36
		(5.1) *			(2.7) *				
	(2)	1.84	0.21		0.07	3.4	0.12	1.57	36
		(2.2) *	(1.0)		(0.6)				

1/ T-statistics are given in parenthesis. Statistical significance at the 5 percent and 10 percent level is indicated by * and **, respectively.

Table 2. Regression Results: All Countries (Africa, Asia and Western Hemisphere) 1/

$lnS = C + B_1\ lnG(o) + B_2\ lnE + B_3 ln H + B_4 D_A + B_5 D_W + e$

S: Social indicator
$G(o)$: initial level of development given by per capita GDP in PPP
E: Average per capita spending on education in PPP
H: Average per capita spending on health in PPP
D_A, D_W: Dummies for Asia and Western Hemisphere, respectively

S	Regression	Intercept	G(o)	E	H	D_A	D_W	F Statistic	Adjusted R^2	Durbin Watson	Sample size
Primary school enrollment	(1)	3.35		0.11		0.31	0.25	13.1	0.32	2.03	78
		(10.8) *		(3.2) *		(3.5) *	(3.6) *				
	(2)	3.09	0.12	0.04		0.29	0.17	10.6	0.33	2.01	78
		(7.9) *	(1.4)	(0.8)		(3.2) *	(2.1) *				
Secondary school enrollment	(1)	0.38		0.29		0.73	0.83	27.3	0.51	2.10	78
		(0.7)		(4.5) *		(3.7) *	(6.3) *				
	(2)	-0.47	0.38	0.08		0.65	0.59	23.6	0.54	2.11	78
		-(0.6)	(2.0) *	(0.7)		(3.2) *	(3.3) *				
Illiteracy	(1)	6.12		-0.28		-0.77	-1.15	34.0	0.56	1.76	80
		(10.4) *		(-4.0) *		(-4.0) *	(-6.6) *				
	(2)	6.20	-0.04	-0.26		-0.76	-1.13	25.2	0.55	1.77	80
		(7.8) *	(-0.2)	(-2.5) *		(-3.7) *	(-5.7) *				
Life expectancy	(1)	3.63			0.05	0.16	0.19	44.3	0.64	2.10	80
		(38.9) *			(3.7) *	(5.3) *	(6.7) *				
	(2)	3.41	0.06		0.02	0.15	0.17	39.2	0.66	2.09	80
		(23.2) *	(2.2) *		(1.4) **	(4.8) *	(5.5) *				
Infant mortality	(1)	6.22			-0.24	-0.68	-0.64	33.2	0.55	1.81	80
		(13.7) *			(-3.9) *	(-4.4) *	(-4.2) *				
	(2)	7.70	-0.40		-0.07	-0.60	-0.45	35.4	0.64	2.00	80
		(10.9) *	(-3.0) *		(-1.1)	(-4.2) *	(-2.7) *				
Measles inoculation	(1)	3.30			0.08	-0.01	0.18	5.8	0.15	1.67	81
		(11.9) *			(2.3) *	(-0.1)	(2.1) *				
	(2)	2.70	0.15		0.01	-0.01	0.12	5.7	0.19	1.84	81
		(6.4) *	(1.7) *		(0.3)	(-0.1)	(1.3) **				
DPT inoculation	(1)	2.90			0.12	0.20	0.26	7.7	0.20	1.80	83
		(9.5) *			(3.1) *	(1.4) **	(2.4) *				
	(2)	2.52	0.11		0.07	0.19	0.22	6.2	0.20	1.82	83
		(5.5) *	(1.2)		(1.3) **	(1.4) **	(2.0) *				

1/ T-statistics are given in parenthesis. Statistical significance at the 5 percent and 10 percent level is indicated by * and **, respectively.

immunizations) than for the entire sample, suggesting that government spending on education and health has a stronger impact in Africa than elsewhere. The results also suggest the existence of diminishing returns to scale in the production of education and health services in regions with relatively high per capita income and a limited private sector role in the provision of education and health services. Two dummy variables capture regional differences in countries outside Africa: one for countries in Asia, and another for those in the Western Hemisphere. Except for the regressions of measles and DPT immunizations, these dummies are positive and strongly significant.

Linking health spending in the current time period to contemporaneous illiteracy and life expectancy rates raises the issue of lags. Illiteracy is measured for the population over 15 years of age, and therefore partly reflects the impact of past schooling. Life expectancy is measured as the current expected life span of a newborn. To the extent that current mortality patterns reflect health care in previous years, life expectancy will be historically determined and unaffected by current health spending. Data limitations, particularly missing observations, preclude the use of stock-adjustment methods to gauge which part of these output indicators are historically determined. Less sophisticated methods of circumventing the problem of lags, such as taking first differences or estimating the historic component by regressing output indicators on past values, do not accurately capture the impact of current public spending. The change in the illiteracy rate, for example, captures the difference in illiteracy of those who have just turned 15 and those who have recently died, and is therefore also driven by past schooling and lags. An alternative would be to regress output indicators on past values and take the error terms as indicators of output that is instantaneously affected by government spending. This option is also not without problems, as output indicators as well as public spending on education and health turn out to be strongly autoregressive.[17]

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[17]Using OLS regressions of the form $S(t) = \alpha\, S(t\text{-}1) + \beta + \varepsilon$, where $S(t)$ is the output indicator and $S(t\text{-}1)$ is the output indicator lagged one time period, the following results are obtained:

Output Indicator	Value of α	t-Statistic of α	$\bar{R}^2$
Primary school enrollment	0.86	21.7	0.77
Secondary school enrollment	1.02	59.1	0.96
Illiteracy	0.92	48.2	0.95
Life expectancy	1.02	56.3	0.97
Infant mortality	0.94	46.7	0.96
Measles immunizations	0.58	6.9	0.40
DPT immunizations	0.67	9.5	0.55

Similar regression for public spending generates the following results:

Spending	Value of α	t-Statistic of α	$\bar{R}^2$
Education	1.18	41.6	0.93
Health	1.23	23.6	0.91

The fact that both output indicators and government spending are autoregressive makes it impossible to differentiate between lagged and current effects of spending by using the regression approach. Therefore, in this paper, no attempt has been made to distinguish between the lagged and current impact of government spending on output indicators.[18]

As noted, social indicators would be expected to be affected by the general level of economic and social development. For instance, nutrition is better and school enrollment is higher at an advanced stage of development. This suggests that previously reported regressions should include a variable to capture the level of the countries' economic and social development. This is proxied by GDP per capita in PPP terms measured at the start of the observation period (e.g., GDP in 1984 is taken as the explanatory variable for a regression with average primary school enrollment during 1984-87).[19]

Table 2 shows that the coefficient for initial per capita GDP is significant in a majority of cases (see line (2)),[20] but, at the same time, the coefficients assigned to government spending become statistically insignificant in a number of regression equations (e.g., life expectancy, infant mortality, and immunizations in the sample of African countries). This is, *inter alia,* attributable to a high degree of collinearity between the two independent variables,[21] unavailability of the breakdown of spending that impacts directly on specific output indicators (e.g., spending on primary education would be expected to impact on primary school enrollment), and the lack of information on the population targeted by public

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[18]The implications of this will be discussed in the final concluding section.

[19]Isenman (1980) follows a similar approach. In the present paper, the GDP at the start of the time period rather than the average over the period is taken; this is to predetermine explanatory variable in relation to other variables in the regression and to minimize collinearity between government spending and the proxy for the level of economic development (see below). It should be noted that the variable for the level of economic development will capture some of the lagged effects discussed above.

[20]Carrin and Politi (1997) also find a positive relationship between life expectancy and GDP per capita. Their results indicate that this relationship, *inter alia,* reflects the (negative) relationships between per capita GDP and poverty, and poverty and health status.

[21]For African countries, the correlation coefficient between education spending and initial per capita GDP is 0.76; between health spending and initial per capita GDP, the correlation coefficient is 0.78.

spending.[22] The fit may also be affected by the specification; for example, it could be argued that the regressions for enrollment should include a variable capturing the share of the school-aged in the total population. Nevertheless, the coefficients for public spending are significant at the five percent confidence level in equations that explain primary school enrollment, secondary school enrollment, and illiteracy in the African countries. The regression results for the sample including the Asian and the Western Hemisphere countries is similarly affected by the introduction of the GDP level as an explanatory variable.

B. FDH Analysis

The regression results suggest that a relationship exists between government spending on education and health and indicators of educational attainment and health status, respectively, and therefore, that the application of FDH analysis to government spending is justified. The regressions also indicate that the level of economic development has an impact on output indicators, suggesting that differences in economic development should be taken into account when assessing the efficiency of government spending (see also Musgrove, 1996). This is done here by dividing the sample of countries in Africa, Asia, and the Western Hemisphere into two groups: low-income and high-income countries. Countries with a PPP income above US$4,500 per capita during 1988-91 (period 2 in the sample of education data) are considered to be high-income countries.[23] Conducting the FDH analysis for the two income groups separately mitigates considerably the impact on the results of differences in economic development.

An alternative way of dealing with the impact of economic development would be to control for differences in income levels in measurement of both government expenditure and output indicators. However, netting out the effect of the level of economic development on government spending on education and health is anything but straightforward. Barro (1990), for example, argues that education spending has a positive impact on economic growth through its effect on the accumulation of human capital.[24] Isolating the effect of economic

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[22]In an analysis of data from 86 countries, Anand and Ravallion (1993) also find that a statistically significant relationship between the level of economic development and indicators of educational attainment and health output. However, the relationship between economic development and health output becomes insignificant when they control for the incidence of poverty and public spending. It is inferred from this result that economic development only contributes to increased health output in so far as it enables a reduction in poverty and an increase in public spending on health. However, no statistical significant relationship is found between poverty and public spending on education, on the one hand, and education output, on the other hand.

[23]The low-income group includes all African countries in the sample except Mauritius. The presentation in this paper focuses on the results for the low-income group.

[24]The existence of a relationship between public spending and economic growth is disputed by (continued...)

development on government spending on education and health would thus require the formulation of an economic model capturing the causal links between the two variables. The development of such a model lies outside the scope of this paper. Netting out the effect of economic development on output indicators, but not on public spending on education and health would distort the analysis. The relatively high level of economic development of countries such as Mauritius and Korea leads to a large downward adjustment of output indicators while their corresponding high spending levels remain unadjusted. This would leave them with low efficiency scores and at the bottom of the efficiency ranking.

Government spending and social indicators: initial results

The relationship between government spending on education and health and each of the output indicators is illustrated in Figures 3 through 9. This is equivalent to the one-input one-output case shown in Figures 1 and 2. In Figures 3 through 5, the level of education spending is plotted against primary school enrollment, secondary school enrollment, and literacy,[25] for African countries in each of the three time periods.[26] For each time period and each output indicator, a production possibility frontier is drawn that indicates the relatively efficient way ("the best practices") of achieving educational attainment, with a given level of government spending. As in Figures 1 and 2, relative efficiency can be measured by the distance from the production possibility frontier.[27] This distance can be measured horizontally (in which case the input efficiency score would be obtained), vertically (i.e., by the output efficiency score), or by some combination of these measures. In the analysis below, both the horizontal and vertical distances have been taken into account.

Figures 3 through 5 reveal that in at least two time periods government spending on education in The Gambia, Guinea, Malawi, Niger, and Tanzania—with an average annual spending of 2.4 percent of GDP in the most recent time period (1992-95)—is relatively efficient in impacting on primary school enrollment rates;[28] however, Côte d'Ivoire, Senegal,

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[24](...continued)
Levine and Renelt (1992).

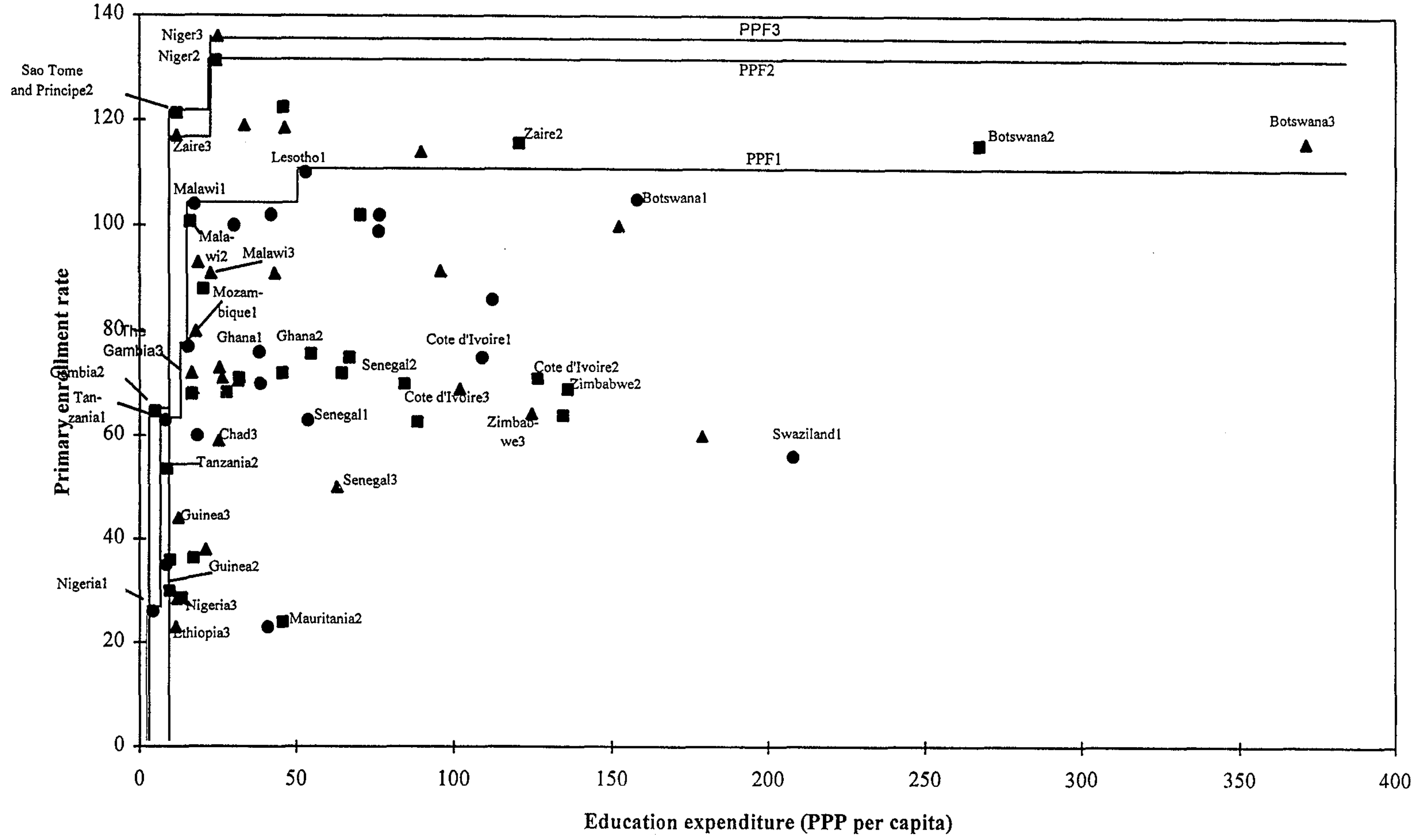
[25]The literacy rate is defined as 100 minus the illiteracy rate.

[26]Data are not available for all countries and all time periods.

[27]The results of the FDH analysis presented here, particularly the cross-country comparisons, should be interpreted with some caution, as the coverage of education and health expenditures may vary among countries. Although spending is measured in per capita PPP terms for the FDH analysis, expenditure as a share of GDP are given for comparison.

[28]Nigeria also has high primary school enrollment rates considering the level of government
(continued...)

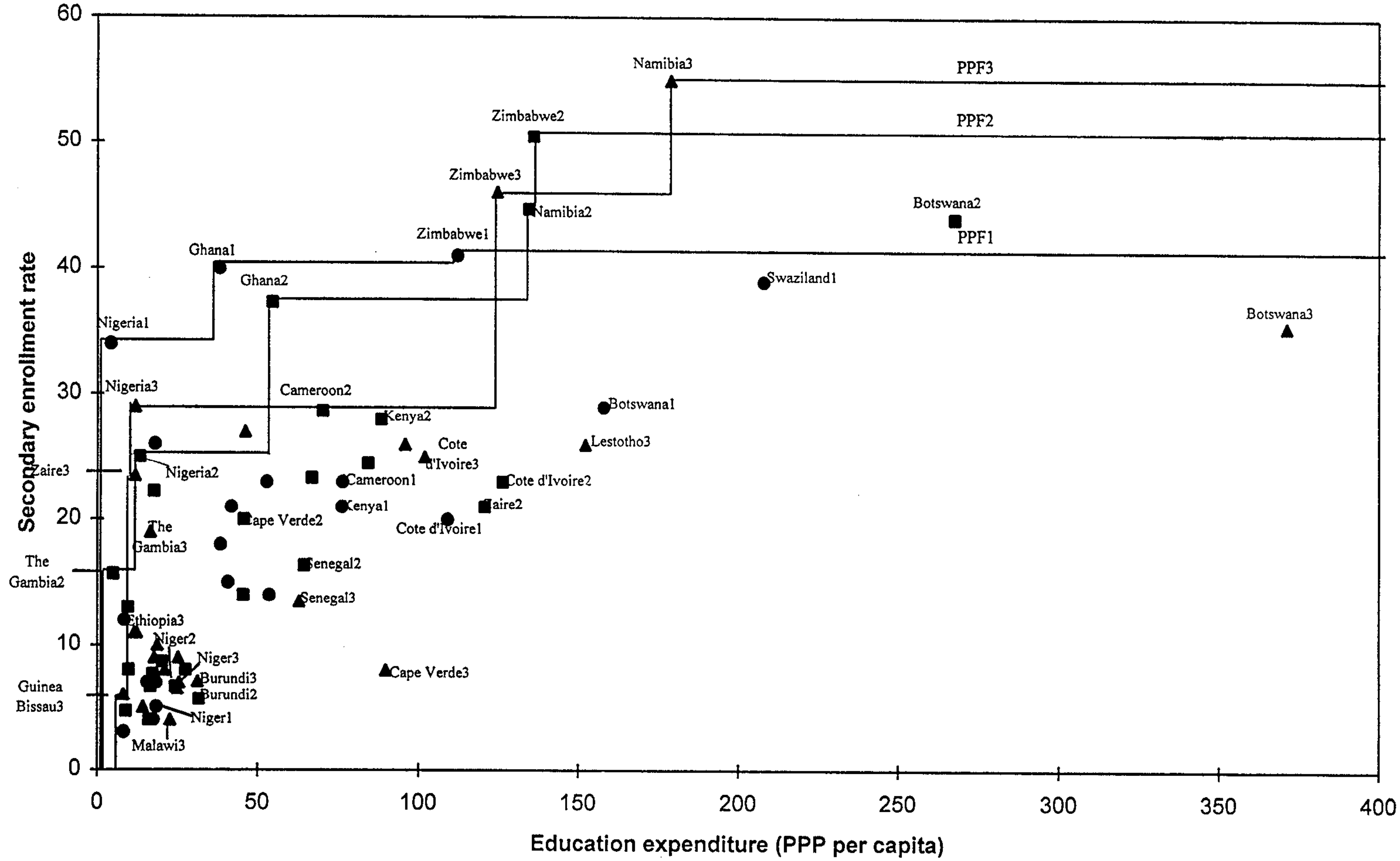
Figure 3. Government Spending and Social Indicators in Africa: Education Expenditure and Primary Enrollment 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1, 2 and 3 are indicated by PPF1, PPF2, and PPF3, respectively. Numbers with country names indicate time periods.

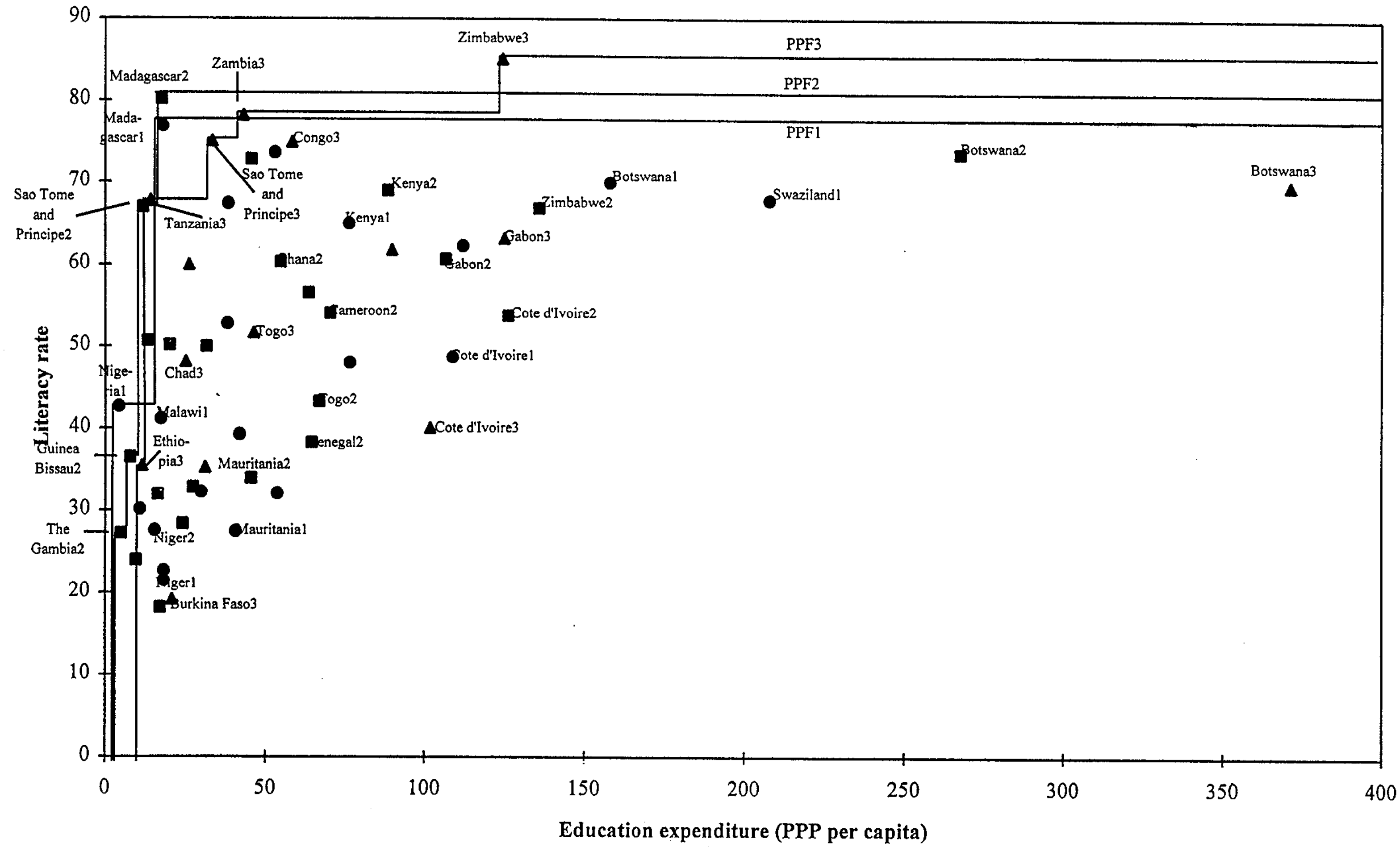
Figure 4. Government Spending and Social Indicators in Africa: Education Expenditure and Secondary Enrollment



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1, 2 and 3 are indicated by PPF1, PPF2, and PPF3, respectively. Numbers with country names indicate time periods.

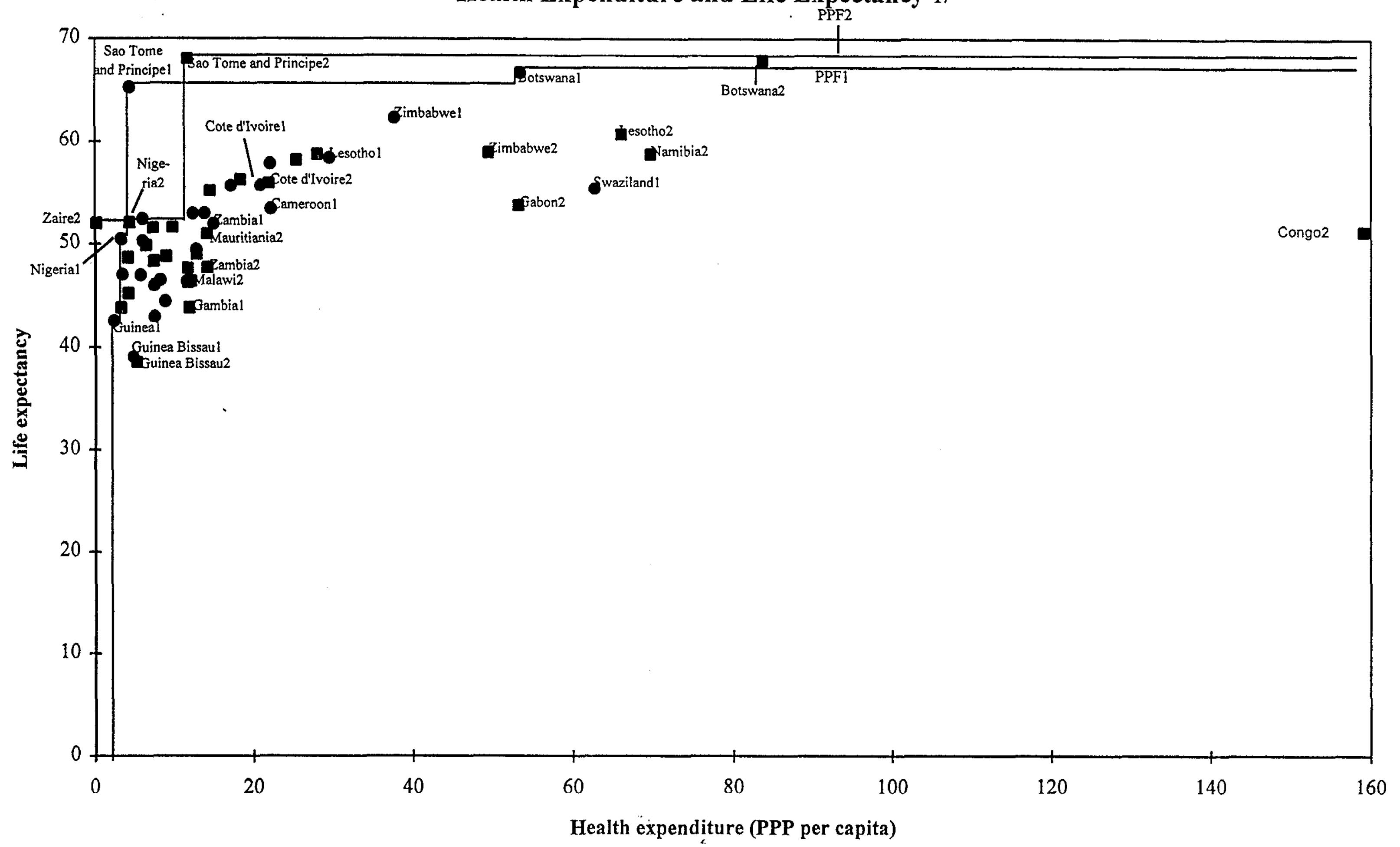
Figure 5. Government Spending and Social Indicators in Africa: Education Expenditure and Literacy



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1, 2 and 3 are indicated by PPF1, PPF2, and PPF3, respectively. Numbers with country names indicate time periods.

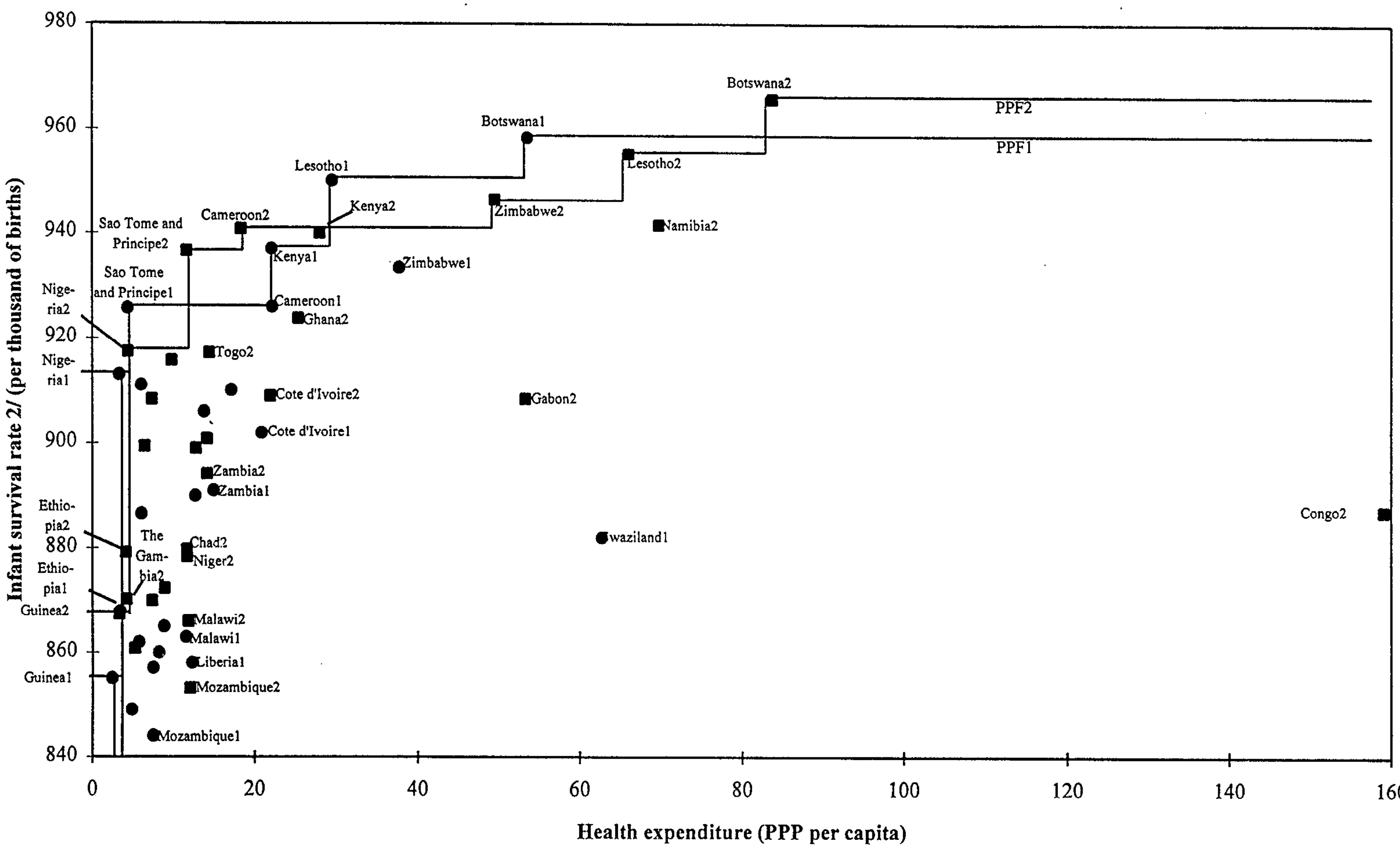
Figure 6. Government Spending and Social Indicators in Africa:
Health Expenditure and Life Expectancy 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1 and 2 are indicated by PPF1 and PPF2, respectively. Numbers with country names indicate time periods.

Figure 7. Government Spending and Social Indicators in Africa: Health Expenditure and Infant Survival 1/

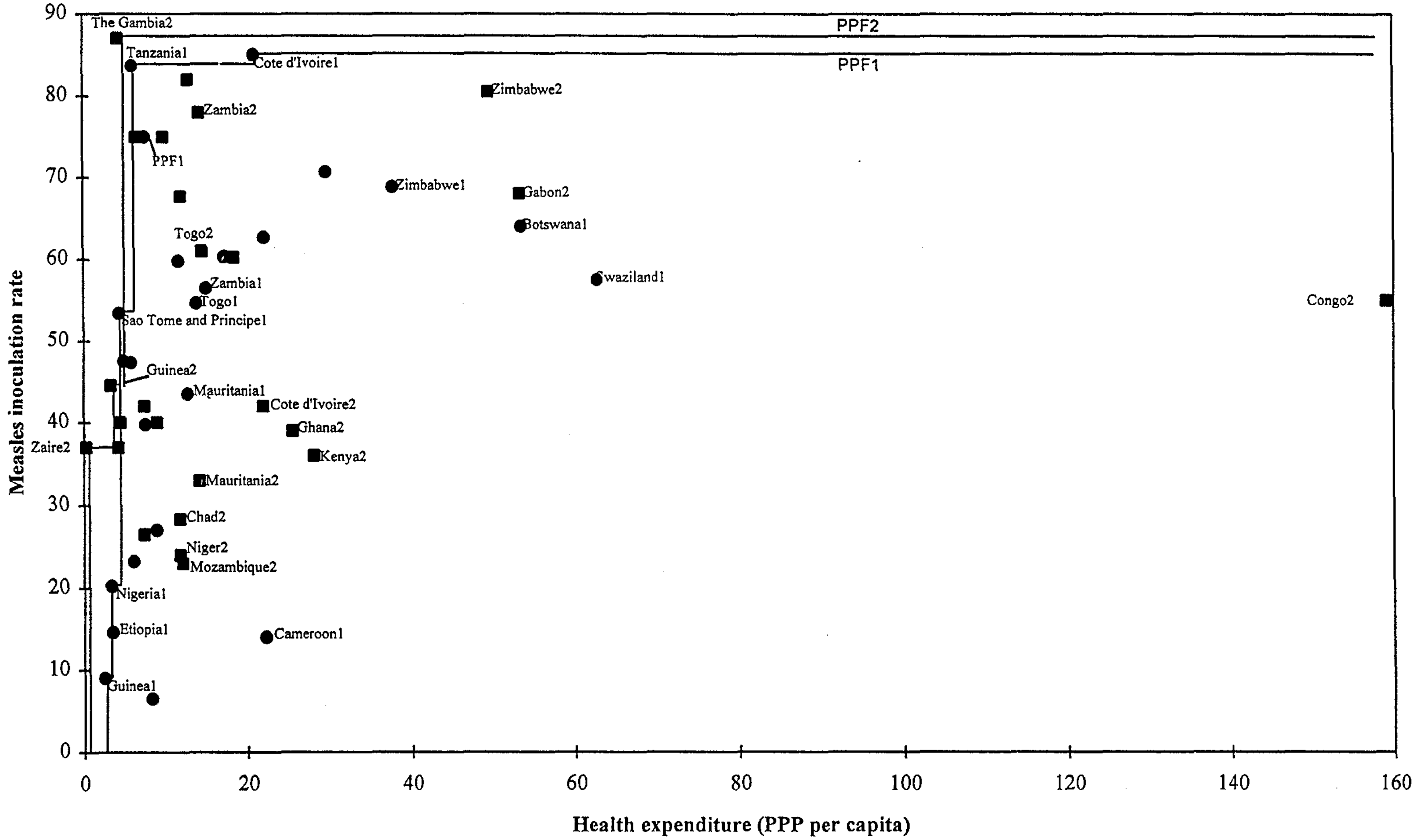


Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1 and 2 are indicated by PPF1 and PPF2, respectively. Numbers with country names indicate time periods.

2/ The infant survival rate is defined as 1,000 minus the infant mortality rate.

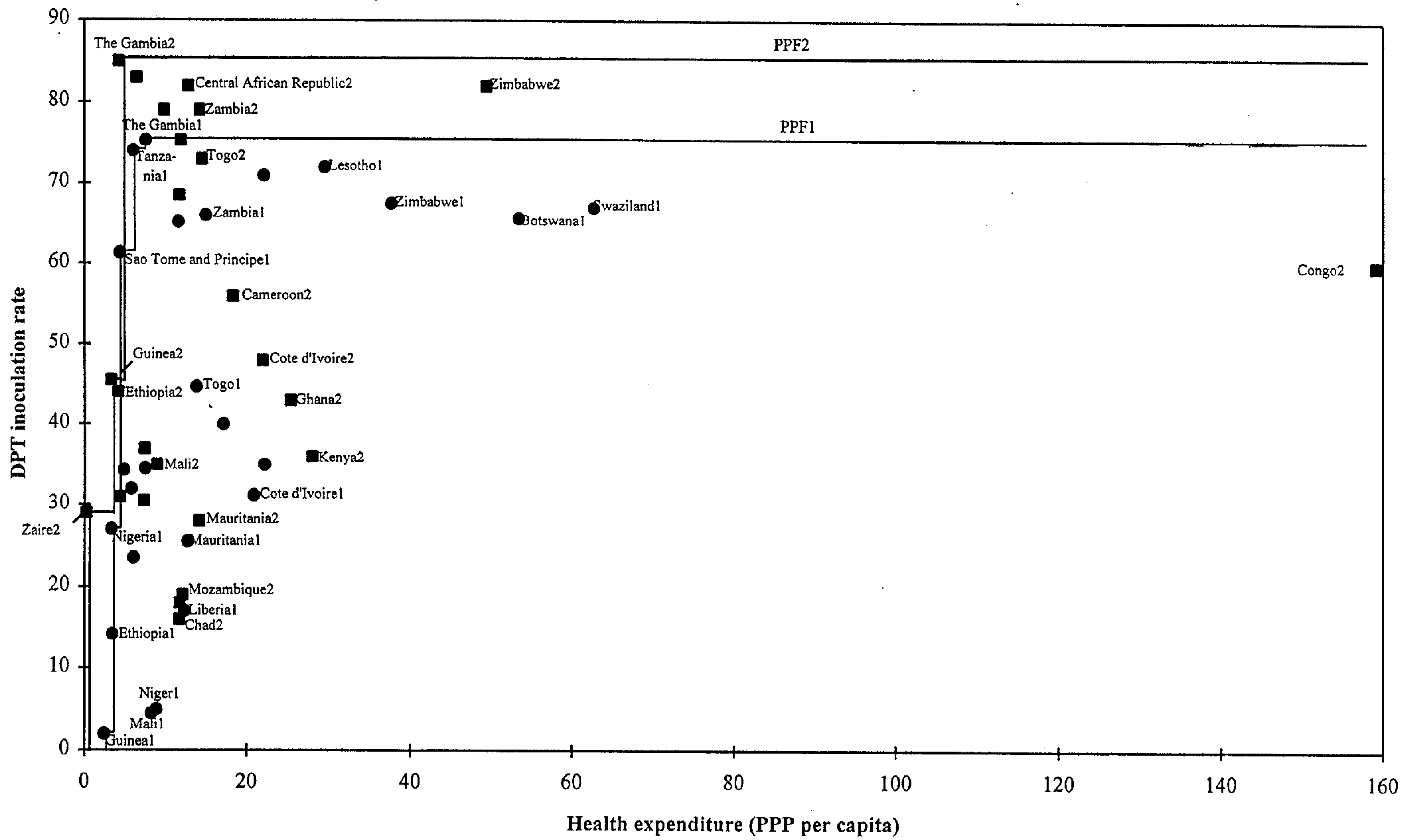
Figure 8. Government Spending and Social Indicators in Africa: Health Expenditure and Measles Inoculation 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1 and 2 are indicated by PPF1 and PPF2, respectively. Numbers with country names indicate time periods.

Figure 9. Government Spending and Social Indicators in Africa: Health Expenditure and DPT Inoculations



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations for period 1 (1984-87) are indicated by round dots, for period 2 (1988-91) by squares, and for period 3 (1992-95) by triangles. The production possibility frontiers for periods 1 and 2 are indicated by PPF1 and PPF2, respectively. Numbers with country names indicate time periods.

and Zimbabwe—with an average annual spending of 5.9 percent of GDP—are not as efficient. By the same measure, The Gambia, Ghana, Namibia, and Zimbabwe—where yearly government spending on education averages 6.0 percent of GDP—achieve relatively high secondary school enrollment, whereas Burundi, Côte d'Ivoire, Niger, and Senegal—with annual government spending of on average 4.3 percent of GDP—do not. In Madagascar, Niger, and São Tomé and Príncipe—with an average annual government spending of 4.0 percent of GDP—public spending facilitates relatively high rates of literacy; however, Côte d'Ivoire, Gabon, and Kenya—where annual government spending averages 5.4 percent of GDP—do not fare as well.

The figures also show the development in the productivity of education spending over time. It should be noted that the concept of productivity is different from the concept of efficiency. Efficiency is a measure of how far an individual country is from the production possibility frontier, whereas productivity measures the maximum output associated with different levels of spending, that is, the position of the production possibility frontier. In all three cases, the production possibility frontier shifts outwards, which suggests that the productivity of government spending in terms of different measures of educational attainment has increased. However, the outward shift in the production possibility frontier is not necessarily attributable to better use of inputs due to changes in production technology; it could also be the result of economic growth and private spending.

Figures 6 through 9 show the respective relationships between per capita government spending on health expressed in PPP terms and life expectancy, infant survival rate,[29] and the immunization rates. They show that Botswana and São Tomé and Príncipe—with an average annual government spending of 2.1 percent of GDP in the most recent time period (1990-95)—have relatively high life expectancy, whereas Côte d'Ivoire, Lesotho, and Zimbabwe—where yearly public spending averages 2.7 percent of GDP—are not faring as well. With respect to infant survival, Botswana, Ethiopia, Guinea, Lesotho, and São Tomé and Príncipe—with an average yearly spending of 1.8 percent of GDP—are achieving better results than Côte d'Ivoire and Mozambique, where annual spending averages 1.4 percent of GDP. Yearly government spending on health in The Gambia and Guinea—averaging 0.5 percent of GDP—engenders relatively high rates of immunization, but it does not do so in Mauritania, Togo, and Zambia—where annual spending averages 1.3 percent of GDP. Over time, the productivity of health spending in Africa has generally increased, as evidenced by the outward shift of the production possibility frontier over most of its range (except for the frontier for life expectancy).[30]

[29]Defined as 1,000 minus the infant mortality rate.

[30]A World Bank (1997) study finds that since 1900, worldwide life expectancy has increased by 25 years for similar income levels.

The efficiency of health and education spending: combining output indicators

Analyzing the efficiency of government spending separately for each output indicator does not give a definitive answer to the question which countries spend their public resources relatively efficiently, as this would require taking into account all indicators of output. For example, although Niger attains high primary school enrollment, it performs relatively badly in secondary school enrollment. The reverse is true for Zimbabwe. To establish whether Niger and Zimbabwe efficiently spend their government resources for education (and health care), all indicators of education output—and health output—need to be combined.

Tables 3 and 4 present results from FDH analyses of education and health spending of African countries in the sample, taking account all output indicators separately for each of the time periods. Both input efficiency scores and country rankings are shown in these tables. The country ranking is a lexicographic ordering based on: (1) the relative input efficiency scores; and (2) the number of countries relative to which the country in question is more efficient.[31] Country observations that cannot be compared because they are neither more nor less efficient than any other country in any time period—the independently efficient cases—are identified with a + sign, and are omitted from the rankings.

The analysis in this section focuses on input efficiency scores rather than output efficiency scores, as the former have a straightforward interpretation and more relevance for policymaking. The input efficiency score indicates the amount of spending that would be needed to achieve the same or a higher level of each output at the same level of efficiency as the most efficient country. In other words, if the input efficiency score is 0.1 percent, 90 percent of education spending does not contribute in an efficient manner to educational attainment in that country. As the expenditure allocations (rather than outputs) are under the control of the policymakers, a focus on input efficiency scores is more meaningful.[32]

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[31]The ranking proposed here allows for a distinction among countries on the production possibility frontier, which would not be possible if the efficiency score were used as the sole argument for ranking the countriės (as noted earlier, all countries on the production possibility frontier are assigned an efficiency score of 1). The number of observations relative to which a country is more efficient is an indication of the robustness of the efficiency result; the greater the number of countries which are less efficient than a given country on the production possibility frontier, the smaller the chance that this country will shift into the interior of the production possibility set if the sample were to change slightly.

[32]Results of output efficiency scores for education and health spending (not presented here) tend to be higher and more evenly distributed than input efficiency scores.

Table 3. Africa : Education Input Efficiency Scores During 1984-87, 1988-91, and 1992-95 1/
(Output Indicators: Literacy, Primary Enrollment, and Secondary Enrollment)

	Period 1 (1984-1987)			Period 2 (1988-1991)			Period 3 (1992-1995)		
	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient
Botswana	1		+	1		+	1		+
Burkina Faso				0.29	(13)		0.56	(3)	
Burundi				0.64	(9)		0.38	(6)	
Cape Verde							0.13	(7)	
Cameroon	1		+	1	(4)				
Chad							0.47	(4)	
Cote d'Ivoire	0.35	(8)		0.43	(11)		0.45	(5)	
Ethiopia							1		+
Gambia				1	(2)				
Ghana	1	(1)		1	(1)				
Guinea				0.51	(10)				
Kenya	0.69	(7)		1		+			
Lesotho	1	(1)							
Malawi	1		+						
Mali	1		+	1		+			
Mauritinia	0.10	(9)		0.29	(12)				
Mozambique	1		+	0.73	(8)				
Niger				1		+			
Nigeria	1	(4)		1	(4)				
Rwanda				1	(2)				
Senegal	0.71	(6)		0.85	(6)				
Swaziland	1		+						
Togo	1	(4)		0.82	(7)		1	(2)	
Zaire							1	(1)	
Zambia	1	(3)							
Zimbabwe	1		+	1		+	1		+
Average input efficiency score 2/		0.79			0.74			0.57	
Median input efficiency score 2/		1.00			0.82			0.47	
Total number of countries		16			18			10	
of which: not independently efficient		9			13			7	

Sources: Data provided by country authorities; and Fund staff estimates.

1/ The efficiency scores and rankings are based on separate FDH analyses of education spending in Africa for all three time periods separately.
2/ Independently efficienct countries are excluded from the calculation of the average and median input efficiency score.

Table 4. Africa: Health Input Efficiency Scores During 1984-89, 1990-95 1/
(Output Indicators: Life Expectancy, Infant Survival, DTP and Measles Inoculation)

	Period 1 (1984-89)			Period 2 (1990-1995)		
	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient
Botswana	1		+			
Burkina Fasso	0.75	(10)		0.88	(11)	
Burundi				1	(1)	
Cameroon	0.99	(7)		1		+
Central African Republic				1	(6)	
Chad				0.38	(13)	
Congo				0.06	(18)	
Cote d'Ivoire	1		+	1		+
Ethiopia	0.96	(8)		1	(4)	
Gambia	1		+	1	(6)	
Ghana	1		+	1		+
Guinea	1		+	1		+
Guinea Bissau	0.89	(9)				
Kenya	1	(3)		1		+
Lesotho	1	(5)				
Madagascar	0.71	(11)		1	(4)	
Malawi	0.52	(13)		0.35	(15)	
Mali	0.40	(15)		0.72	(12)	
Mauritania	0.34	(17)		0.31	(17)	
Mozambique	0.58	(12)		0.35	(16)	
Niger	0.49	(14)		0.36	(14)	
Nigeria	1	(3)		1	(3)	
Sao Tome and Principe	1	(1)				
Swaziland	0.35	(16)				
Tanzania	1	(2)		1	(1)	
Togo	1		+	1	(6)	
Zambia	1		+	0.90	(10)	
Zimbabwe	1	(5)		1	(6)	
Average input efficiency score 2/		0.76			0.74	
Median input efficiency score 2/		0.89			0.95	
Total number of countries		24			23	
of which: not independently efficient		17			18	

Sources: Data provided by country authorities; and Fund staff estimates.

1/ The efficiency scores and rankings are based on separate FDH analyses of education spending in Africa for the two time periods separately.

2/ Independently efficient countries are excluded from the calculation of the average and median input efficiency score.

Comparing efficiency within Africa

Table 3 shows that in at least two time periods, the efficiency of education spending is relatively high in Ghana and Togo—with an average annual spending of 4.3 percent of GDP in the last time period (1992-95);[33] Burkina Faso, Côte d'Ivoire, and Mauritania, however, where yearly government spending averages 4.0 percent of GDP, have relatively low efficiency. For example, Côte d'Ivoire used only 35-45 percent of its education spending efficiently when judged against the best practice benchmark set by Ghana.

The relative efficiency of education spending improved significantly in a number of countries (Burkina Faso and Mauritania), as shown by an improvement in ranking and an increase in efficiency scores in Table 3. In Burkina Faso, the input efficiency score increased from 0.29 during period 2 (1988-91) to 0.56 during period 3 (1992-95), which is reflected in an improvement of its ranking from last to a better-than-median position, with annual government spending on education increasing from 2.7 percent of GDP to 3.0 percent of GDP. Education spending in Burundi, on the other hand, became relatively less efficient between period 1 and period 3, even when yearly government education spending remained unchanged at 4.4 percent of GDP.

Table 4 presents results for health spending. It shows that Ethiopia, Tanzania, and Zimbabwe—with an average annual spending of 2.1 percent of GDP in the last time period (1990-95)—perform relatively well in two time periods, whereas the ranking and input efficiency scores for Malawi, Mali, Mauritania, Mozambique, and Niger—with an average annual spending of 1.8 percent of GDP—are lower. Finally, the relative efficiency of health spending improved between period 1 (1984-89) and period 2 (1990-95) in Madagascar and Mali, as yearly government spending remained about constant at 1.0 percent and 1.6 percent of GDP, respectively, while it declined in Malawi and Mozambique, as annual government spending fell from 1.7 percent of GDP to 1.5 percent of GDP and increased from 1.4 percent to 1.6 percent of GDP, respectively.

Comparing efficiency in Africa with that in Asia and the Western Hemisphere

In the previous section, separate production possibility frontiers were derived for each time period. It was thus assumed that the production technology varies between time periods and that shifts in this technology are reflected in productivity changes. Alternatively, it can be assumed that the production technology is constant and that the production possibility frontier does not shift over time. This would be captured in the FDH analysis by pooling observations for all time periods, and by deriving production possibility frontier and efficiency scores from pooled observations. The advantage is that, contrary to the analysis of the previous sections, efficiency scores for different time periods can be compared directly.

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[33]For Togo, this result partly reflects the coverage of education spending data; capital expenditure are not included in education spending.

Figure 10 and Table 5 present input efficiency scores for education spending for low-income countries in Africa, Asia, and the Western Hemisphere for a sample in which all time periods are pooled. Results are sorted by time period as well as presented in aggregate terms for all time periods combined. They show that Africa has, on average, the lowest efficiency of education spending, with an average input efficiency score of 0.08 in all three time periods. Asia performs the best with an average input efficiency score of 0.53, whereas the countries in the Western Hemisphere are between countries in the other two regions with an average score of 0.36. This is against the background that the countries in Africa, on average, spend more on education than the countries in Asia and the Western Hemisphere. In the last time period (1992-95), education spending in Africa averaged 4.0 percent of GDP, against 3.2 percent of GDP in Asia and 3.4 percent of GDP in the Western Hemisphere.

The results for efficiency scores are consistent with averages of the results also presented in Table 5 for the number of more efficient countries, for the number of less efficient countries, and for the ranking of countries in the sample. For instance, in reflection of low-average input efficiency scores for all time periods, the countries in Africa are, on average, more efficient than only 1.9 countries in the overall sample, and less efficient than 14 countries. It is interesting to note that the average efficiency score for period 1 (1984-87) is higher for the Western Hemisphere than for the Asian countries, but since then the relative performance in the Western Hemisphere has declined and that of Asia improved. The result that the countries in Africa are, on average, less efficient than those in Asia and the Western Hemisphere is consistent with the regression analysis, where a positive and significant impact of the dummy variables assigned to countries in Asia and the Western Hemisphere was found.

The observed inefficiency of education spending in Africa cannot be explained by differences in private spending on education. Jimenez and Lockheed (1995) find that in 1985, the average share of government schools in primary enrollment in the African countries varied from 80 percent in East Africa to 84 percent in West Africa. In both Asia and the Western Hemisphere, the government share in primary enrollment averaged 88 percent in 1985. In that same year, the government share in secondary enrollment averaged 52 percent in East Africa and 72 percent in West Africa, against 78 percent in Asia and 75 percent in the Western Hemisphere. Furthermore, James (1991) finds that in the African countries a relatively low share of funding of private education is from public sources, such as government subsidies. These findings suggest that the share of private spending in total education spending is higher in the African than in Asian and Western Hemisphere countries. And as a relatively large part of educational attainment in Africa is produced with private inputs, the African countries should come out of the FDH analysis as being *more*—not less—efficient than those in Asia and the Western Hemisphere, all other things being equal.[34]

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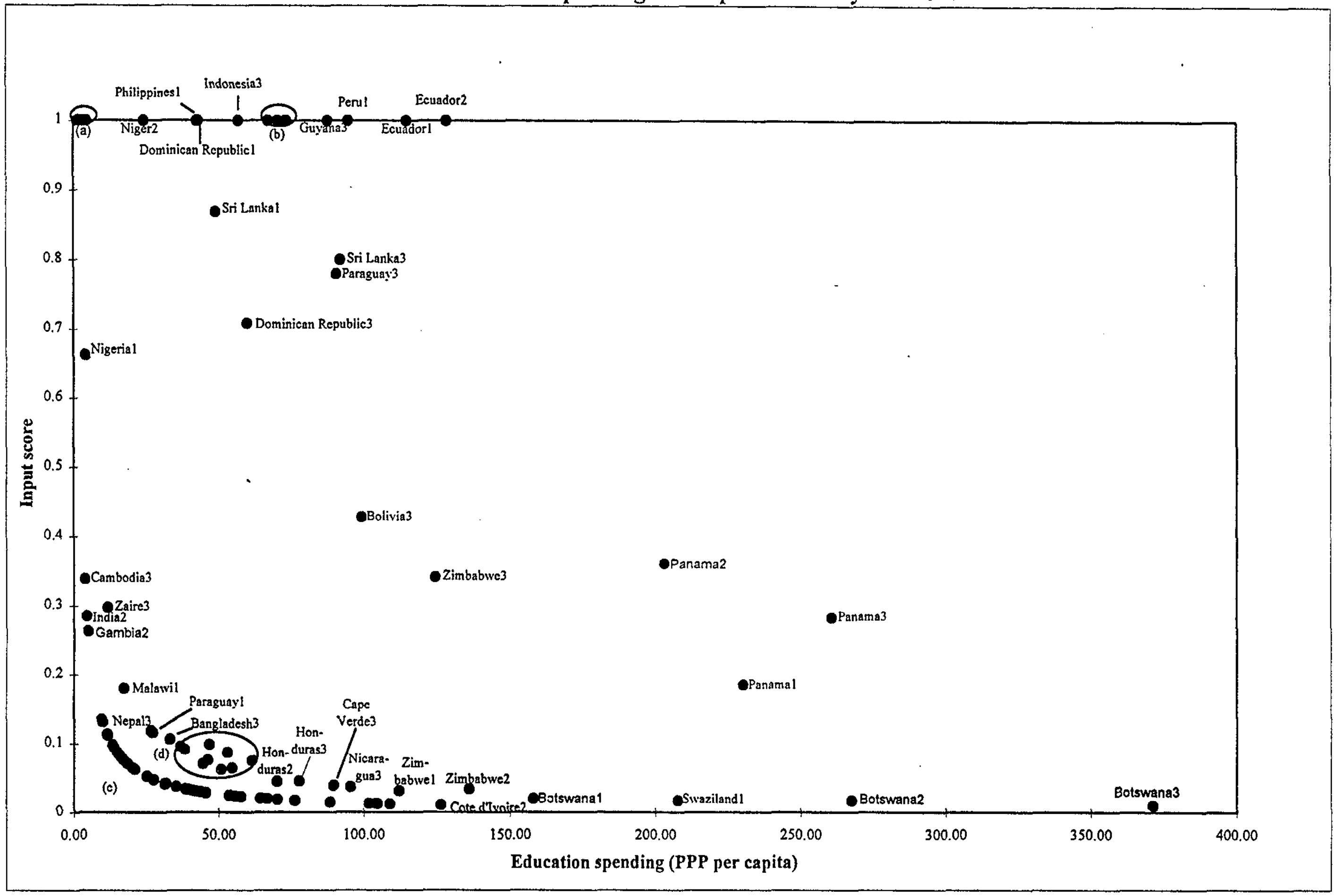
[34]Using a limited dataset by Psacharapoulos and Nguyen (1997) on private education spending, a statistically significant relationship could not be found between private spending on education and input efficiency scores.

Figure 10. Education in Low-Income Countries: Government Spending and Input Efficiency Scores 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations are identified by country name and a number for the period (1 for 1984-87, 2 for 1988-91, and 3 for 1992-95). Some country observations were too closely clustered to be labeled separately, and are identified as a group with letters. The following countries are included in these groupings (from left to right):

(a) Vietnam2, India1, Vietnam3, China2, India3, and China3.

(b) Sri Lanka2, Maldives3, Philippines2, and Philippines3.

(c) Nigeria2, Bangladesh1, Bhutan1, Mozambique1, Nepal1, Mali12, Burkina Faso2, Nepal2, Mali1, Bangladesh2, Rwanda2, Burkina Faso3, Chad3, Mozambique2, Burundi3, Burundi2, El Salvador2, Zambia1, Guatemala1, Mauritania1, Togo1, El Salvador3, Mauritiania2, Senegal1, Guatemala2, Guatemala3, Senegal2, Togo2, Cameroon2, Kenya1, Cameroon1, Kenya2, Cote d'Ivoire3, Papua New Guinea3, Papua New Guinea2, and Cote d'Ivoire1.

(d) Indonesia1, Ghana1, Paraguay2, Togo3, Indonesia2, Sri Lanka1, Lao PDR3, Lesotho1, Ghana2, Dominican Republic3, and Bolivia2.

Table 5. Low-Income Countries: Input Efficiency Scores and Ranking 1/

	Number of Observations	Input Efficiency Score	Number of More Efficient Country Observations	Number of Less Efficient Country Observations	Rank
		Education Expenditures			
Overall sample	95	0.29 (0.08)	9.0 (7.0)	9.0 (4.0)	48 (48)
Period 1 (1984-87)	30	0.27 (0.09)	9.5 (7.0)	7.8 (3.0)	49 (46)
Period 2 (1988-91)	33	0.19 (0.07)	10.7 (8.5)	7.5 (3.0)	55 (56)
Period 3 (1992-95)	32	0.40 (0.20)	6.7 (3.0)	11.6 (6.0)	40 (32)
Africa	43	0.08 (0.04)	14.0 (10.0)	1.9 (0.0)	64 (66)
Period 1 (1984-87)	16	0.09 (0.03)	14.7 (13.5)	1.6 (0.0)	66 (74)
Period 2 (1988-91)	17	0.06 (0.04)	14.9 (12.0)	1.2 (0.0)	65 (66)
Period 3 (1992-95)	10	0.10 (0.06)	11.2 (9.0)	3.6 (0.0)	58 (60)
Asia	29	0.53 (0.34)	4.7 (2.0)	19.9 (21.0)	29 (26)
Period 1 (1984-87)	8	0.42 (0.11)	4.4 (2.5)	16.1 (22.0)	31 (38)
Period 2 (1988-91)	8	0.45 (0.20)	7.1 (2.0)	21.0 (19.5)	35 (33)
Period 3 (1992-95)	13	0.65 (1.00)	3.5 (0.0)	21.5 (19.0)	24 (10)
Western Hemisphere	23	0.36 (0.12)	4.9 (3.0)	8.3 (7.0)	43 (36)
Period 1 (1984-87)	6	0.56 (0.59)	2.5 (0.5)	13.0 (8.5)	29 (24)
Period 2 (1988-91)	8	0.21 (0.07)	5.1 (5.0)	7.3 (7.5)	51 (54)
Period 3 (1992-95)	9	0.37 (0.28)	6.3 (8.0)	6.2 (6.0)	44 (29)
		Health Expenditures			
Overall sample	90	0.16 (0.06)	6.3 (4.0)	6.3 (1.0)	45 (46)
Period 1 (1984-89)	46	0.17 (0.06)	6.1 (4.0)	4.3 (1.0)	44 (41)
Period 2 (1990-95)	44	0.16. (0.05)	6.5 (3.5)	8.4 (3.0)	47 (48)
Africa	47	0.08 (0.06)	8.4 (6.0)	2.3 (1.0)	46 (45)
Period 1 (1984-89)	24	0.08 (0.07)	7.5 (6.0)	2.3 (0.5)	45 (41)
Period 2 (1990-95)	23	0.07 (0.06)	9.3 (6.0)	2.2 (1.0)	47 (46)
Asia	25	0.28 (0.09)	4.2 (3.0)	15.8 (9.0)	35 (30)
Period 1 (1984-89)	13	0.27 (0.09)	4.5 (3.0)	8.5 (7.0)	35 (31)
Period 2 (1990-95)	12	0.29 (0.12)	3.8 (1.5)	23.7 (16.0)	34 (25)
Western Hemisphere	18	0.21 (0.02)	3.9 (2.0)	3.7 (1.5)	59 (72)
Period 1 (1984-89)	9	0.23 (0.03)	4.8 (2.0)	3.7 (1.0)	55 (69)
Period 2 (1990-95)	9	0.20 (0.02)	3.1 (2.0)	3.8 (3.0)	63 (75)

Sources: Data provided by country authorities; and Fund staff estimates.

1/ The input efficiency scores are based on a production possibility frontier for all country observations and for all time periods. For example, the average input efficiency score is 0.29 for all country observations, with 9 countries being more efficient than the average country observation. The input efficiency score 0.27 for period 1 (1984-87) refers to the performance of countries in this period relative\ to the production possibility frontier derived for the overall sample.
2/ Numbers outside brackets refer to averages, numbers in parenthesis are medians. The observation of Niger during period 2 (1988-91) for education spending is independently efficient, and is excluded from the table.

Table 5 also shows median values for the input efficiency scores. These are generally lower than the average scores, indicating that the majority of countries are clustered at relatively low efficiency scores, and that the average is pulled up by a few countries with high efficiency scores.

Figure 10 reinforces Table 5's conclusion that the African countries, on average, are less efficient with their education spending than countries in Asia and Western Hemisphere. No African country in the sample has an efficiency score of 1, and the highest efficiency score for a recent time period is 0.34 for Zimbabwe. Relatively high efficiency scores were also achieved by The Gambia, Malawi, and the Democratic Republic of Congo (formerly Zaïre).[35] Many of the African countries are at the lower end of the efficiency score distribution, particularly Botswana, Cameroon, Côte d'Ivoire, and Kenya. Of the Asian countries, China, India, the Philippines, and Vietnam record high efficiency scores.[36] Papua New Guinea, on the other hand, does not perform as well. Apart from relatively high scores for Ecuador and Guyana, most Western Hemisphere countries perform around the average for the sample. Education spending in Guatemala, Honduras, and Nicaragua is relatively less efficient.

The results for the low-income countries in the sample show that high efficiency scores for education spending are clustered at low levels of expenditure. No country spending more than US$150 per capita on education has an input efficiency score greater than 0.4, suggesting that over half their spending is not allocated efficiently. It also suggests that increased government spending would have to be accompanied by improved targeting of such spending if a discernible impact on attainment indicators is to be felt.

This inverse relationship between government spending and relative efficiency can be partly explained by the fact that it becomes harder to achieve improvements in educational attainment when the initial level of educational attainment is high. Thus, as spending on education increases, it generates fewer added benefits in the form of higher educational attainment. A further explanation could be that the input measure of total government spending on education is not very precise. What is needed are measures of government spending's impact on primary and secondary school enrollment, that is government spending on primary and secondary education. Unfortunately, such disaggregated data on government spending are not available for most countries. Furthermore, the observed pattern may reflect the inability of the analysis to capture the differential impact of private spending on social indicators. Finally, spending on higher education may reflect the higher cost of tertiary

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[35]For Malawi, this is partly due to the fact that total education spending does not cover capital expenditure.

[36]The results for China and India are influenced by the partial coverage of government spending. For instance, both countries have a significant level of government spending on education and health undertaken at the lower levels of government, which is not captured in the data used in this paper.

education with rising per capita incomes; in that case, spending differences partly reflect cost differences among countries. However, the impact of such differences is minimized in this study by using a PPP measure of spending and by distinguishing between low-income and high-income countries.

The cost of tertiary education can be large. In sub-Saharan Africa in 1990, government spending per student on higher education was 44.1 times as large as government spending per primary school student (in 1980, it was 65.3 times, see World Bank, 1997). That same year in Asia, a higher education student was 7.4 times as costly; in the Western Hemisphere, 8.2 times. This higher cost of tertiary education for African countries is reflected in the social rate of return of different levels of education (the impact of education on lifetime income in relation to total—government and private—spending per pupil). The annual social rate of return to primary education in sub-Saharan African countries is 24.3 percent, against only 11.2 percent for tertiary education. In Asian countries, these rate of returns are 19.9 percent and 11.7 percent, respectively; in Western Hemisphere countries, 17.9 percent and 12.3 percent, respectively (Psacharapoulos, 1994). In terms of social indicators, such as illiteracy, the rate of return to primary education is even higher and the rate of return to higher education lower. It can thus be concluded that, when compared with the cost of primary education, the cost of higher education is high and the rate of return low, particularly in Africa. An inordinately high level of government spending on tertiary education would therefore exact a high price in terms of efficiency loss.[37]

Turning to health spending in Table 5, the Asian countries also have the highest average input efficiency score (an average of 0.28 during both time periods), followed by the Western Hemisphere (0.21), and Africa (0.08). Government spending on health as a percent of GDP was on average the highest in the last time period (1990-95) in the Western Hemisphere countries (2.6 percent of GDP), followed by the African countries (1.6 percent of GDP) and the Asian countries (1.4 percent of GDP). The median efficiency scores vary less between regions than the average scores, and are higher for Africa than for the Western Hemisphere. If the median score is interpreted as the score of a "typical" country, it would imply that a typical country in Africa is more efficient than a typical country in the Western Hemisphere.

Input efficiency scores for health spending of the entire sample of low-income countries are shown in Figure 11. In this case too, inefficiencies in African countries are evident, and there is a negative relationship between input efficiency scores and the level of spending. The efficiency scores for health spending of relatively well-performing countries in Africa—Guinea, Ethiopia, and The Gambia—vary from 0.15 to 0.20. Congo, Côte d'Ivoire,

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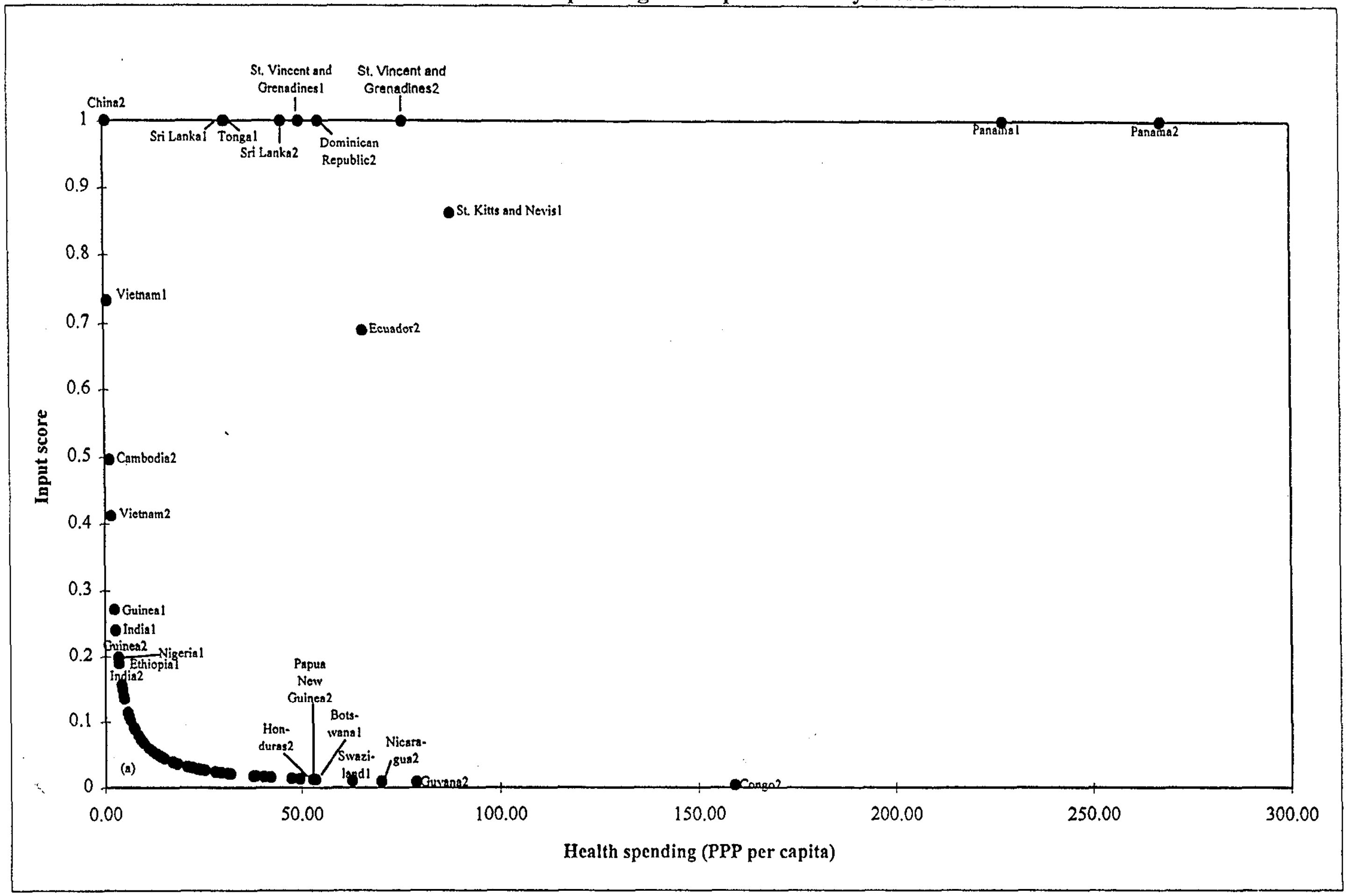
[37]In a sample of 19 African countries, the share of tertiary education in total government education spending in the early 1990s varied from 5.5 percent in Guinea Bissau to 35.0 percent in Tanzania, with an average of 20.8 percent. See Appendix Table 8 and 9 for the intrasectoral allocation of education and health spending in selected low-income countries.

Figure 11. Health Care in Low-Income Countries:
Government Spending and Input Efficiency Scores 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Observations are identified by country name and a number for the period (1 for 1984-89 and 2 for 1990-95). Some country observations were too closely clustered to be labeled separately, and are identified as a group with the letter (a). The following countries are included in this grouping (from left to right): Ethiopia2, The Gambia2, Myanmar2, 'Sao Tome and Principe1, Nigeria2, Myanmar1, Guinea Bissau1, Burkina Faso1, Tanzania1, Madagascar1, Burundi2, Nepal2, Nepal1, Bangladesh1, Madagascar2, Burkina Faso2, Mozambique1, The Gambia1, Indonesia1, Mali1, Niger1, Mali2, Maldives1, Tanzania2, Paraguay1, Malawi1, Chad2, Niger2, Malawi2, Mozambique2, Mauritania, Central African Republic2, Bangladesh2, Togo1, Philippines1, Mauritania2, Zambia2, Togo2, Zambia1, Indonesia2, El Salvador1, Ghana1, Philippines2, Lao PDR2, Cameroon2, Cote d'Ivoire1, Cote d'Ivoire2, Kenya1, Cameroon1, Guatemala1, El Salvador2, Bolivia1, Paraguay2, Ghana2, Kenya2, Lesotho1, Belize 1, Guatemala2, Peru1, Zimbabwe1, Dominican Republic1, Bolivia2, Solomon Islands1, Ecuador1, Papua New Guinea1, and Zimbabwe2.

Ghana, Kenya, and Zimbabwe have lower scores. Of the Asian countries, China, Sri Lanka, and Vietnam have relatively high efficiency scores, whereas Papua New Guinea is among those with the lowest. Of the Western Hemisphere countries, Panama, and St. Vincent and the Grenadines have been performing well, whereas Honduras, Nicaragua, Bolivia, and Guatemala have relatively low efficiency scores.

No trend consistent with the efficiency results is discernable from the relative shares of government and private spending on health in the three regions. In Africa, private per capita spending on health is on average US$10.7, and government spending is US$13.3.[38] In Asia, private spending on health averages US$36.7 per capita, and government expenditure amounts to US$24.5. In the Western Hemisphere, private spending averages US$42.0 per capita, against US$63.1 for government spending. Therefore, whereas per capita private spending on health in Asia and the Western Hemisphere is larger than in Africa, it is smaller as a share of total health spending in the Western Hemisphere, and larger in Asia.

As noted above, the differences in efficiency levels could reflect differences in the cost of providing education and health services. It could be, for example, that the relatively poor performance of some countries is due to relatively high wages of teachers and medical personnel. As a result, too few resources would be available for teaching materials, medical equipment, and other types of inputs, resulting in a distorted input mix and a loss of efficiency. To test this hypotheses, two OLS regressions were run for a sample of 25 countries in Africa, Asia, and the Western Hemisphere with average government wages as a percent of per capita GDP as the explanatory variable and the efficiency ranking for education and health spending as the explained variables.[39] In the case of health spending, no statistically significant relationship could be found, but a negative and statistically significant relationship was found between the degree of efficiency and relative government wages.[40] This suggests that in the case of education spending, part of the inefficiency due to cost differences is traceable to wage level differentials. This result is not surprising in light of the study by Harbison and Hanushek (1992), who conclude on the basis of a sample of education production functions, that teacher wages have no significant effect on education output. In other words, consistent with the finding in this paper, their study suggests that countries with relatively high teacher salaries incur larger costs, but not significantly higher education output than countries with relatively low teacher salaries.

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[38]The figures refer to 1990 and are based on Psacharapoulos and Nguyen (1997).

[39]Wage data were obtained from Kraay and Van Rijckeghem (1995) and authors' calculations.

[40]The coefficient of government wages as a percent of per capita GDP is 0.04, with a t-statistic of 2.1. The adjusted R^2 of the regression is 0.12.

Mauritius was the only high-income African country in the sample. Compared with 32 other high-income countries, Mauritius attains an input efficiency score of 0.22 in period 1 (1984-87), and ranks twenty-fourth. In period 3 (1992-95), Mauritius's score falls to 0.10. Argentina, Colombia, Korea, and Mexico[41] are the most efficient among the high-income countries in their government spending on education, whereas Costa Rica and Malaysia are relatively less efficient. Mauritius's input score in period 1 (1984-89) for health spending is 0.68 (the only available observation for Mauritius), and its rank fourth out of 25. The analysis further suggests that Argentina, Chile, Korea, Singapore, and Uruguay use government resources for health relatively efficiently, but the Bahamas and Brazil do not.

The development of efficiency over time

Table 5 shows that the average input efficiency score of education expenditure for all observations between period 1 (1984-87) and period 3 (1992-95) rose from 0.27 to 0.40. This indicates that low-income countries during period 1 were less efficient than during period 3. In period 2 (1988-91), however, the average efficiency score dropped to 0.19. The efficiency scores for the African countries show the same pattern—a decrease in period 2 followed by a marked increase in period 3—although the absolute changes are much smaller. For the Asian countries, the scores suggest that the efficiency of education spending has steadily improved, whereas in the Western Hemisphere countries, the input efficiency score has fallen since the second half of the 1980s. The same pattern is reflected in the development of the average number of more efficient countries, the average number of less efficient countries, and the average rankings.

Increases in the efficiency score over time indicate that the *relative* efficiency of government spending has improved, that is, that the country or region has moved closer to the production possibility frontier. This does not imply that individual countries have become more efficient in the latter time periods. As explained above, for a country to become more efficient requires constant or increasing output indicators and falling spending levels. Such an increase in efficiency can only be observed for education spending in India and Togo between period 2 (1988-91) and period 3 (1992-95), and for health spending in Cameroon, The Gambia, and Myanmar between period 1 (1984-89) and period 2 (1990-95).

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[41] This favorable result for Mexico may be partly due to incomplete coverage of government spending on education, and deficiencies in the measurement of school enrollment.

Figures 12 and 13 provide further illustration of the developments of the input efficiency scores of education and health spending over time in low-income countries in different regions.[42] The charts showing the frequency of the input efficiency scores of education spending (the three panels on the left-hand side of Figure 12) confirm that efficiency scores of the African countries tend to be relatively low, whereas those of the Asian countries are relatively high. The three charts in the right-hand side of Figure 12 show the cumulative frequency distribution of the input efficiency scores.[43] The unevenness of the frequency distribution of input efficiency scores is reflected by the deviation from the diagonal line shown. In the first period (1984-87), the frequency distributions of all regions are below and to the right of the diagonal line, indicating that efficiency scores are clustered around relatively high values near 1. In the second period (1988-91), the frequency distribution for Africa shows the opposite pattern, with a clustering of efficiency scores at relatively low levels. The frequency distributions for the Western Hemisphere and Asian countries, on the other hand, show both a clustering at relatively low and at relatively high levels, with few countries scoring intermediate values. This pattern remains basically unchanged for the third period (1992-95).

Figure 13 shows the frequency of input efficiency scores for health spending. In period 1 (1984-89), all regions show a similar clustering of scores at relatively low and relatively high values. In the next period (1990-95), the distribution of efficiency scores is concentrated at low levels, particularly in Africa and the Western Hemisphere.

Sensitivity of FDH analysis

The FDH analysis results for the African countries, as presented in Tables 3 and 4, include a number of independently efficient observations. Because little can be gauged from the classification of a country as independently efficient, this limits the information from the FDH analysis. One way of limiting the number of independently efficient results is to reduce the number of output indicators. Tables 6 and 7 present the results of FDH analyses using two output indicators each for education and health instead of three and four, respectively (literacy and primary enrollment were used for education, and life expectancy and infant survival for health).

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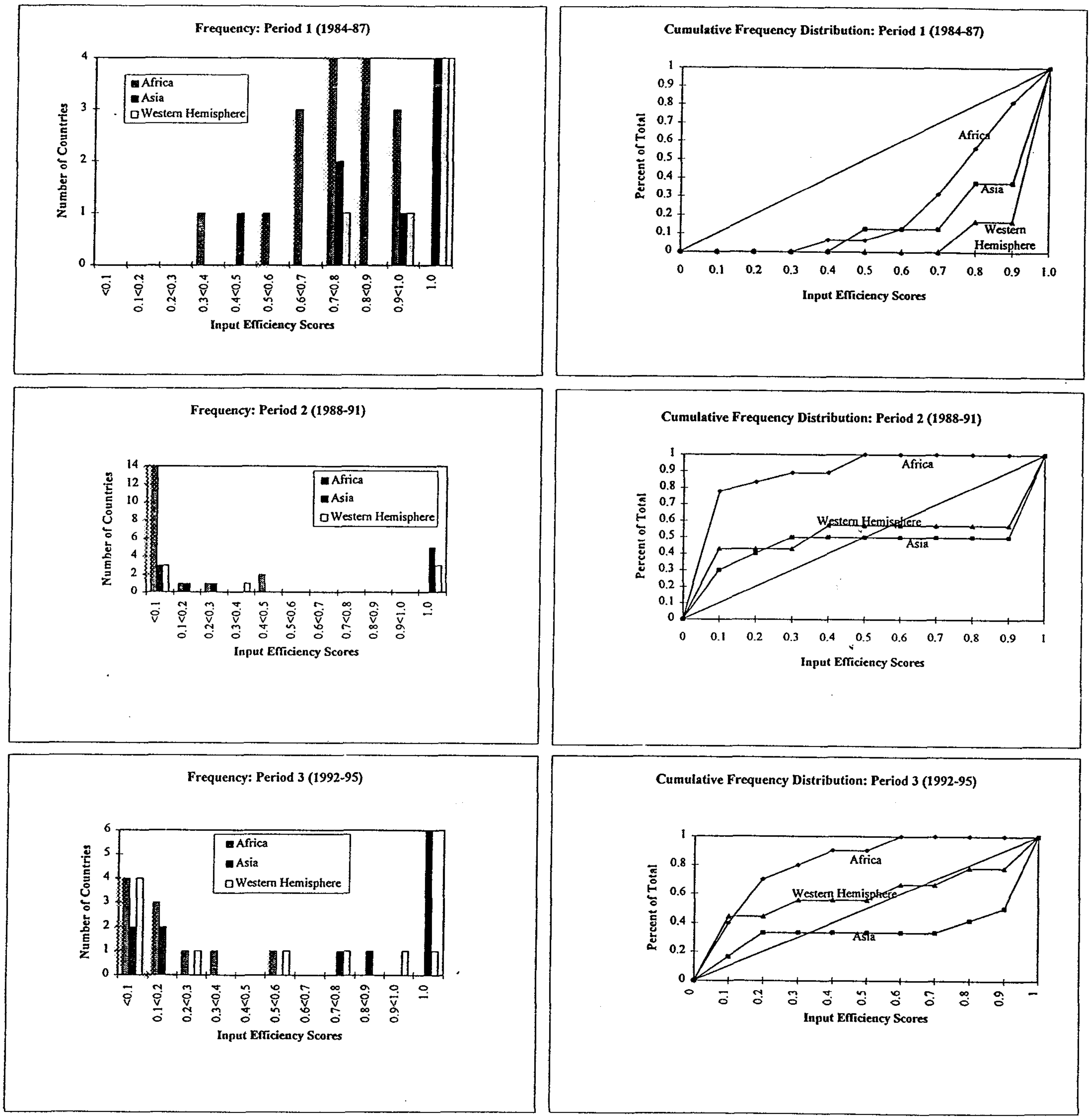
[42]The figures illustrate results of FDH analyses for separate time periods. As noted above, efficiency scores generated by such separate FDH analyses are not directly comparable across time because the production possibility frontier relative to which efficiency is measured is different for each period.

[43]The surface above the line depicting the frequency distribution reflects the average efficiency scores. For example, if the frequency distribution were along the 45° line (shown in the figures), the average efficiency score would be 0.5.

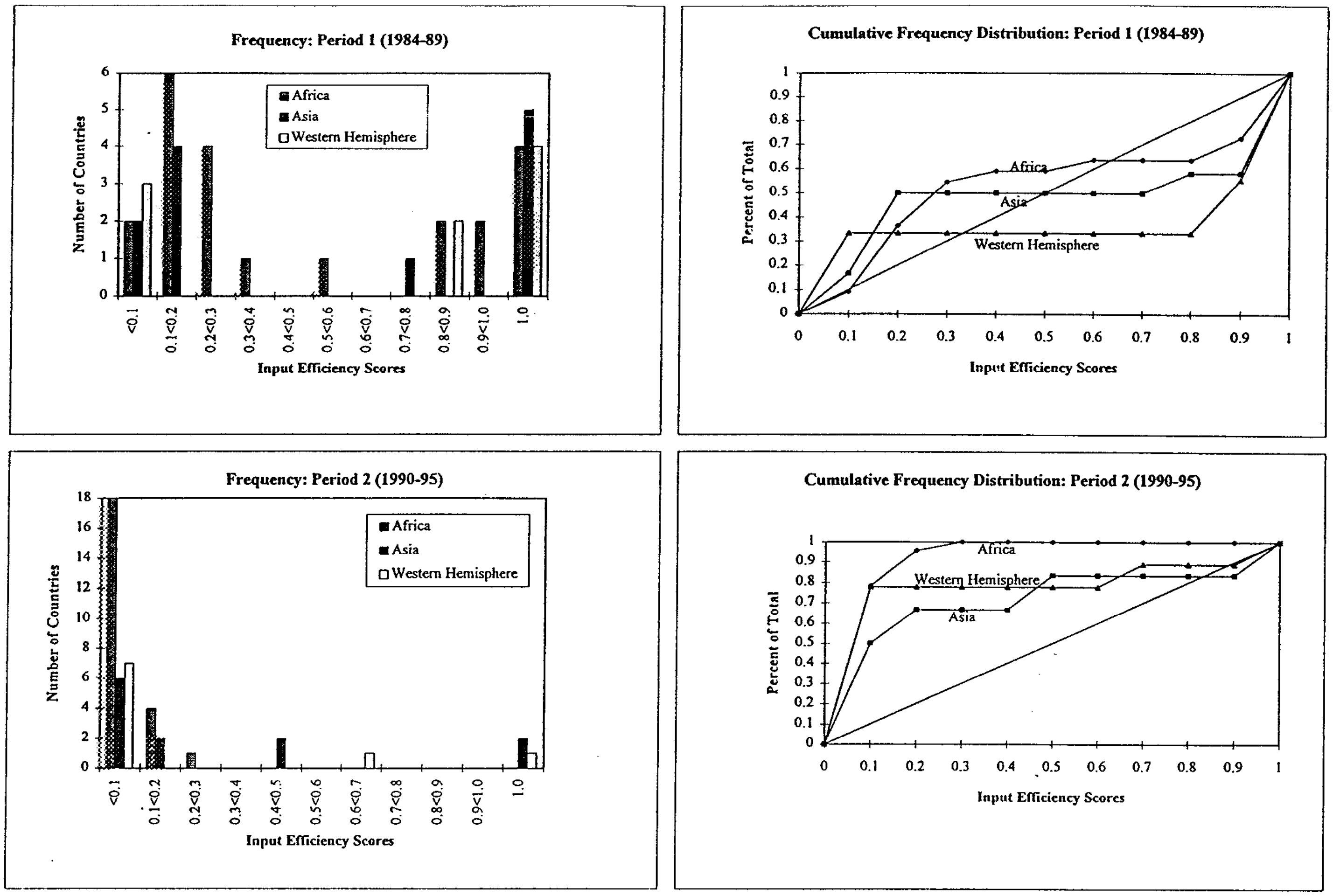
Figure 12. Education Expenditures in Low-Income Countries: A Cross-Regional Comparison of Input Efficiency Scores 1/



Source: Data provided by country authorities; and Fund staff estimates.

1/ Reflects the results of FDH analyses of the efficiency of education expenditures in low-income countries for the three periods 1984-87, 1988-1991, and 1992-95 separately. Independently efficient countries are excluded from the samples.

Figure 13. Health Expenditures in Low-Income Countries: A Cross-Regional Comparison of Input Efficiency Scores 1/



Source: Data provided by authorities; and Fund staff estimates.

1/ Reflects the results of FDH analyses of the efficiency of health expenditures in low-income countries for the two periods 1984-89 and 1990-95 separately. Independently efficient are excluded from the samples.

Table 6. Africa : Education Input Efficiency Scores During 1984-87, 1988-91, and 1992-95 1/
(Output Indicators: Literacy and Primary Enrollment)

	Period 1 (1984-1987)			Period 2 (1988-1991)			Period 3 (1992-1995)		
	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient
Botswana	0.34	(14)		1	(4)		0.1	(11)	
Burkina Faso				0.29	(12)		0.56	(5)	
Burundi				0.37	(11)		0.38	(8)	
Cape Verde							0.13	(9)	
Cameroon	0.69	(9)		0.17	(17)				
Chad							0.47	(6)	
Central African Republic							0.45	(7)	
Cote d'Ivoire	0.35	(13)		0.09	(18)		0.12	(10)	
Ethiopia							1		+
Gambia				1	(3)				
Ghana	1	(3)		0.22	(14)				
Guinea				0.51	(9)				
Kenya	0.69	(8)		0.52	(8)				
Lesotho	1	(1)							
Liberia	0.58	(10)							
Malawi	1	(2)							
Mali	0.84	(7)		0.72	(6)				
Mauritinia	0.10	(17)		0.26	(13)				
Mozambique	1	(4)		0.43	(10)				
Niger				1		+			
Nigeria	1	(6)		0.89	(5)				
Rwanda				0.59	(7)				
Sao Tome and Principe				1	(1)		1	(2)	
Senegal	0.33	(15)		0.18	(15)				
Swaziland	0.25	(16)							
Togo	0.42	(12)		0.18	(16)		0.72	(4)	
Zaire							1	(1)	
Zambia	1	(4)		1	(2)		1	(3)	
Zimbabwe	0.47	(11)		0.09	(19)		1		+
Average input efficiency score 2/		0.65			0.50			0.61	
Median input efficiency score 2/		0.69			0.43				
Total number of countries		17			20			13	
of which: not independently efficient		17			19			11	

Sources: Data provided by country authorities; and Fund staff estimates.

1/ The efficiency scores and rankings are based on separate FDH analyses of education spending in Africa for all three time periods separately.
2/ Independently efficienct countries are excluded from the calculation of the average and median input efficiency score.

Table 7. Africa: Health Input Efficiency Scores During 1984-89, 1990-95 1/
(Output Indicators: Life Expectancy and Infant Survival)

	Period 1 (1984-89)			Period 2 (1990-1995)		
	Efficiency Score	Rank	Independently Efficient	Efficiency Score	Rank	Independently Efficient
Botswana	1	(4)		1	(11)	
Burkina Fasso	0.57	(12)		0.57	(17)	
Burundi				0.68	(15)	
Cameroon	0.99	(8)		1	(6)	
Central African Republic				0.34	(25)	
Chad				0.38	(21)	
Congo				0.03	(29)	
Cote dIvoire	0.21	(24)		0.53	(18)	
Ethiopia	0.96	(9)		1	(5)	
Gabon				0.22	(28)	
Gambia	0.44	(15)		1	(6)	
Ghana	0.25	(23)		0.46	(20)	
Guinea	1	(4)		1	(11)	
Guinea Bissau	1	(13)		0.62	(16)	
Kenya	1	(3)		1	(6)	
Lesotho	1	(4)		1	(6)	
Liberia	0.35	(18)				
Madagascar	0.72	(11)		1	(3)	
Malawi	0.29	(21)		0.35	(23)	
Mali	0.40	(16)		0.49	(19)	
Mauritania	0.26	(22)		0.31	(26)	
Mozambique	0.44	(14)		0.35	(24)	
Namibia				0.95	(13)	
Niger	0.37	(17)		0.36	(22)	
Nigeria	1	(2)		1	(1)	
Sao Tome and Principe	1	(1)		1	(2)	
Swaziland	0.07	(25)				
Tanzania	0.72	(10)		1	(4)	
Togo	0.31	(19)		0.81	(14)	
Zambia	0.29	(20)		0.31	(27)	
Zimbabwe	1	(4)		1	(6)	
Average input efficiency score		0.63			0.68	
Median input efficiency score						
Total number of countries		25			29	
of which: not independently efficient		25			29	

Sources: Data provided by country authorities; and Fund staff estimates.

1/ The efficiency scores and rankings are based on separate FDH analyses of education spending in Africa for the two time periods seperately.
2/ Independently efficient countries are excluded from the calculation of the average and median input efficiency score.

Tables 6 and 7 show that the number of independently efficient observations is greatly reduced; the results for education spending include only three independently efficient cases, and no cases for health spending. On the basis of the results presented in Table 6, it can be concluded that education spending in São Tomé and Príncipe and Zambia seems relatively efficient, which is not obvious from Table 3.

The results show that FDH analysis are impacted strongly by changes in the number of output indicators, underscoring the sensitivity of the FDH analysis results to changes in the data set. The efficiency of education spending in Ghana, Senegal, and Togo seems lower with two output indicators than when three output indicators are used. Reducing the number of output indicators from four to two for health spending does not seem to have such a large effect on the results.

IV. Conclusions and Policy Implications

With the help of a technique used in production theory, this paper attempts to assess the efficiency of government spending on health and education in sample countries in Africa, both relative to each other and to sample countries in Asia and the Western Hemisphere. The results are revealing. There is a wide variation in the way government spending in the African countries impacts on measurable output indicators. For instance, in comparison with other countries in Africa and countries in Asia and the Western Hemisphere, health and education spending in The Gambia, Guinea, Ethiopia, and Lesotho is associated with relatively high educational attainment and health output. This is not the case in countries such as Botswana, Cameroon, Côte d'Ivoire, and Kenya.

The results further indicate that, on average, governments in the African countries are less efficient in the provision of health and education services than the countries in Asia and the Western Hemisphere, with those in Asia appearing as most efficient.The results suggest that the inefficiencies observed in Africa are unrelated to the level of private spending, but may be the result of relatively high government wages (in the case of education spending) and the intrasectoral allocation of government resources. Furthermore, the results reveal no apparent relationship between input efficiency scores and public spending as a share of GDP.

There is some evidence that suggests that productivity of government spending on education and health in the African countries has improved since the mid-1980s, as evidenced by the outward shift of the production possibility frontier. However, in a sample that combines country observations for all time periods, the average level of efficiency since the mid-1980s has declined in relation to the countries in Asia and the Western Hemisphere.

Due to the lagged impact of government spending on some output indicators (particularly literacy and life expectancy),[44] caution needs to exercised in interpreting the efficiency results. In the absence of such lags, input efficiency scores would indicate the extent of expenditure reallocation that could be achieved, without affecting the level of output. In the presence of lags, the observed inefficiencies could be the result of past spending decisions. Reducing inefficiencies and government expenditures may therefore only be achieved gradually and over time.

The FDH analysis of the efficiency of government spending on education and health provides important insights not revealed by regression analysis. The regression analysis shows a positive relationship (with a constant elasticity) between government spending on education and health and indicators of educational attainment and health output, respectively. This suggests that an increase in spending generates benefits in the form of improved output, independent of the level of government spending. However, the efficiency analysis shows that the degree of inefficiency increases rapidly with the level of government spending. In contrast to the regression analysis, this implies that governments should carefully consider expanding government expenditure on education and health when the initial level of spending is already high.

The above results suggest that improvements in educational attainment and health output in Africa and the Western Hemisphere are feasible by correcting inefficiencies in government spending on education and health. For instance, relatively low allocations for primary education, or relatively high allocations for curative health care, or directing most benefits of such government spending to high-income groups is symptomatic of expenditure inefficiencies.[45] This suggests that caution needs to be exercised in increasing budgetary allocations for education and health. This is of direct relevance for the Highly-Indebted Poor

[44]In the case of investment, government spending would have an additional lagged impact on output indicators.

[45] For instance, outlays on wages and salaries in Bolivia between 1980 and 1995 accounted for 95-98 percent of primary and secondary current expenditure compared with the Latin American average of 75 percent. Furthermore, budgetary allocations for curative care in Bolivia are excessive and there is a high concentration of health facilities in higher-income regions. Similarly, wages accounted for 95 percent of current costs in Ghana in the early 1990s. The bottom 20 percent of the population received 16 percent of the benefits of education spending in 1992. Only 11 percent of health spending went to the poorest 20 percent, and urban Ghana received 49 percent of the health budget, despite the fact that only 33 percent of the population lived in urban areas. Primary education in Togo received 41 percent of the 1995 education budget, even though primary school enrollment accounted for 83 percent of the school population.

Countries (HIPC) under the recently announced Initiative. The efficiency ranking of countries, including those eligible for relief under the Initiative in the short term (e.g., Bolivia, Burkina Faso, Côte d'Ivoire, Ethiopia, Guyana, Mozambique, and Uganda) indicates that the level of government spending alone is not sufficient for achieving higher social indicators.

The Calculation of Efficiency Scores in the Multiple Input-Output Case

This appendix describes how FDH efficiency scores can be calculated in case the production process involves more than one input and/or more than one output. We begin by turning to the calculation of the input efficiency score in the multiple input case. First, a producer, *Z*, is selected. Then, all producers that are more efficient than *Z* are identified.[46] For every pair of producers comprising *Z* and a more efficient producer, an input efficiency score is calculated by dividing that producer's input use by *Z*'s use of that input. The result is an $m \times n$ matrix, where m is the number of inputs and n is the number of producers who are more efficient than *Z*. Next, for every more efficient producer, the input that brings producer *Z* closest to the production possibility frontier is selected. In other words, from each column of the matrix, the largest efficiency score—one for each more efficient producer—is taken, leaving a $n \times 1$ vector of efficiency scores. Finally, the efficiency score of the most efficient producer is selected, that is, the smallest score in the $n \times 1$ vector. This is the input efficiency score.

The calculation of the input efficiency score can be illustrated with an example of a 2-input 3-output case. Let $f(x;y)$ be the production set where x and y are inputs and outputs, respectively, and where $x_i(N)$ denotes usage of the i-th type of input by producer *N*. Assume four producers, *A* through *D*, with production sets *A*(50, 72.5; 29.6, 4.2, 35.2), *B*(35, 60; 35, 4.3, 37), *C*(55, 70; 33.3, 5, 38), and *D*(40, 23.4; 43.5, 5.6, 44.5). Producer *A* is less efficient than *B* and *D*—*A* uses more of both inputs but its outputs are smaller—although it is not less efficient than *C*. To calculate the input efficiency score, a comparison is made of *A*'s use of inputs with those of the countries that are more efficient, that is, *B* and *D*. The following matrix of input quotients (or scores) is used:

	x_1	x_2
B/*A*	0.70	0.83
D/*A*	0.80	0.32

From the above matrix, the maximum in each of the two columns (0.80, 0.83) is taken. The smallest of these scores is the relevant input efficiency score: 0.80. In formula form, the input efficiency score is

$$\underset{N=B,D}{MIN}\ \underset{i=1,2}{MAX}\ \frac{x_i(N)}{x_i(A)}$$

The input score indicates by how much producer *Z* will have to decrease the use of its inputs at the same rate so that the input with the highest score has a score of 1 (thus, the

[46]As in the one-input one-output case, if a more efficient producer cannot be identified, producer Z is assigned input and output efficiency scores of 1.

higher the score, the lower the required decrease in input use). Then, producer Z will cease to be relatively inefficient and will be on the production possibility frontier. In this way, the input efficiency score reflects the shortest distance to the production possibility frontier, that is, the minimum improvement in efficiency required to become as much or more efficient as all other producers.[47]

In the above example, the output efficiency score can be calculated in a similar manner, using:

$$\underset{N=B,D}{MIN}\ \underset{i=1,2,3}{MAX}\ \frac{y_i(A)}{y_i(N)}$$

It should be noted that in the case of multiple inputs (outputs), FDH analysis does not rely on some weighing of inputs (outputs) to obtain a unit-dimensional indicator of efficiency. Calculating the input efficiency score involves selecting the input quotient that most accurately captures the distance to the production possibility frontier, and not some weighted average of input quotients.

This sets FDH analysis apart from most economic analyses that involve indexes of economic achievement. For instance, the "Misery Index," an often-used negative measure of macroeconomic performance, is a sum of the inflation and unemployment rates, and the "Magic Diamond," developed by the OECD, combines the rate of GDP growth, inflation, unemployment, and the trade balance, assigning an equal weight to all variables. Although these measures are informative, the practice of assigning unitary weights in both cases appears somewhat arbitrary. FDH analysis, on the other hand, allows a multidimensional focus without imposing weights on different factors entering the analysis.

[47]The choice of the largest efficiency score, as adopted in most applications of FDH analysis, is based on the notion of radial efficiency introduced by Charnes, Cooper, and Rhodes (1978). (See Tulkens, 1993, pp.186-88).

SAMPLE COUNTRIES

Africa

Low-income countries (37)

Botswana
Burkina Faso
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Republic of Congo
Côte d'Ivoire
Equatorial Guinea
Ethiopia
Gabon
The Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Liberia
Madagascar
Malawi
Mali
Mauritania
Mozambique
Namibia
Niger
Nigeria
Rwanda
São Tomé and Príncipe
Senegal
Swaziland
Tanzania
Togo
Democratic Republic of Congo (formerly Zaïre)
Zambia
Zimbabwe

High-income country (1)

Mauritius

Asia

Low-income countries (18)

Bangladesh
Bhutan
Cambodia
China
India
Indonesia
Lao People's Democratic Republic
Maldives
Mongolia
Myanmar
Nepal
Pakistan
Papua New Guinea
Philippines
Solomon Islands
Sri Lanka
Tonga
Vietnam

High-income countries (6)

Fiji
Korea
Malaysia
Singapore
Thailand
Vanuatu

Western Hemisphere

Low-income countries (14)

Belize
Bolivia
Dominican Republic
Ecuador
El Salvador
Guatemala
Guyana
Honduras
Nicaragua
Panama
Paraguay
Peru
St. Kitts and Nevis
St. Vincent and the Grenadines

High-income countries (10)

Argentina
The Bahamas
Barbados
Brazil
Chile
Colombia
Costa Rica
Mexico
Uruguay
Venezuela

Appendix Table 8. Allocation of Public Education Expenditure in Selected Countries 1/

(As percent of total)

	Year	Primary Education	Secondary Education	Primary and Secondary Education	Tertiary Education	Other
All countries		46.8	23.1	69.2	20.9	8.6
Benin	1992	54.0	...	...	...	...
Bolivia	1994	...	...	50.0	32.0	18.0
Burkina Faso	1993	17.0	...	...	...	...
Burundi	1993	44.0	25.0	69.0	23.0	8.0
Central African Republic	1992	56.0	16.0	72.0	23.0	5.0
Côte d'Ivoire	1995	48.6	33.5	82.1	17.8	0.0
Ethiopia	1992-93	45.0	24.0	69.0	13.0	18.0
Gambia, The	1990	63.0	16.0	79.0	...	...
Ghana	1992	41.5	43.2	84.7	15.3	0.0
Guinea	1992	42.0	25.0	67.0	33.0	0.0
Guinea Bissau	1992	54.3	11.4	65.7	5.5	28.8
Kenya	1992-93	60.0	17.0	77.0	17.0	6.0
Lesotho 2/	1991-92	52.0	30.0	82.0	15.0	3.0
Madagascar	1993	44.9	29.9	74.8	25.2	0.0
Mozambique	1990	50.0	35.6	85.6	14.4	0.0
Myanmar	1990	...	...	76.0	24.0	0.0
Nicaragua	1994	40.1	9.5	49.6	32.9	17.5
Nepal	1985	...	...	46.0	20.0	34.0
Niger	1992	42.0	25.0	67.0	22.0	1.0
Senegal	1991	48.9	25.5	74.4	25.5	0.0
Sierra Leone	1991	38.6	22.6	61.2	29.6	9.2
Tanzania	1993-94	52.0	13.0	65.0	35.0	0.0
Togo	1995	41.0	16.0	57.0	25.0	18.0
Zambia	1994	46.1	12.1	58.2	11.5	30.6
Zimbabwe	1990	49.3	30.6	79.9	20.2	0.0

Sources: World Bank Poverty Assessments: Benin (1994), Burkina Faso (1993), Burundi (1992), Cameroon (1992), Central African Republic (1993), Ethiopia (1994), Guinea (1997), Guinea Bissau (1994), Kenya (1995), Lesotho (1995), Mongolia (1995), Mozambique (1992), Nicaragua (1995), Niger (1996), Senegal (1992), Sierra Leone (1994), Tanzania (1994), Togo (1996), Zambia (1995), and Zimbabwe (1995); IMF Government Finance Statistics database (1995): Bolivia, The Gambia, Malawi, and Nepal; and Castro-Leal and others (forthcoming): Côte d'Ivoire, Ghana, and Madagascar.

1/ The coverage of other expenditure varies by countries and includes items such as unallocated administrative expenses, adult education, vocational and technical training.

2/ Current expenditure only.

Appendix Table 9. Public Expenditure Allocations Between Preventive and Curative Health Care in Selected Countries 1/

Country	Year	Preventive/Primary Health Care	Curative/Tertiary Hospital Health Care
All Countries		28.0	61.8
Angola 2/	1992	6.0	48.5
Bolivia	1994	...	31.0
Burundi	1993	24.2	42.3
Central African Republic	1991	5.0	95.0
Côte d'Ivoire 3/	1995	42.5	57.5
Ethiopia	1995	50.0	50.0
Gambia, The	1991	63.0	37.0
Ghana	1992	32.2	67.8
Guinea	1991-94 4/	24.0	62.0
Honduras	1991	42.9	57.1
Kenya	1991	27.6	68.8
Lesotho	1990-91	5.0	95.0
Madagascar	1993	52.2	47.8
Nepal	1985	33.0	67.0
Uganda	1991-92	10.0	90.0
Tanzania	1993-94	14.0	79.0
Zambia	1994	...	33.0
Zimbabwe	1989	16.0	84.0

Sources: World Bank Poverty Assessments: Angola (1992), Burundi (1992), Central African Republic (1993), Côte d'Ivoire (1994) Ethiopia (1994), Guinea (1997), Honduras (1994), Kenya (1995), Lesotho (1995), Mongolia (1995), Tanzania (1994), Zambia (1995) and Zimbabwe (1995); IMF Government Finance Statistics database (1995): Bolivia, The Gambia, and Nepal; and Castro-Leal and others, *Public Social Spending in Africa: Do the Poor Benefit?*, World Bank (forthcoming): Ghana and Madagascar.

1/ The totals do not sum up to 100 for five countries because of nonallocation of administrative and other expenditure to preventive/primary health care and curative/tertiary hospital health care.
2/ Capital expenditure only.
3/ Recurrent expenditure only.
4/ Average from 1991 to 1994.

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