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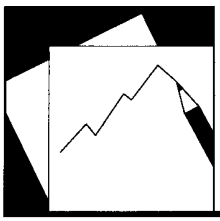

IMF Working Paper

Government Spending on Health Care and Education in Croatia: Efficiency and Reform Options

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Government Spending on Health Care and Education in Croatia: Efficiency and Reform Options

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Abstract

This paper assesses the relative efficiency of government spending on health care and education in Croatia by using the so-called Data Envelopment Analysis. The analysis finds evidence of significant inefficiencies in Croatia's spending on health care and education, related to inadequate cost recovery, weaknesses in the financing mechanisms and institutional arrangements, weak competition in the provision of these services, and weaknesses in targeting public subsidies on health care and education. These inefficiencies suggest that government spending on health and education could be reduced without undue sacrifices in the quality of these services. The paper identifies ways to do that.

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I. INTRODUCTION

The Croatian authorities envisage a significant expenditure-led fiscal consolidation in the next few years.[2] In its latest *Economic and Fiscal Policy Guidelines*, the Ministry of Finance (MoF) projects a decline in general government spending of almost 6 percentage points of GDP from 2007 to 2010, and a reduction of the general government deficit to ½ percent of GDP in 2010.[3] Spending on health care and education constitutes a large share of total general government spending, and therefore reforming the provision of health care and education services are important areas that could be part of this consolidation effort.

A key policy issue is how to contain the cost of health care and education services without undue sacrifices in quality. While Croatia's performance on health indicators has been better than most EU-10 countries, it is well behind most EU-15 countries, as discussed later in the paper, and Croatia's education outcomes are lagging behind most EU-10 and EU-15 countries.[4] Improving health care and education indicators while containing costs requires greater efficiency of spending.

With this in mind, and to help identify areas for reform, this paper analyzes the relative efficiency of government spending on health care and education in Croatia. It does so by comparing spending on these sectors and key health care and education (outcome) indicators in Croatia to those of comparator countries. Relative efficiency is defined as the distance of a country's observed input-output combination from an efficiency frontier. This frontier is estimated using so-called Data Envelopment Analysis (DEA, see Appendix) and represents the maximum attainable social outcome for a given input (spending or intermediate output such as the number of hospital beds, the density of physicians, etc.) level. The efficiency of spending on health care and education in Croatia is evaluated against frontiers estimated for the EU-15, the EU-10, Cyprus, Malta, and OECD countries.

The analysis finds evidence of significant inefficiencies in Croatia's health care and education spending and therefore significant potential to reduce government expenditure. As discussed later, this potential could be realized by: (i) containing demand for health care and education services by introducing (or increasing the existing) fees for

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[2] Expenditure-led fiscal adjustment will help to address Croatia's large current account deficit, and maintain strong economic growth on a sustainable basis. At the same time, rationalizing spending is key for enhancing the flexibility of fiscal policy, a necessary ingredient for coping with shocks in the context of tightly managing the exchange rate.

[3] The projection does not include spending related to the use of EU structural funds.

[4] EU-10 countries are new EU members and comprise the Czech Republic, Estonia, Latvia, Hungary, Lithuania, Poland, Slovakia, Slovenia, Bulgaria, and Romania. EU-15 countries comprise Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

users of these services; (ii) reforming finance mechanisms for spending; (iii) introducing greater competition in the provision of these services; (iv) improving the administration of spending on these services; and (v) better targeting health care and education subsidies.

The rest of the paper is organized as follows. Section II compares health care and education spending and performance indicators in Croatia with those in other countries. Section III assesses efficiency scores of key health care and education spending categories, outlines possible explanatory factors for understanding cross-country differences in efficiency, and discusses potential reforms to enhance efficiency. Section IV concludes.

II. International Comparisons of Spending on Health Care and Education and Performance

Box 1 summarizes the performance indicators that are used.

Box 1. Performance Indicators

As in Verhoeven et al. (2007), performance indicators are divided into desired *outcome* and intermediate *output* indicators. Outcomes correspond to the underlying objectives sought by policy makers. Intermediate outputs are thought to be related to desired outcomes but can be more closely associated with current spending. The following indicators are used:

- Health care: The intermediate output indicators considered are the density of physicians, pharmacists, and healthcare workers; the number of hospital beds; and the number of immunization vaccines. The key outcome variables include infant-, child-, and maternal mortality rates; the standardized death rate from all causes per 1,000 people, as defined by the World Health Organization (WHO); incidences of tuberculosis; and healthy average life expectancy (as defined by the WHO).

- Education: The key intermediate output indicators are primary pupil-teacher ratios, enrollment rates, rates of progression to secondary education, and graduation (completion) rates. The main outcome indicator is the average score on an international standardized test (PISA 2006) in mathematics (secondary education).

Health Care

Health care in Croatia is mainly financed (around 90 percent) by the Croatian Health Insurance Institute (HZZO). Only a small share of the funding comes from other sources such as co-payments, informal patient payments and payments from other insurance companies. Payroll contributions are set at 15 percent of the gross wage. In addition, enterprises pay another ½ percent of wages for work-related injury insurance.

In terms of health outcomes, Croatia has performed better than most countries with similar income levels. For example, in terms of healthy average life expectancy (HALE), Croatia has better results than all EU-10 countries (Table 1) except for Slovenia and the

Czech Republic. Furthermore, Croatia's performance is better than the average for EU-10 countries in terms of all the other available indicators: standardized death rates; incidence of tuberculosis; maternal, infant and child mortality rates.[5]

Unlike many other former socialist countries, Croatia does not have an acute overcapacity problem in terms of intermediate output indicators. Croatia's ratios of hospital beds and physicians per 1,000 inhabitants and the health worker density index (6, 2, and 8, respectively) are at or lower than the averages for EU-15 countries (6, 3, and 13, respectively), and are lower than the averages for EU-10 (7, 3, and 10, respectively) and OECD countries (6, 3, 13, respectively). Moreover, Croatia's ratio of in-patient admission per 100 is also below the averages for EU-10, EU-15, and OECD countries (Table 2).

However, significant challenges remain. First, the health care system is not financially sustainable and runs persistent deficits: at end-2006, the stock of health sector arrears was 1.1 percent of GDP. While part of these arrears was repaid in 2007, reform measures have been insufficient to harden budget constraints. Second, Croatia's public spending on health care in proportion to GDP is one of the highest in the region, so Croatia's good performance in comparison to the EU-10 comes at a high cost. In particular, Croatia spends about 8 percent of its GDP on health care, which is higher than any of the EU-10 countries except Slovenia (Table 1). Moreover, about 84 percent of health care spending comes from public sources. For comparison, while EU-15 countries, on average, spend more on health care than Croatia, much larger shares of their spending are privately financed (Figure 1). Thus, in terms of public health care spending, Croatia's expenditure in percent of GDP is among the highest in Europe. Third, population aging is likely to exert further upward pressure on public finances, including through spending on health care. Fourth, compared with the averages for EU-15 countries, Croatia performed worse in terms of all the available outcome indicators. Gaps with EU-15 countries are large especially in terms of standardized mortality rates for non-communicable diseases (cardio-vascular diseases, cancer, injuries, chronic respiratory diseases, diabetes, etc.).

[5] Results for the EU-10 are heavily influenced by the results for Bulgaria and Romania, which have significantly worse results than the other new EU members. But Croatia's performance is still slightly better than the averages for the other EU-10 countries.

Table 1. Croatia: Health Expenditure and Outcomes 1/

	Total Expenditure on Health (in percent of GDP)	Public Expenditure on Health (in percent of GDP)	Healthy Life Expectancy (years)	Standardized Death Rates (per 100,000 people)	Infant Mortality Rate (per 1,000 live births)	Child Mortality Rate (per 1,000 live births)	Maternal Mortality Rate (per 100,000 live births)	Incidence of Tuberculosis (per 100,000 people)
Croatia	7.9	6.6	66.6	886.9	6.0	7.0	10.0	40.6
Bulgaria	7.7	4.3	64.6	1,056.4	12.0	15.0	32.0	39.0
Czech Republic	7.2	6.6	68.4	837.6	3.0	4.0	9.0	10.4
Estonia	5.2	4.0	64.1	993.6	6.0	7.0	38.0	42.7
Hungary	7.9	5.6	64.9	1,015.5	7.0	8.0	11.0	21.7
Latvia	6.5	3.4	62.8	1,107.2	9.0	11.0	61.0	62.6
Lithuania	6.5	4.8	63.3	1,081.6	7.0	9.0	19.0	62.5
Poland	6.3	4.5	65.8	872.0	6.0	7.0	10.0	26.1
Romania	5.7	3.5	63.1	1,076.4	16.0	19.0	58.0	134.2
Slovak Republic	6.1	5.4	66.2	945.0	7.0	8.0	10.0	17.0
Slovenia	8.9	6.8	69.5	729.4	3.0	4.0	17.0	14.6
EU-8 average	6.8	5.1	65.6	947.7	6.0	7.3	21.9	32.2
EU-10 average	6.8	4.9	65.3	971.5	7.6	9.2	26.5	43.1
EU-15 average	8.6	6.4	71.3	628.9	4.0	4.9	9.9	12.8
OECD average	8.7	6.3	70.7	672.2	4.3	5.3	9.5	15.4

Sources: WHO; and World Bank, *World Development Indicators* database.

1/ Spending data are averages for 2001–04, HALE data are for 2002, death rates are for the latest year available during 2001–05, infant and child mortality and incidence of tuberculosis are for 2005, and maternal mortality data are estimates for 2000.

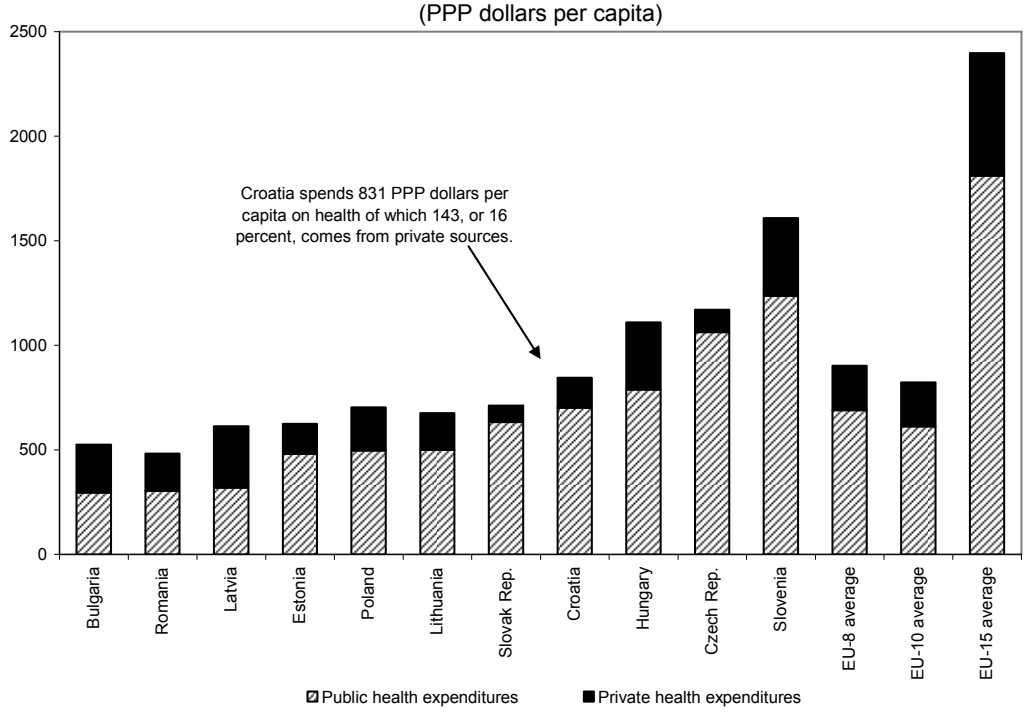
Table 2. Selected Real Health Resources 1/

	Hospital Beds (per 1,000)	Physicians (per 1,000)	Health Worker Density Index (per 1,000)	Pharmacists (per 100,000)	Doctors' Consultations (per capita)	Bed Occupancy Rate, Acute Care Hospitals (percent)	In-patient Care Admissions (per 100)	Average Length of Stay (all hospitals)	Immunization, Measles (percent of children ages 12-23 months)
Croatia	5.6	2.4	7.7	55.8	…	88.1	16.6	10.3	96.0
Bulgaria	6.3	3.6	8.3	12.5	…	...	21.0	8.1	96.0
Czech Republic	8.8	3.5	13.4	56.3	13.0	74.6	22.1	10.8	97.0
Estonia	6.0	3.2	9.8	62.6	…	68.4	19.2	8.0	96.0
Hungary	7.8	3.2	11.9	52.7	12.1	75.7	25.5	8.1	99.0
Latvia	7.8	3.0	8.2	...	…	...	22.1	10.0	95.0
Lithuania	8.7	4.0	12.4	70.2	…	78.6	23.8	10.2	97.0
Poland	5.6	2.5	7.7	58.1	5.9	...	17.6	6.9	98.0
Romania	6.6	1.9	6.2	4.8	…	...	24.6	8.0	97.0
Slovak Republic	7.2	3.1	10.6	49.0	12.7	68.6	18.5	8.9	98.0
Slovenia	5.0	2.3	9.4	42.5	…	70.1	17.6	7.1	94.0
EU-8 average	7.1	3.1	10.4	55.9	10.9	72.7	20.8	8.7	96.8
EU-10 average	7.0	3.0	9.8	45.4	10.9	72.7	21.2	8.6	96.7
EU-15 average	5.5	3.2	13.0	82.5	5.9	74.3	17.9	8.4	90.1
OECD average	6.1	3.0	12.5	74.4	6.9	76.2	18.6	8.4	91.6

Sources: WHO; and World Bank, *World Development Indicators* database.

1/ Data are for the latest year available except for data on doctors' consultations, which are averages over 2002–03, and data on immunizations, which are for 2005.

Figure 1. The Share of Private Funding inTotal Health Care Spending in Croatia is One of the Smallest in the Region, Average 2001–04
(PPP dollars per capita)

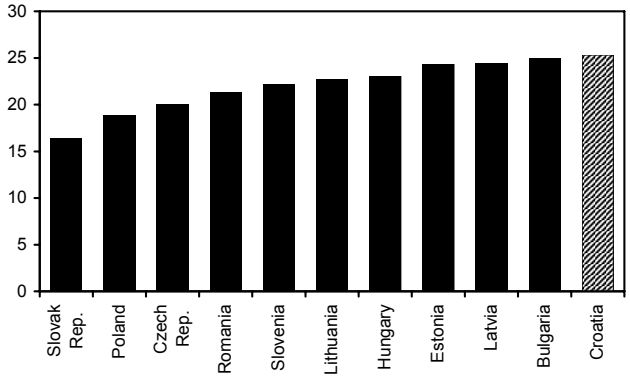


Sources: WHO; and Fund staff estimates.

High and increasing public health spending reflects both strong demand and supply inefficiencies:

- The old-age dependency ratio (ratio of population aged 65 and older, which require more health care than younger generations, to population aged 17–64) in Croatia is one of the highest in the region. Moreover, this ratio is projected to increase from 26 percent in 2006 to 48 percent in 2051.

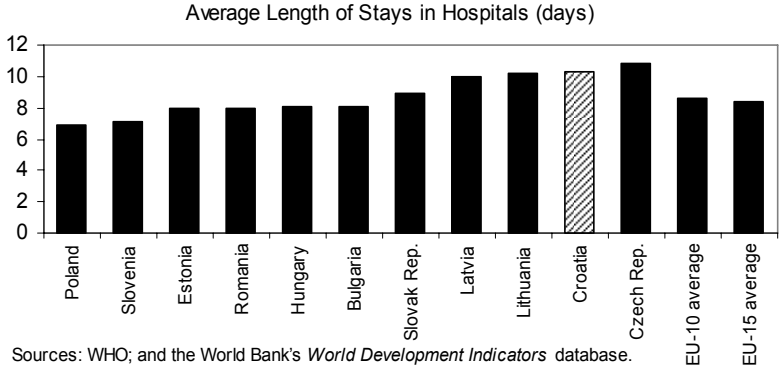
Share of Population Aged 65 and Older in Total Population, 2006



Source: Eurostat; and Central Bureau of Staistics of Croatia.

- Under the existing health insurance system, low rates of co-payments in combination with widespread exemptions from contributions have boosted the demand for health services.[6] The coverage of the basic benefit package is very broad, while medical services essentially become free for 600,000 people who have supplementary insurance offered by the HZZO, as this insurance pays for co-payments. Indeed, the share of co-payments in total health spending is less than 1 percent, compared with 7–33 percent in Western European countries.[7] Around 1,900 types of drugs on the so-called A list are fully paid by the HZZO, while 300 types of drugs on the so-called B list are partially paid by the HZZO.[8] While the government introduced a flat administrative fee of 10 kuna per person (with a cap of 30 kuna per month) in 2005, its impact on demand for health services has been weakened by exemptions from these fees. The government has decided to abolish this fee in 2008.

- The system of capacity- and input-based payments to hospitals has encouraged hospitals to keep beds full and extend the length of patients' stay. Thus, the system does not provide needed incentives for hospital managers to cut costs. As a result, the average length of stay in (all) hospitals (ALOS) in Croatia in 2005 was about 10.3 days, one of the longest in Europe (compared with 8.6 days in EU-10 countries and 8.4 days in EU-15 countries). Although ALOS has recently fallen significantly, it is still high compared to other countries.[9]



Sources: WHO; and the World Bank's *World Development Indicators* database.
1/ Data are from latest year available except for the data on doctors' consultations which are the average over 2002–03 and immunization from 2004.

[6] Twenty groups of people, including pensioners, unemployed, and students, are exempt from paying contributions. Only around 35 percent of the population pays contribution.

[7] See *Funding Health Care* by Mossialos et al. (2002) for a description of cost sharing in Europe. Several countries, including Australia, Canada, and Switzerland, do not allow supplementary insurance to cover co-payments associated with services paid for by the health insurance fund.

[8] These lists were introduced in 2006. For drugs on the B list, the HZZO pays a reference price for drugs on the A list and consumers pay the difference between the sale and reference prices. As a result of strong bargaining, pharmaceutical spending was reduced by about 2 percent in 2007, despite a 6 percent increase in consumption of drugs.

[9] Over a third of total health care spending in Croatia finances hospital (in-patient) care.

- A substantial share of the care at the primary level is provided by costly specialists. This outcome is mainly due to the fact that primary-care physicians, who are supposed to play the role of "gatekeepers" of the health system, are paid on a capitation-basis (that is, physicians are paid flat fees per patient per year). This approach provides an incentive for physicians to sign up as many patients as possible and refer them to specialists instead of treating them. Seventy percent of patients at the primary health care level are referred to hospitals, but experts believe this figure could be reduced to 30 percent.

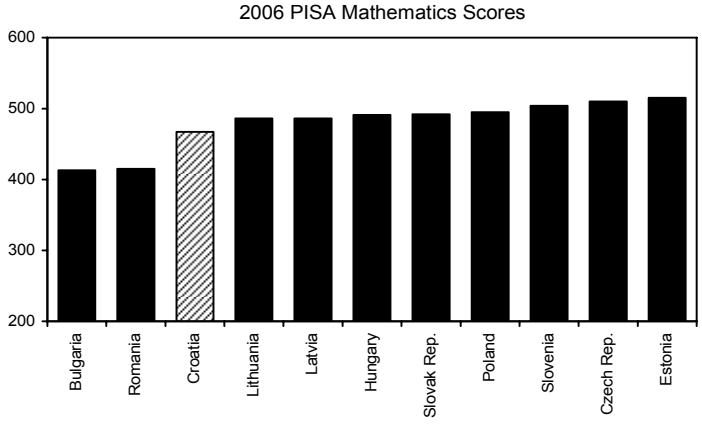
- There is little competition among health care providers. Of the 66 hospitals, only 3 were privately owned in 2006. The majority of specialists and health care workers are at the state-owned hospitals. Only 3 percent of medical doctors work in the private sector. Private institutions are largely limited to the provision of specialized medical services.

In all, without reforms, health care expenditures will increase significantly. The authorities' latest Pre-accession Economic Program envisages an increase of 4 percentage points of GDP in public health spending from 2005 to 2050. This increase could be higher because, for example, of underestimating the costs of new medical technology.

Education

Croatia's education system is, like most European and transition countries, mainly financed and operated by the public sector. Recognizing discrepancies both in quality and quantity aspects, the government has since 2005 been undertaking a large reform program, detailed in the government's Strategic Development Framework 2006–13 and the Education Sector Development Plan (ESDP) 2005–10.

Croatia's total spending on education as a share of GDP is in line with EU-10 and EU-15 countries, but its educational output and outcome levels are lower. In 2005, Croatia spent around 5.6 percent of GDP on education, similar to average spending by the EU-15 (Table 3). Croatia's public education spending was about 4.8 percent of GDP, somewhat less than the averages for EU-10 and EU-15 countries (5 percent of GDP and 5.4 percent of GDP, respectively). Thus, Croatia's private spending (at about ¾ percent of GDP) is higher than the averages for EU-10 and EU-15 countries (at about 0.4 percent of GDP), notwithstanding Croatia's few private schools. Private spending in Croatia is mainly on pre-school and tertiary education. Regarding outcomes, Croatia's school



Source: The OECD Programme for International Student Assesment (PISA).

enrollment and completion rates are lower than those in comparator countries. In tertiary education, for example, gross enrollment was about 46 percent in 2006, compared to about 53 percent in the EU-10. Furthermore, only one third of the students at the tertiary level reportedly complete their programs, with an average completion rate of 6.7 years in four-year programs (World Bank, 2007). In the 2006 PISA standardized test in mathematics, only Bulgaria and Romania in the EU-10 scored worse than Croatia: out of 57 countries, Croatia ranked 36th.[10]

Croatia's student-teacher ratios in primary and secondary schools have been falling and are lower than those in comparator countries. Contributing to this, the number of students fell at all levels except for tertiary education from 1990 to 2005, reflecting declining fertility rates. Also contributing to this, during the same period, the number of full-time teachers increased at all levels of education except primary education, where the number remained stable.

School infrastructure is used intensively, but teaching hours are short. About 65 percent of schools have double shifts, and 8 percent of schools have triple shifts (although only 10 percent and 2 percent of students, respectively, attend these schools). The government is trying to eliminate multiple-shift schools, especially those with three shifts. Regarding teaching hours, teachers with a full position are required to teach 15–21 hours per week, compared with 21–24 hours per week in OECD countries.

There are notable differences in the composition of education spending between Croatia and other countries. Wages and salaries constitute a very large share of primary education spending in Croatia (about 90 percent of recurrent spending, compared with about 82 percent in the EU-15 and 73 percent in the EU-10). In primary and secondary education, Croatia spends a significantly larger share on investments (22 percent, compared with about 7 percent in the EU-15 and 8 percent in the EU-10) which leaves a smaller share for spending on non-wage recurrent expenditures, including spending on books for libraries and laboratory equipment. In contrast, the share of investments in tertiary education in Croatia is smaller than those in its peer countries. Recent increases in education spending have gone mainly to overheads and to a growing pre-school subsector.

Decision making and financing of education is fragmented. For example, decisions about establishing schools are made by local governments while teachers are hired and financed by the central government. Coordination issues in decision making contributes to excess spending since local governments do not face the full costs of their decisions to build schools.

Public subsidies on education mostly benefit households with higher income. The Household Budget Survey suggests that students from higher-income families receive the

[10] Croatia ranked 26th on the PISA science scale, ahead of some EU countries (e.g., Italy and Spain).

Table 3. Education Expenditure, Output, and Outcomes 1/

	Public Expenditure on Education (percent of GDP)	School Enrollment, Primary (percent; net)	Primary Completion Rate (percent of relevant age group)	Progression to Secondary School (percent)	Pupil-Teacher Ratio, Primary	School Enrollment, Secondary (percent; net)	School Enrollment, Tertiary (percent; gross)	Average PISA Mathematics Test Scores
Croatia	4.5	87.3	91.4	99.9	17.7	85.0	38.7	467
Bulgaria	3.8	95.1	97.6	95.9	16.7	88.5	41.1	413
Czech Republic	4.4	…	102.8	98.0	17.9	…	43.2	510
Estonia	5.6	94.1	102.4	96.2	14.1	89.7	65.1	515
Hungary	5.4	89.1	96.0	98.8	10.5	90.7	59.6	491
Latvia	5.5	87.0 2/	95.2	98.5	13.0	91.0 2/	74.3	486
Lithuania	5.6	89.4	101.5	99.2	14.7	92.9	73.2	486
Poland	5.5	97.3	100.0	98.5	12.6	90.0	61.0	495
Romania	3.5	91.9	91.5	98.0	17.5	80.8	40.2	415
Slovak Republic	4.3	…	100.3	98.2	17.7	…	36.1	492
Slovenia	6.0	97.8	108.2	99.5	15.1	94.7	73.7	504
EU-8 average	5.3	92.4	100.8	98.4	14.4	91.5	60.8	497
EU-10 average	5.0	92.7	99.5	98.1	15.0	89.8	56.8	481
EU-15 average	5.6	98.2	97.2	99.5	13.8	91.2	62.2	498
OECD average	5.5	97.5	99.2	99.3	14.7	90.9	62.2	504

Sources: UNESCO; and World Bank, *World Development Indicators* database.

1/ Data are for the latest year available except for data on primary completion rates, which are averages over 2003–04, and data on public education spending and progression to secondary, which are averages over 2001–03.

2/ Fund staff estimates, based on gross enrollment rates.

lion's share of scholarships and rewards. In particular, the amount of scholarships and rewards going to students from households in the top-income quintile (that is the top 20 percent of the income distribution) is almost 10 times higher than the amount going to students from the bottom quintile. Two observations are relevant: (i) most scholarships and rewards go to students with better academic achievements; and (ii) students in this category tend to come from families in the top-income quintile, which can spend more money to support education. Students from the top-income quintile also benefit from other subsidies, such as free books, dormitories, and transportation.

III. The Relative Efficiency of Social Spending

This section carries out the data envelopment analysis (DEA), discusses possible explanatory factors behind cross-country differences in efficiency, and highlights potential reforms to enhance efficiency. As noted earlier, the analysis generates a best-practice frontier of input-output combinations (e.g., social spending and outcomes) that dominate the other combinations in the sample, and countries that are not on the frontier are then ranked according to the distance from the frontier. Similar to Verhoeven, Gunnarsson, and Lugaresi (2007) and Verhoeven, Gunnarsson, and Carcillo (2007), correlation analyses are also conducted to understand reasons for variation in efficiency across countries. Finally, in highlighting potential efficiency-enhancing reforms, the section draws on the findings in the World Bank's *Public Finance Review*.[11] Data are drawn from Eurostat, OECD, WHO, UNESCO, and the World Bank's World Development Indicators database. Spending data are adjusted into internationally comparable purchasing power parity (PPP) terms.

Health Care

The results of the DEA suggest significant inefficiencies in Croatia's public health spending and, correspondingly, significant room to rationalize public spending without sacrificing, and potentially improving, health outcomes.[12] In terms of the efficiency scores for public spending, Croatia ranks in the 63rd percentile among 37 countries. Reflecting low private health expenditures in Croatia, it ranks in the 48th percentile for total spending on health (Table 4). With respect to individual outcome indicators, Croatia's ranking is in the last quartile for the standardized death rates (SDR) and incidence of tuberculosis; in the third quartile for HALE, the child mortality rate, and infant mortality rate; and in the second quartile for maternal mortality rates (Figure 2).

[11] The sequencing of possible reforms and related political economy issues are beyond the scope of this paper.

[12] The results are broadly comparable to those in Verhoeven, Gunnarsson, and Lugaresi (2007), which analyzes health care spending in the Slovak Republic.

Table 4. Relative Efficiency of Croatia and the EU-10 in Health
(Distribution by percentile of the ranking of efficiency scores) 1, 2/

	1-25	26-50	51-75	76-100
Public expenditures		Bulgaria Czech Republic Latvia	Croatia Estonia Poland Slovak Republic Slovenia Romania	Hungary Lithuania
Public and private expenditures	Bulgaria Czech Republic Poland	Croatia Estonia Romania Slovak Republic	Lithuania Slovenia	Hungary Latvia

Source: WHO; World Bank, *World Development Indicators* database; and Fund staff estimates.
1/ Croatia's efficiency scores for public expenditure countries ranked, on average, at the 63rd percentile of the overall ranking of efficiency scores of OECD countries, EU-10 countries, Cyprus, Malta, and Croatia. This places Croatia in the third (51-75) quartile of the sample ranking distribution. The rankings are based on the point estimate of the bias-corrected output-oriented efficiency scores.
2/ Based on a combination of outcome indicators comprising infant, child, and maternal mortality rates; standardized death rates; the incidence of tuberculosis; and healthy life expectancy.

Inefficiencies in the Croatian health care system occur mostly in the process of transforming intermediate resources into health outcomes. In addition to estimating efficiency from health spending to outcomes (e.g., infant mortality rates) as above, we also estimate efficiency from intermediate outputs (e.g., hospital beds) to outcomes (e.g., infant mortality rates), with a view to understanding the stage at which (production) inefficiencies occur (called system efficiency hereafter; see also Appendix). As can be seen from Table 5, system efficiency is relatively low in Croatia. This is only in part related to long stays in hospitals. As the two first columns in Table 5 suggests, there are other inefficiencies in the system: the system efficiency using ALOS-to-outcome combinations is significantly worse than in EU-15 countries.

Table 5. Ratio of Percentile Rank of Efficiency Scores in Health to the Average of Percentile Ranks for OECD Countries1/

	System Efficiency 2/		Overall Efficiency 3/	
	Intermediary inputs/outputs to outcomes	Average length of stay to outcomes	Public expenditures to outcomes	Public and private expenditures to outcomes
Croatia	1.6	1.7	1.2	0.9
Bulgaria	2.0	2.2	0.5	0.5
Czech Republic	1.4	1.1	0.9	0.7
Estonia	1.9	2.1	1.5	0.7
Hungary	1.9	1.9	1.6	1.5
Latvia	2.2	2.4	1.0	1.4
Lithuania	2.1	2.2	1.7	1.2
Poland	1.7	1.8	1.1	0.5
Romania	2.2	2.4	1.4	0.6
Slovak Republic	1.8	1.8	1.2	0.5
Slovenia	1.0	1.4	1.1	1.1
EU-8 average	1.8	1.8	1.2	0.9
EU-10 average	1.8	1.9	1.2	0.9
EU-15 average	0.9	0.9	1.0	1.1

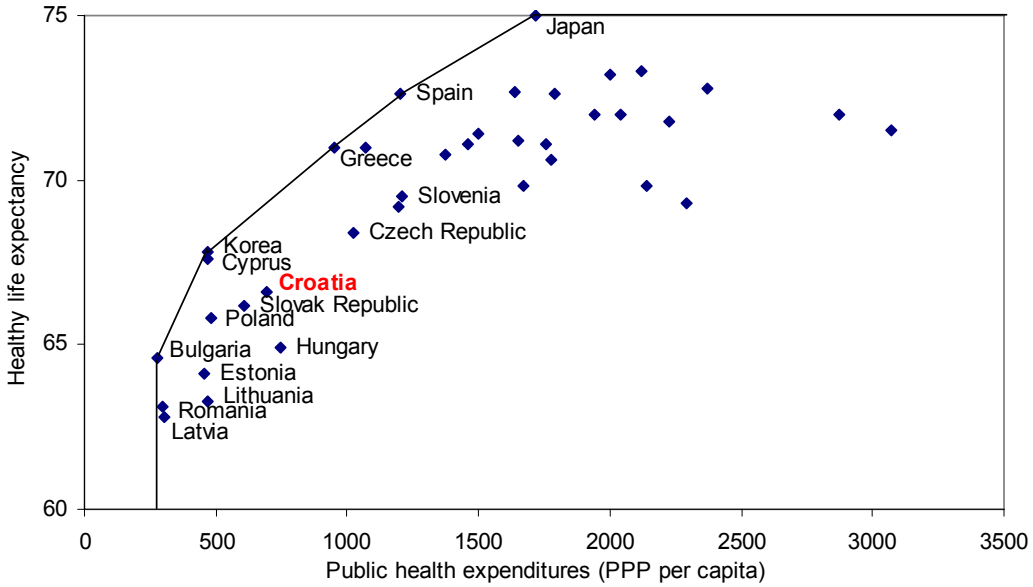
Sources: WHO; World Bank, *World Development Indicators* database; and Fund staff estimates.

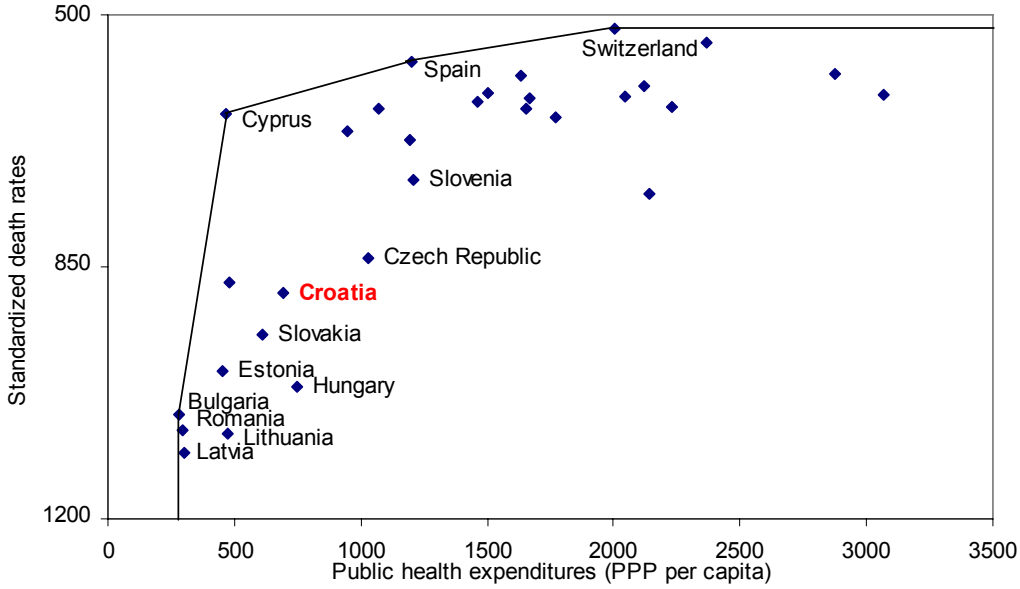
1/ Ratio of bias-corrected output-oriented efficiency rankings of countries to the average ranking of OECD countries.

2/ Based on bias-corrected output-oriented efficiency rankings using, as inputs, the average of various intermediate inputs/outputs and, as production, various outcome indicators.

3/ Based on bias-corrected output-oriented efficiency rankings from Table 4.

Figure 2 Efficiency Frontiers for Selected Health Outcome Indicators - Croatia's efficiency scores for HALE, the child mortality rate, infant mortality rate, and incidence of tuberculosis are among the lowest in the sample. 1/

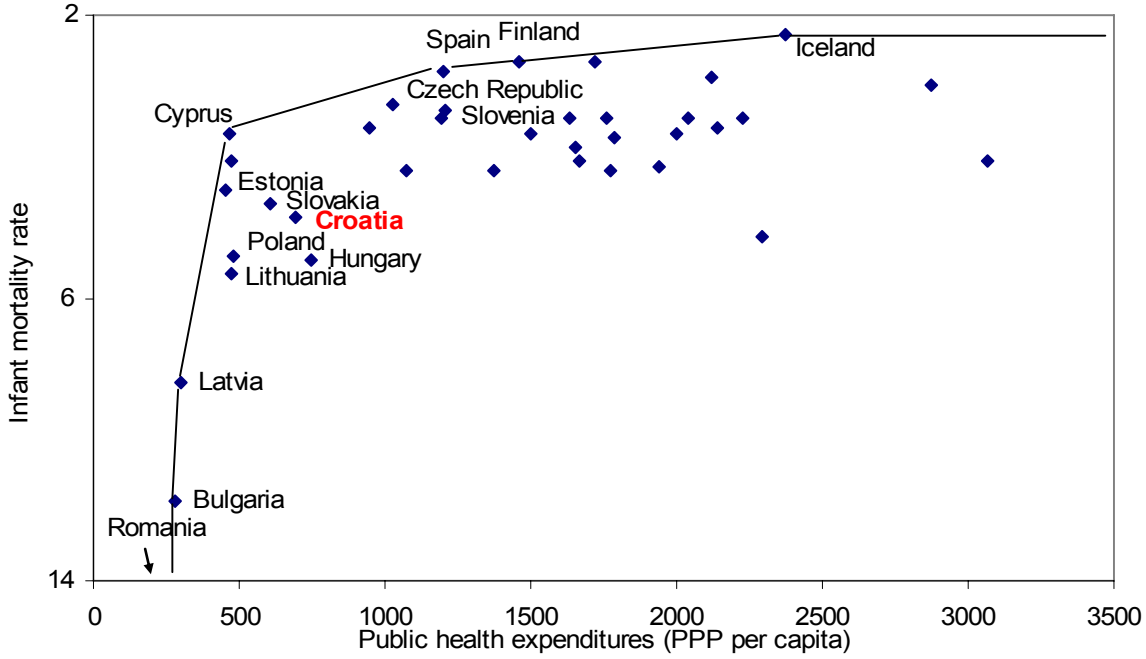


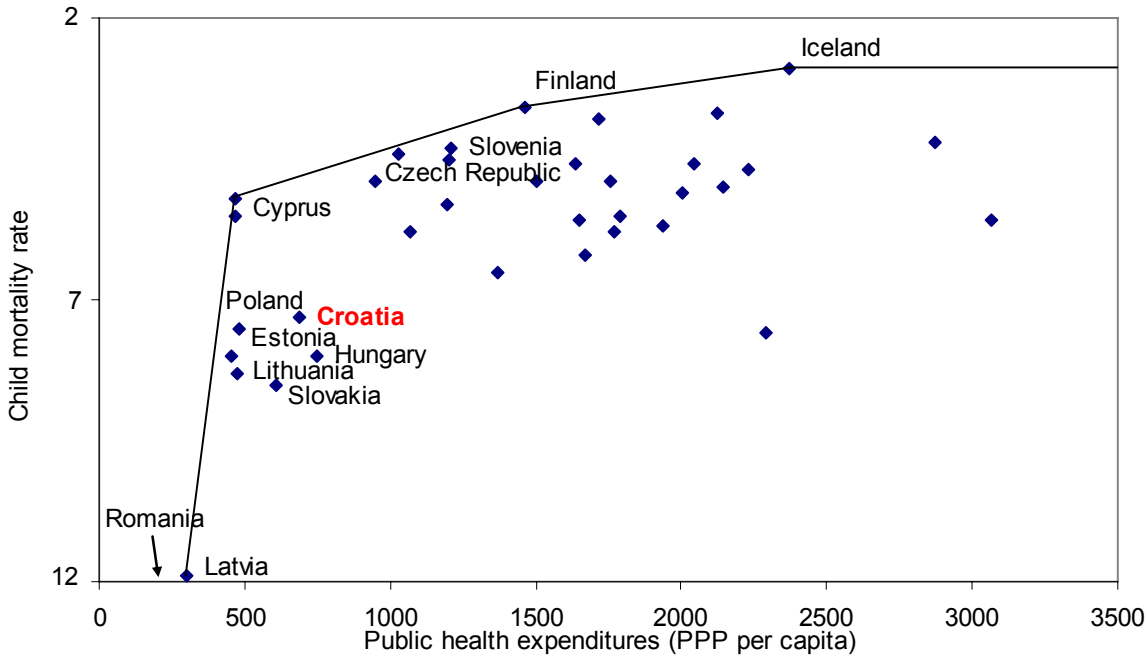


Sources: WHO; World Bank, *World Development Indicators* database; and Fund staff estimates.

1/ Each point in the figure is for a country in the sample, but only the names of the EU-10 countries and the countries on the efficiency frontier line are shown to avoid excessive clutter.

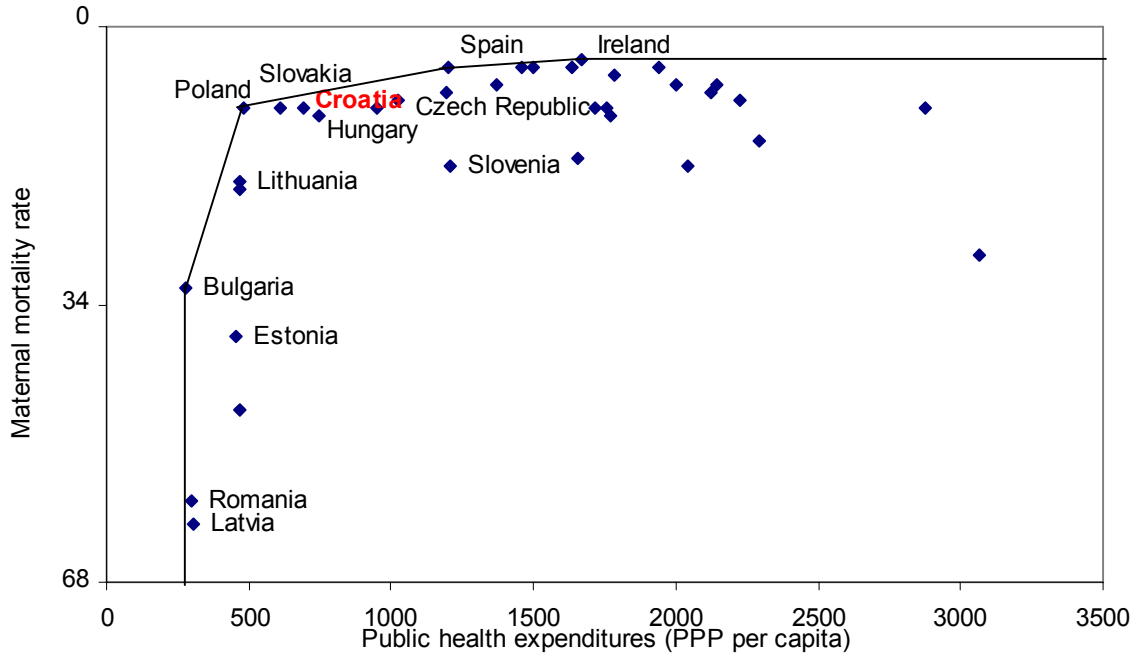
Figure 2 Efficiency Frontiers for Selected Health Outcome Indicators - Croatia's efficiency scores for HALE, the child mortality rate, infant mortality rate, and incidence of tuberculosis are among the lowest in the sample (continued).

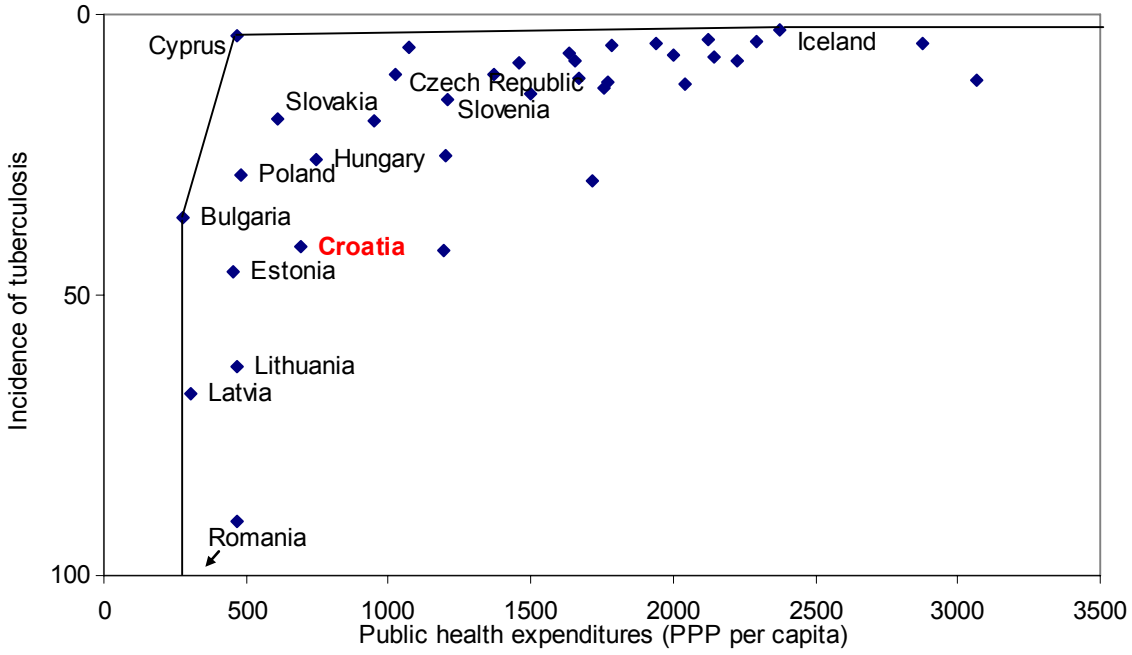




Sources: WHO; World Bank, *World Development Indicators* database; and Fund staff estimates.

Figure 2 Efficiency Frontiers for Selected Health Outcome Indicators - Croatia's efficiency scores for HALE, the child mortality rate, infant mortality rate, and incidence of tuberculosis are among the lowest in the sample (concluded).





Sources: WHO; World Bank, *World Development Indicators* database; and Fund staff estimates.

The results of correlation analysis suggest that relative efficiency is associated with a wide range of factors (Table 6). The key correlations include adverse relationships between efficiency on the one hand, and on the other (1) exogenous and lifestyle factors such as alcohol consumption; (2) spending on collective care and administration; (3) spending on pharmaceuticals; (4) doctors' wages; (5) the number of doctor consultations, in-care admissions, and outpatient contacts; and (6) length of stays in hospitals (although only weakly).[13] [14] Moreover, out-of-pocket payment is strongly associated with increased relative efficiency in the sample. These results suggest that inefficiencies in health spending in Croatia are, in part, related to high pharmaceutical spending, long stays in hospitals, low levels of out-of pocket spending and private participation.

The above results suggest that system efficiency can be improved by containing demand for health services and changing the mix of resources spent on health care. The following reforms, including those already underway or planned by the Croatian authorities,[15] could greatly improve the efficiency of health care spending:

- Increasing out-of-pocket spending could help contain demand for health care spending and generate significant budgetary savings. For example, if the level of private co-financing was raised to 7 percent of total health spending (one of the lowest co-payments-to-total-health-spending ratios of the Western European countries), through increases in co-payment rates and/or eliminating exemptions from co-payments, this could generate budgetary savings of 0.5 percent of GDP. Increasing the share of the

[13] This analysis does not provide estimates of causality. It is possible that causality goes the other way around or both ways. The small sample size precludes regression analysis in the second-stage.

[14] Given the close relationship of spending and outcomes with income levels, correlations of efficiency scores and associated factors are conditional on GDP. GDP per capita is adversely related to efficiency since many of the factors that are associated with efficiency are also closely related to income level. In order to avoid attribution of factors whose effects on the variation in efficiency cannot be separated from the effect of GDP, only GDP per capita and factors that are correlated with efficiency independently of GDP per capita are considered in the second-stage analysis of this chapter. The association with efficiency of factors that are strongly correlated with GDP is assessed by regressing the efficiency score on both GDP and the associated factor.

[15] The Croatian government adopted the National Health Care Development Strategy 2006–11 to enhance and secure better-quality health care for citizens. The strategy includes both system reforms and financing reforms.

Table 6. Correlations of Relative Efficiency in Health with Associated Factors 1/

	Healthy Life Expectancy	Standar-dized death rate	Infant mortality rate	Child mortality rate	Maternal mortality rate	Incidence of tuber-culosis
	Overall efficiency: public expenditures to outcomes					
Exogenous factors						
Alcohol intake (liters per capita per year)	NN	NN			N	
Average schooling years in the population			NN	NN		
GINI Index			N	N		
Expenditure composition						
Collective care expenditure (percent of public health exp.) 3/			NN	NN		
Collective care expenditure (PPP per capita) 3/			NN	NN		
Out-of-pocket expenditure (percent of private health exp.)	P		PP	PP		
Doctors' wages (percent of GDP)			NN	NN		
Health resources						
MRIs per million capita	P		P	P		
	Overall efficiency: public and private expenditures to outcomes					
Exogenous factors						
GDP per capita (PPP dollars)	NN		NN	NN	NN	
GINI Index			NN	NN		
Average schooling years in the population			NN	N		
Expenditure composition						
Pharmaceutical expenditure (PPP per capita) 3/			NN	NN		
Collective care expenditure (percent of total health exp.) 3/			NN	NN		
Collective care expenditure (PPP per capita) 3/			NN	NN		
Personal care expenditure (PPP per capita) 3/			NN	NN		
Administration and insurance (percent of total health exp.) 3/			NN	NN	N	
Administration and insurance (PPP per capita) 3/			NN	NN		
Out-of-pocket expenditure (percent of private health exp.)	PP		PP	PP		
Doctors' wages (percent of GDP)			NN	NN	N	
	System efficiency: intermediate resources/services to outcomes					
Exogenous factors						
GDP per capita (PPP dollars)	PP	PP	PP	PP	P	PP
Population over 65 years (percent of total population)	P			P		
Expenditure composition						
Pharmaceutical expenditure (percent of total health exp.) 3/	NN	NN	NN	NN		NN
Administration and insurance (percent of public health exp.) 3/	NN	NN	NN	NN		NN
Health resources 2/						
Doctors' consultations per capita per year	NN	NN		N		NN
In-patient care admissions per 100 capita 4/	NN	NN	NN	NN	N	
Outpatient contacts per capita per year 4/	N	N				
Average length of stay at hospital					N	N

Sources: WHO; World Bank, *World Development Indicators*; OECD; and Fund staff estimates.

1/ Correlations are run on bias-corrected output-oriented efficiency scores. This table summarizes the results of correlations of associated factors with the level of efficiency. PP (P) indicates that the associated factor is positively correlated with level of efficiency (negatively correlated with output-oriented efficiency scores) at the 5 (10) percent significance level. NN (N) indicates that the associated factor is negatively correlated with level of efficiency (positively correlated with output-oriented efficiency scores) at the 5 (10) percent significance level. Several of the associated factors are highly correlated with GDP. Only correlations that are significant after conditioning on GDP are considered (see Appendix).

2/ Only real health resources/services not included in the DEA (hospital beds, number of physicians, health workers, pharmacists, and measles immunization rate are included in the DEA) are considered.

3/ Excludes non-OECD countries due to missing data.

4/ Excludes non-European OECD countries due to missing data.

private sector in financing sick leave and reducing the replacement rates[16] would also significantly curb demand and public spending for health services.[17] Restricting the basic benefit package provided by the HZZO would enhance the impact of this measure.[18] It should be noted, however, that co-payments could curtail access to the system for lower-income families. To prevent this possibility, means-testing could be used to grant limited exemptions (e.g., pensioners are exempt, but some of them may not need to be subsidized).

- Phasing out public supplementary insurance provided by the HZZO would reduce demand for health care services and stimulate the provision of additional insurance by private participants. The equity impact of this measure is not likely to be significant because essential services are covered by basic insurance.

- Restraining demand for pharmaceuticals by increasing the share paid by consumers and exposing producers to more competition could further reduce pharmaceutical spending. The former could be achieved through reducing the number of medicines on the A-list, while the latter could be achieved through determining the specific drugs to be subsidized for each illness by periodic competitive tenders. Strengthening incentives to prescribe/use generic substitutes would also help reduce drug spending.

- Accelerating reforms to introduce performance-based payments instead of input- or capacity-based payments would help curb excess spending. While the government has introduced case-based payments on a pilot basis, the effectiveness of this initiative has been weakened by options provided to hospitals to opt-out of the new payment system that essentially guarantees highest prices for services of hospitals. The authorities intend to introduce the so-called Diagnosis Related Groups (DRG) payment method in all hospitals treating acute diseases in late 2008. These measures would facilitate reducing the length of stays in hospitals and could generate significant budgetary savings over the medium term.

- Restructuring the system by moving more resources to more affordable outpatient care could also generate significant savings. Reforms to the payment system to strengthen incentives of general practitioners to treat patients rather than to refer them to specialists, as well as increases in co-payments for inpatient care, would serve this purpose.

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[16] The replacement rate is the ratio of benefits to (previously received) income.

[17] About 6 percent of the labor force was on sick leave in 2005; anecdotal evidence suggests that sick leave is used to deal with excess employment at the business level.

[18] Moreover, restricting the basic benefit package would stimulate private participation in the provision of additional insurance.

Administrative measures such as requesting general practitioners to explain the reasons for their referrals could also help reduce referrals to specialists.

Rationalizing the network of hospitals would allow Croatia to significantly improve the efficiency of health care spending and generate budgetary savings in the medium to long term. This would require developing a master plan by assessing the needs of the population by type of service and geographic location and identifying potential areas for efficiency gains. The master plan should also include closing some facilities, reorienting some facilities for alternative uses such as long-term care and private sector practice, and improving the infrastructure and upgrading equipment in the remaining facilities.

The efficiency of health spending could be significantly increased by improving the management of health institutions and introducing more competition into healthcare markets. Mihaljek (2007) notes that "virtually the entire secondary and tertiary health care sectors are managed by physicians, who often lack the adequate training in strategic management, financial planning, and other skills necessary for hospital management in a competitive market environment." Furthermore, there are coordination issues among different government agencies, leading to inefficiencies. For example, while hospitals are managed by local governments, staff hiring is done at the central government level. Accordingly, giving more independence to hospitals, imposing hard budget constraints on them, bringing in professional management expertise, and exposing them to competition could help significantly reduce inefficiencies in the health care sector. In this regard, a privatization program of hospitals should be considered in the context of the master plan.

Finally, stepping up efforts to prevent diseases (beyond immunizations which are covered in the above DEA analysis) would also help enhance efficiency and contain costs. For example, the share of overweight people in Croatia is among the highest in the Europe, which may be one of the factors of high incidences of death from the circulatory system and from heart diseases.[19] Smoking-related death incidents are also significantly higher than in EU-15 countries, as well as in Slovenia and the Czech Republic (Table 7), suggesting that increasing people's awareness of a healthy lifestyle could help reduce health care spending.

[19] The share of obese people in Croatia is almost double the average of the EU-15. Mihaljek (2007) mentions an unhealthy lifestyle (high alcohol and tobacco consumption, and prevalence of physical inactivity) as the likely reason for the difference in mortality rates for non-communicable diseases between Croatia and EU-15 countries.

Table 7. Standardized Death Rates, All Ages, 2005
(per 100,000)

	All Causes	Circulatory System	Ischemic Heart Diseases	Alcohol-Related Causes	Smoking-Related Causes	Cancer of the Cervix
Croatia	886.9	435.8	167.9	90.5	380.9	3.5
Czech Republic	837.6	419.0	177.5	81.0	359.3	5.3
Estonia	993.6	498.2	264.2	158.3	448.6	6.8
Hungary	1,015.5	502.4	261.3	129.5	490.5	6.5
Latvia	1,107.2	578.7	287.0	157.2	532.2	6.6
Lithuania	1,081.6	562.8	355.0	190.8	548.1	9.8
Poland	862.4	384.2	114.4	89.5	293.1	7.8
Slovak Republic	945.0	508.7	268.3	90.6	414.1	6.8
Slovenia	729.4	288.0	80.2	93.8	215.7	2.7
EU-8 average	946.5	467.8	226.0	123.8	412.7	6.5
EU-15 average	606.2	213.7	82.3	57.9	200.3	2.2

Source: WHO, *European Health for All* database.

Education

The analysis suggests significant inefficiencies in the education sector (Table 8)**.** In terms of the efficiency scores, Croatia ranks in the third quartile for primary education and secondary education (as well as in terms of PISA test scores);[20] and in the last quartile for tertiary education. For tertiary education, this inefficiency is related to low enrollment and graduation rates. For secondary education, this low ranking reflects mainly low enrollment rates and relatively low PISA scores (in mathematics), and in primary education the inefficiencies stem from low enrollment, low completion rates, and high overhead costs related to the excess number of schoolteachers, which has not matched the declining school-age population.

Similar to that in the health care sector, the main inefficiencies in the Croatian education sector lie in transforming intermediate education outputs into real outcomes. As can be seen from Table 9, Croatia's system efficiency from secondary enrollment to PISA scores was worse than the EU-10 average and significantly worse than the OECD average.[21] These results suggest that there is significant scope for streamlining education expenditures in Croatia and that the education system could be improved by relevant policy reform.

[20] Efficiency in secondary education is estimated using both a combined set of secondary intermediary outputs and outcomes, and PISA scores only.

[21] System efficiency was estimated only for the secondary education level, where PISA test scores were used as education outcome. The overall public sector efficiency (quartile) rankings in the primary and secondary levels presented in Table 7 are for the first stage of the production process (spending to intermediary outputs), since no education outcomes such as test scores are available at these levels.

Table 8. Relative Efficiency of Croatia and the EU-10 in Education
(Distribution by percentiles of the ranking of efficiency scores) 1/

	1-25	26-50	51-75	76-100
Primary education 2/	Romania	Bulgaria Czech Republic Lithuania Slovak Republic	Croatia Estonia Hungary Latvia Poland Slovenia	
Secondary education 3/	Bulgaria Lithuania Poland Romania	Estonia Hungary Latvia Slovak Republic Slovenia	Croatia Czech Republic	
PISA test scores	Estonia Poland Romania Slovak Republic Slovenia	Czech Republic Latvia Lithiuania	Bulgaria Croatia Hungary	
Tertiary education 4/	Latvia	Estonia Lithuania Poland Slovenia	Hungary	Bulgaria Croatia Czech Republic Romania Slovak Republic

Sources: UNESCO; World Bank, *World Development Indicators* database; and Fund staff estimates.
1/ Croatia's efficiency scores for primary education ranked, on average, at the 70th percentile of the overall ranking of efficiency scores of OECD countries, EU-10 countries, Cyprus, Malta, and Croatia. This places Croatia in the third (51-75) quartile of the sample ranking distribution. The rankings are based on the point estimate of the output-oriented efficiency scores.
2/ Based on primary expenditure efficiency in producing primary enrollment, primary pupil-teacher ratio, primary completion rates and progression to secondary education.
3/ Based on secondary expenditure efficiency in producing secondary enrollment, upper secondary graduation rates, and average PISA mathematics scores.
4/ Based on tertiary expenditure efficiency in producing tertiary enrollment.

Correlation analysis of efficiency of education spending is revealing (Table 10). The key findings include a positive relationship between overall efficiency on the one hand, and on the other: (1) the share of current expenditure in total education; (2) classroom size; (3) parent's education; and (4) school quality and autonomy indicators such as student admissions prerequisites, student discipline and principle responsibility of hiring. Also, note that the coefficient of correlation between GDP per capita and overall efficiency has a minus sign while the coefficient of correlation between system efficiency and GDP per capita has a plus sign. This perhaps reflects the fact that rich countries spend more money on education and health—due mainly to high costs for intermediary output—but causing only marginal improvements in outcomes. However, these countries are more efficient in transforming intermediate output into outcome. There are two implications for Croatia. First, more spending, especially capital spending, will not automatically improve education outcomes.

Second, the costs of having an excess number of teachers will rise significantly as teachers' wages grow in line with income levels.

Table 9. Ratio of Percentile Rank of Efficiency Scores in Education to the Percentile Rank of the Average Efficiency Score of the OECD 1/

	System Efficiency	Overall Efficiency 2/
	Secondary enrollment rate to PISA scores	Total education expenditures to PISA scores
Croatia	1.9	1.3
Bulgaria	2.3	1.0
Czech Republic	…	0.8
Hungary	1.4	1.0
Latvia	1.7	0.5
Lithuania	1.7	0.7
Poland	2.2	0.1
Romania	2.2	0.1
Slovak Republic	…	0.4
Slovenia	1.1	0.3
EU-8 average	1.6	0.5
EU-10 average	1.8	0.5
EU-15 average	1.1	1.2

Sources: UNESCO; World Bank, *World Development Indicators* database; and Fund staff estimates.
1/ Ratio of output-oriented efficiency rankings of EU-10 and EU-15 countries to the average ranking of OECD countries.
2/ Based on output-oriented efficiency rankings from Table 8.

The following reforms, which are largely consistent with many reform measures included in the ESDP, could help improve the efficiency of education spending:

- Rationalizing the teaching force would help contain declines in the student-teacher ratio, as well as related fiscal costs and rigidities that limit the scope for discretionary cuts in short-term education spending. This could be achieved through natural attrition and a selective hiring freeze for new teachers. If Croatia's student-teacher ratios could be increased to the levels of OECD countries, it would allow to reduce the number of teaching staff by around 11 percent at the primary level and by around 17 percent at the secondary level. In this regard, the authorities project the number of students 7–29 years of age to decline by another 358,000 or about 25 percent from 2005 to 2030. This implies a significant potential for savings, if the number of teachers and overall education spending could be reduced in line. Also, as the number of students decline, schools could consider pooling resources by sharing teachers. Otherwise, further declines in the student-teacher ratio would lead to significant inefficiencies and aggravate the fiscal burden.

- Rationalizing the school network would also help realize potential benefits from expected declines in the number of students. This could be facilitated by increases in spending on transportation and the usage of multi-grade teaching in small schools. The government's efforts to eliminate triple shifts are welcome, but attempts to eliminate double shifts need to be well planned to avoid unnecessary spending.

- Increasing teaching hours may allow for better education outcomes while containing education spending. This would provide room to contain the decline in the student-teacher ratio in the event that enrollments increase.

- Moving toward performance- and per-capita based budgeting could significantly reduce inefficiencies in the education sector. The authorities have already made good progress toward these ends by introducing a transparent system of performance evaluation of students' achievements as well as the quality of teachers. More could be done, however, to take into account the number of students, as well as selected output and outcome indicators such as graduation and drop-out rates, student-teacher ratios, scores on international standardized tests.

- Reducing rigidities related to institutional and funding mechanisms could generate savings. In particular, gradually raising local governments' control over and responsibility in delivering educational services, in line with their capacity, would allow them to internalize the full cost of their decisions and could increase the efficiency of education spending.

- Greater cost recovery should be considered in pre-school education and university tuition. In pre-school education, which is under the control of local governments, unit costs have risen faster than the other levels of education, which may reflect inefficiencies in provision of services by local governments. Regarding university tuition, education is free for about 48 per cent of students, but a study at the University of Rijeka suggests that those who pay fees complete with better grades and earlier than other students (World Bank, 2007). Introducing means-testing for programs providing free textbooks, transportation, and dormitories would help to better target the vulnerable groups and curb education spending without sacrificing education outcomes.

More generally, improving the skills base to match that demanded by the labor market will be important for ensuring that the Croatian economy competes successfully in Europe and globally. The Lisbon Council's European Human Capital Index ranked Croatia last among 12 central and eastern European countries, mainly due to low scores on utilization of human capital, although this study ranked Croatia in the middle of the 12 countries for human capital endowment (i.e., education and training) and human capital productivity (Ederer, Schuller, and Willms, 2007). This suggests that the impact of education spending on economic growth in Croatia could be enhanced by shifting resources to better meet demands in the labor market.

Table 10. Correlations of Relative Efficiency in Education with Associated Factors 1/

	Primary			Secondary			Tertiary
	Enrollment rates	Completion rates	Pupil-teacher ratio	Enrollment rates	Graduation rates	PISA math scores	Enrollment rates
	Overall efficiency: public expenditures to outputs/outcomes						
Exogenous factors							
GDP per capita (PPP dollars)		NN		NN		NN	
Healthy life expectancy (years)	PP	PP					
Mothers education ICED 3 or higher (percent students) 2/	...	...	...	PP	P	P	...
Fathers education ICED 3 or higher (percent students) 2/	...	...	...	PP		P	...
Expenditure composition							
Private education expenditure (as a share of public educ. exp.)			NN				
Total current expenditure (percent of non-tertiary educ. exp.)		P	PP	PP			...
Total capital expenditure (percent of non-tertiary educ. exp.)		N	N	N			...
Education resources							
Pupil-teacher ratio in secondary 3/	...	...	...			PP	...
Student admission record is prerequisite (percent schools) 2/	...	...	...			PP	...
Principal is responsible for hiring teachers (percent schools) 2/	...	...	...	P		PP	...
Student absenteeism hinder learning (percent schools) 2/	...	...	...			NN	...
Student skipping classes hinder learning (percent schools) 2/	...	...	...			NN	...
Student lacking respect hinder learning (percent schools) 2/	...	...	...			N	...
Students bullying hinder learning (percent schools) 2/	...	...	...	NN			...
	System efficiency: secondary enrollment/PISA math scores						
Exogenous factors							
GDP per capita (PPP dollars)	...	...	...	...	...	PP	...
Infant mortality rate (per 1,000 live births)	...	...	...	...	...	NN	...
Education resources 2/							
Student admission record is prerequisite (percent schools) 2/	...	...	...	...	...	P	...
Student absenteeism hinder learning (percent schools) 2/	...	...	...	...	...	NN	...
Student skipping classes hinder learning (percent schools) 2/	...	...	...	...	...	NN	...
Student lacking respect hinder learning (percent schools) 2/	...	...	...	...	...	N	...

Sources: UNESCO; World Bank, *World Development Indicators*; OECD; and Fund staff estimates.

1/ Correlations were run on output-oriented efficiency scores. This table summarizes the results of correlations of associated factors with the level of efficiency. PP (P) indicates that the associated factor is positively correlated with level of efficiency (negatively correlated with output-oriented efficiency scores) at the 5 (10) percent significance level. NN (N) indicates that the associated factor is negatively correlated with level of efficiency (positively correlated with output-oriented efficiency scores) at the 5 (10) percent level. Several of the associated factors are highly correlated with GDP. Only correlations that are significant after conditioning on GDP are considered (see Appendix).

2/ Only covers countries that participated in the 2003 PISA test.

3/ Excludes non-OECD countries due to missing data.

IV. Concluding Remarks

The previous sections demonstrated that there are significant inefficiencies in government spending on health care and education in Croatia. In the health sector, inefficiencies are mainly related to high spending, rather than weak outcomes. In the

education sector, inefficiencies are related to both poor outcomes and increasing overhead costs. While there are caveats to the analysis, the main findings, taken together with the findings of other studies, seem quite robust. In particular, the findings of this paper, derived from simple cross-country comparisons, simple correlation analyses, and DEA,[22] are supported by studies at sectoral levels by the IMF, the World Bank, and Mihaljek (2007).

These inefficiencies suggest that there is room to improve health and education indicators while containing public spending. The paper has suggested a number of measures that can be taken to reduce inefficiencies in public spending and generate budgetary savings. These measures are summarized in Table 11. Some of the above reforms could have disproportionate effects on the poor and other vulnerable groups. Therefore, to avoid vulnerable groups foregoing necessary services, targeted transfers to them may be needed.

Table 11. A Menu of Reform Measures to Increase Efficiency of Government Spending on Health and Education in Croatia

Health Care
• Increase co-payments while minimizing exemptions.
• Further reduce subsidization of pharmaceuticals.
• Accelerate the introduction of the Diagnosis Related Groups (DRG) payment method.
• Restrict the basic benefits package covered by HZZO.
• Shift resources to more affordable outpatient care.
• Increase the role of the private sector in the provision of health care services.
• Strengthen incentives for General Practitioners for reducing referrals.
• Rationalize the hospital network.
Education Sector
• Rationalize the teaching and non-teaching work force and wage bill.
• Consider greater cost recovery in tertiary education by reducing budget financing to universities and means testing scholarships.
• Increase teaching hours to international norms.
• Target free textbooks, transportation, and dormitories programs only to the vulnerable.
• Rationalize the school network and expand multi-grade teaching in small schools.
• Move towards per-student or performance-based budgeting.
• Shift resources to better meet demands in the labor market.

[22] See Annex I for description of caveats of DEA.

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Appendix. Data Envelopment Analysis (DEA)[23]

The DEA technique is a non-parametric method of estimating production possibility sets, which can be used to evaluate the efficiency in the use of inputs in producing outcomes for a sample of production units.[24] It is mostly used for estimating relative efficiency in business applications, but it has recently also been used to assess the relative efficiency of public expenditure. In the context of government expenditure efficiency, indicators of public production are typically used to measure outcomes, for example, life expectancy and infant mortality rates (in health care), youth literacy rates and test scores (in education), and the number of roads and telephone lines (in infrastructure). Inputs used to produce these outcomes are public and private expenditure on health, education, and infrastructure, as well as intermediate outputs and resources such as the number of doctors and hospital beds (in health care) and enrollment rates and student-teacher ratio (in education). The production units in this case are often countries, but could also be sub-national regions.[25]

Figure A.1 illustrates a stylized example of DEA based on a single input and outcome indicator across countries. The efficient frontier connects countries A to D as these units dominate countries E and G in the interior. The convexity assumption allows an inefficient country (point E) to be assessed relative to a hypothetical position on the frontier (point Z) by taking a linear combination of efficient unit pairs (points A and B). In this manner, an ***input-based technical efficiency*** score that is bounded between zero and one can be calculated as the ratio of YZ to YE. The score corresponds to the proportional reduction in inputs that is consistent with relatively efficient production of a given output, and can be interpreted as an indicator of the cost savings that could be achieved from efficiency enhancement. Similarly, an ***output-based technical efficiency*** score can be calculated as the ratio of FX to EX, which reflects the improvement in outputs for given inputs that could be achieved from efficiency

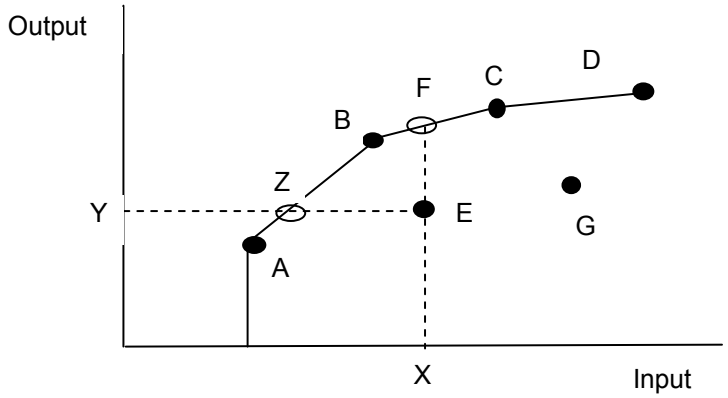
[23] This Appendix is based on Zhu (2003), Mattina and Gunnarsson (2006), and Verhoeven et al. (2007).

[24] It was developed by Farrell (1959) and popularized by Charnes, Cooper and Rhodes (1978). See Zhu (2003) for more detailed discussion of DEA.

[25] There is well-established literature using DEA to assess the relative efficiency of public expenditure. Gupta and Verhoeven (2001) studied the relative efficiency of education spending in a broad sample of African countries during the 1984-95 period. Afonso and St. Aubyn (2004) applied DEA and a related frontier-based approach on health and education spending in a sample of OECD countries. Herrera and Pang (2005) studied the relative efficiency of spending in 140 countries using DEA. Afonso, Schuknecht and Tanzi (2006) applied DEA in a sample of EU and emerging market countries. An important contribution of their work was to apply truncated regression models based on procedures developed by Simar and Wilson (2007) to control for exogenous factors that impact efficiency but that are not directly controlled by policy makers. Coelli, Lefebvre, and Pestieau (2007) applied DEA to study social protection performance in the EU.

enhancement. This paper focuses on output-based efficiency scores, since Croatia will need to improve outcomes without increasing expenditures.[26] [27]

Figure A.1. Illustrative Example of Applying DEA



DEA is a powerful tool to assess the relative efficiency of spending, but also has important caveats. For example, it does not require an assumption about unknown functional forms for the efficiency frontier or complex distributional properties for econometric analysis. However, it is also subject to the following caveats:

- Results are highly sensitive to sample selection and measurement error. As a result, outliers exert large effects on the efficiency scores and the shape of the frontier. For this reason, proper sample selection is the key to ensuring that cross-country input-output combinations are comparable.

- Spending attributes that are difficult to quantify are not easily incorporated in the analysis, such as the quality of spending.

- The outcome indicators against which inputs are evaluated may not actually be targeted by policy makers.

- Large differences across countries in private health care or education spending could bias the efficiency scores of public spending, as the outcomes targeted by policy makers are also impacted by private spending.

[26] An output-based efficiency score of one corresponds to a relatively efficient country operating on the frontier. Scores exceeding one imply that spending could achieve better output performance. This differs from input-based efficiency scores that range between zero and one.

[27] The input- and output-based efficiency scores are equal assuming constant returns to scale. However, the DEA models considered in this chapter permit variable returns to scale.

- Factors beyond the direct control of policy makers can also affect relative efficiency scores. For instance, a high incidence of AIDS would reduce the measured efficiency of health spending in African compared to other countries.

Moreover, simple DEA estimation produces biased estimates of the efficiency scores that need to be corrected. In particular, the best-practice frontier can move *outward,* if efficient pairs/countries are added in the sample, but cannot move inward. This one-sided error means that estimating the best-practice frontier with a finite sample is subject to bias. Since output–oriented efficiency scores are measured in relation to the frontier, the estimated scores are subject to the same finite sample downward bias (i.e., the level of efficiency is overestimated unless a correction is made for the bias). This bias stems from the fact that since we only observe a sub-sample of the possible outcomes representing all feasible combinations of spending and outcomes, we do not know the exact position of the best-practice frontier. Where appropriate, corrections are made for the estimation bias in the best-practice frontier and efficiency scores through bootstrapping, as suggested by Simar and Wilson (2000).[28]

DEA results can be disaggregated to assess at what stage of the spending process inefficiencies arise. This is done as by comparing ***spending efficiency*** (the overall measure of efficiency from spending to outcomes as discussed above) and ***system efficiency*** (the measure of efficiency from intermediate outputs to outcomes; Tables II.5 and II.9). Figure A.2 illustrates how it is done in the analysis of efficiency of health care spending. First, cost efficiency is assessed using health care spending and intermediate output indicators such as hospital beds, immunizations, physicians, health care workers and pharmacists per capita. Second, efficiency scores are calculated, using the intermediate output index as an input and associated outcomes (infant, child, and maternal mortality rates, as well as HALE, standardized death rates and the incidence of tuberculosis). Third, the resulting system efficiency rankings are averaged, and expressed as a ratio of the average OECD ranking, and compared with similar ratios for spending efficiency.

[28] A key issue is how quickly the estimated efficiency scores converge to their unbiased true values if the sample of observations is expanded. This convergence speed is $n^{-2/(p+q+1)}$, where p is the number of inputs and q is the number of production items. In the 1 input / 1 product examples of this Appendix, the convergence speed is $n^{-2/3}$. This is faster than the convergence speed for a standard parametric regression of $n^{-1/2}$, suggesting that reasonable estimates of efficiency scores and confidence intervals can be reached with a lower number of observations than would be needed for standard regression analysis. However, the convergence speed declines exponentially as the number of inputs and production items is increased, and already at two inputs and production items, the speed of convergence is markedly slower than for a parametric regression. This implies that an expansion in the numbers of inputs and production items comes at a significant cost in terms of the ability to draw conclusions on efficiency from a limited number of observations.

Figure A.2. The Efficiency Relationship Between Health Expenditures, Resources, and Outcomes