



IMF Working Paper

Public Expenditure in the Slovak Republic: Composition and Technical Efficiency

Francesco Grigoli

IMF Working Paper

Fiscal Affairs Department

Public Expenditure in the Slovak Republic: Composition and Technical Efficiency

Prepared by Francesco Grigoli ¹

Authorized for distribution by Benedict Clements

July 2012

This Working Paper should not be reported as representing the views of the IMF. The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

Abstract

Good practice suggests that budget allocations should reflect spending priorities and that spending should provide cost-effective delivery of public goods and services. This paper analyzes the composition of public expenditure in the Slovak Republic. It also assesses the relative efficiency of spending in education and health. The Slovak Republic spends more on social benefits and less on wages compared to the EU and OECD average. While it manages to translate the low expenditures into outcomes in an efficient manner in the education sector, this is not true for health. Moreover, the recent increases in expenditure levels have not improved outcomes, suggesting that significant budgetary savings could be achieved through increases in efficiency.

JEL Classification Numbers: H50, H51, H23, H55

Keywords: Slovak Republic, expenditure composition, technical efficiency

Author's E-Mail Address: fgrigoli@imf.org

¹The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management. I would like to thank Benedict Clements, Marek Jakoby, Gil Mehrez, Daria V. Zakharova and colleagues in the Expenditure Policy division for their insightful comments. I am also grateful for the suggestions made by participants in a seminar held at the Slovak Ministry of Finance in May 2012.

Contents	Page
Abstract	3
I. Introduction	3
II. Literature Review: An EU-OECD Perspective	4
III. Features of the Slovak Republic's Public Expenditure	6
A. Public Expenditure Composition	8
B. Spending Agencies	11
IV. Technical Efficiency	13
A. Education	14
B. Health	20
V. Concluding Remarks	26
Tables	
1. Uncommitted Expenditures	11
2. Public Expenditure by Agency, 2009	12
3. Selected Indicators of the Education System	16
4. Selected Indicators of the Health System	22
Figures	
1. Government Size across EU-OECD Countries	6
2. Slovak Government Size	7
3. Public Spending During the Crisis	7
4. Expenditure Composition, 2009	8
5. Expenditure Composition in Real Terms	9
6. Expenditure Categories	10
7. Education Expenditure across EU-OECD countries	15
8. Education Expenditure	15
9. Efficiency of Education Expenditure	19
10. Health Expenditure across EU-OECD countries	20
11. Health Expenditure	21
12. Efficiency of Health Expenditure—Life Expectancy	24
13. Efficiency of Health Expenditure—Infant Mortality	25
Appendices	
1. The DEA Approach	28
Appendix Figures	
1. DEA Production Possibility Frontier	28
References	31

I. INTRODUCTION

The structure of public spending and its efficiency are critical to fostering long-term economic growth and improving living standards. At the same time, when the same output and outcomes are achieved with fewer resources, budget constraints are eased and fiscal discipline is more easily attainable. However, deviations from optimal allocations and efficiency frontiers are common. In fact, it is widely recognized that public expenditure is often inefficient. Resources may be allocated to a mix of public programs that are suboptimal and do not best meet the objectives that justify government intervention (*allocative inefficiency*), or goods and services may not be provided at the minimum cost (*technical or productive inefficiency*). Poor governance, the short-sightedness of politicians, and weak budget institutions can all contribute to the misallocation of resources.

There is no consensus among economists on the optimal level of public expenditure. Some of the traditional reasons justifying government expenditure include market failure and redistributive concerns.² Ideally, a government would maximize a social welfare function (SWF) which reflects the social preferences of society. A government's SWF, however, may differ from that of society. As a result, the allocation structure typically reflects the government's priorities³ and not necessarily a representative view of the average citizen on the appropriate role of the state.

Public spending is more likely to add to societal welfare when it provides services in an efficient manner.⁴ In this sense, cross-country and sector-level analyses are important to highlighting best practices. A recent study by the ECB (2006, page 73) underscores how increased public expenditure levels in Europe may in part reflect a poor use of resources: "Public expenditure ratios have steadily increased in the Euro area since the 1960s before peaking and, in some cases, declining in more recent years. [...] According to many observers, it exceeds the levels required for the efficient provision of essential public services." Afonso and others (2010) go beyond the ECB analysis and quantify the waste of resources for a set of countries including some emerging economies and new EU members. They conclude that countries could use around 45 percent less resources to attain the same outcomes if they were fully efficient.

One of the important policy objectives for the Slovak Republic is to ensure fiscal sustainability, and consolidation efforts are needed to achieve it. In this context, spending

²For a broad discussion on this theme see Chu and Hemming (1991).

³Differences in spending levels can also reflect differences in needs, rather than differences in priorities.

⁴A clear example of an indirect cost of public sector provision inefficiency is the increase in the burden of taxation to collect those resources that are inefficiently spent (Afonso and Gaspar, 2007).

well, and spending on growth-enhancing activities, are of utmost importance. Thus, identifying inefficiencies becomes critical, as efficiency improvements offer substantial opportunities for budgetary savings without sacrificing outcomes.

This paper provides an overview of public expenditure composition for the Slovak Republic and evaluates technical efficiency for education and health expenditure. The results suggest that as a consequence of a long-term trend toward rising expenditures—both before and after the global financing crisis—the Slovak Republic allocates a larger share of expenditures to social benefits than the EU and OECD average. It spends less, however, on the wage bill. Compared with its peers, the Slovak Republic spends relatively less on education and health. While it appears efficient in converting the low levels of spending into outcomes in the education sector, this is not true for health. Moreover, recent increases in expenditures on health have not been reflected in improved outcomes, suggesting that significant budgetary savings could be achieved without undermining the quality of outcomes.

The remainder of this paper is structured as follows. Section II presents a review of the available literature. Section III shows how public expenditure levels in the Slovak Republic have evolved in the recent past and analyzes the public expenditure allocation structure. Section IV assesses technical efficiency for education and health spending. Section VI concludes the paper.

II. LITERATURE REVIEW: AN EU-OECD PERSPECTIVE

The efficiency of public spending has been studied extensively in recent years, particularly with respect to the overall public sector, education, and health. Afonso and others (2005) constructed public sector performance and efficiency composite indicators and compared public expenditure efficiency across 23 OECD countries, highlighting a large potential for savings.⁵ Some years later, Afonso and others (2010) enriched the previous study by extending the analysis to new member states of the EU and some emerging markets from different regions. They find that countries with small public sectors (i.e., with public expenditures lower than 40 percent of GDP) tend to be more efficient. They conclude that, on average, countries could use 45 percent less resources to attain the same outcomes and deliver an additional third of the output if they were as efficient as the best performers in the sample. Similarly, the Social and Cultural planning Office of the Netherlands (SCP, 2004) shows that countries with high income per capita and relatively low expenditures perform better on average.

⁵The composite indicators include a set of seven sub-indicators of public performance. On the one hand they look at administrative, education, health, and public infrastructure outcomes, and on the other they consider the “Musgravian” tasks for government, such as income distribution, economic stability, and economic performance.

Mandl and others (2008) compute efficiency for a few areas where the government accounts for an important share of services, namely general public services, education, and research and development. They show that efficiency varies substantially across EU member states and this translates into potential savings. The paper also warns about some shortcomings of efficiency analysis, especially related to the use and availability of the right input and output indicators and the influence of exogenous factors beyond the control of the public authorities, such as climate. Verhoeven and others (2007a) assess the efficiency of education and health spending in G7 countries and provide recommendations for efficiency-enhancing reforms, including careful planning of staffing and wages, reallocating the composition of spending toward cost-effective intermediate outputs, and implementing regulatory frameworks to ensure accountability.

The education and health sectors generally account for a high share of public expenditures. Clements (2002) finds that 25 percent of education spending is wasteful in the European Union relative to the best practices observed in the OECD. Afonso and St. Aubyn (2005) employ a semi-parametric two-step model of secondary education production for OECD countries to show that inefficiency is significant among its members. They argue that countries could have increased their results by 11.6 percent using the same resources. However, they point out that inefficiency is strongly related to factors beyond government control, such as family economic background and the level of education of parents.

Country-specific studies are also available. Clements (1999) assesses the efficiency of education expenditure in Portugal and highlights considerable inefficiencies. Taking advantage of the availability of new indicators, Sopek (2011) analyzes the efficiency of public education expenditure in Croatia using Program for International Student Assessment (PISA) scores.⁶ The author concludes that Croatia has space for improving the efficiency of its system. Hauner (2007) performs an efficiency analysis of some social sectors for the Russian Federation relative to other countries and among the country's regions. The study argues that while Russia's spending on education appears efficient relative to other countries, this is not the case in health and social protection, where the current level of outputs could be produced with two-thirds of present spending.

Spinks and Hollingsworth (2009) use non-parametric techniques to assess the relative technical efficiency of health expenditures across the OECD. They test for their results' robustness by performing the analysis in 1995 and 2000 with OECD data and by selecting the OECD sub-sample of WHO data. Joumard and others (2010) derive OECD cross-country comparisons of health care spending efficiency, based on health care outcomes measured at a

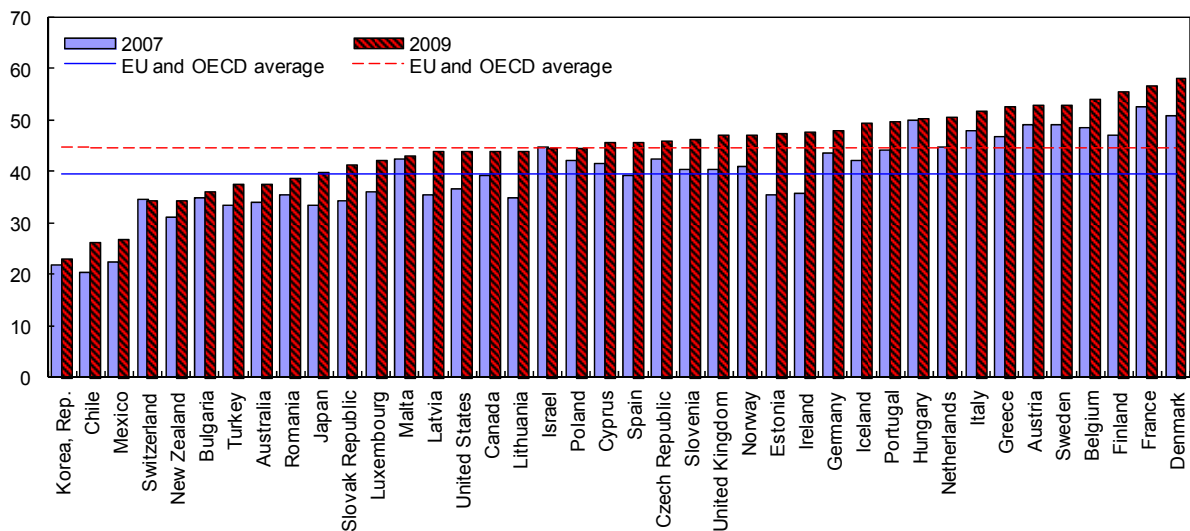
⁶The Programme for International Student Assessment (PISA) is a triennial OECD international survey of the knowledge and skills of 15-year-old pupils, an age at which students in most countries are near the end of their compulsory time in school. PISA ranks countries according to their performance in reading, mathematics, and science by their mean score in each area.

system level. Verhoeven and others (2007b) analyze the financial situation of the health sector in the Slovak Republic and assess the efficiency of health spending. They find that while the country's health system is plagued by financial problems, it is also inefficient in converting inputs into outcomes.

III. FEATURES OF THE SLOVAK REPUBLIC'S PUBLIC EXPENDITURE

The size of government (measured as total general government expenditure as a share of GDP) across EU-OECD countries varies widely, as illustrated in Figure 1. Government spending accounts for about 25 percent of GDP in Korea, Chile, and Mexico, which is less than half of what Finland, France, and Denmark spend. The Slovak Republic is well below the sample average, in the second quartile of the distribution. The significant increase in government size experienced in the aftermath of the crisis has been common to most of the countries. Only Switzerland and Israel reduced government spending.

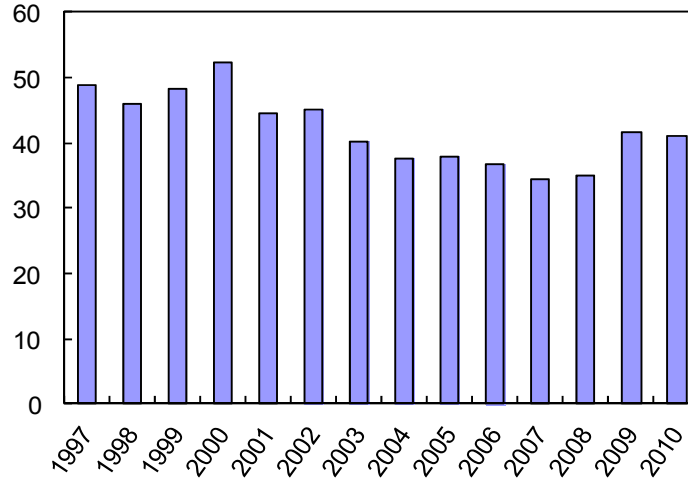
Figure 1. General Government Size across EU-OECD Countries
(Percent of GDP)



Source: IMF WEO.

Figure 2 shows how the Slovak Republic's size of government evolved during the last 13 years. The government shrank its size significantly from 52.1 percent of GDP in 2000 to 34.3 percent of GDP in 2007. The crisis-related stimulus contributed to reversing this trend, with expenditures surging to 41.0 percent of GDP in 2010.

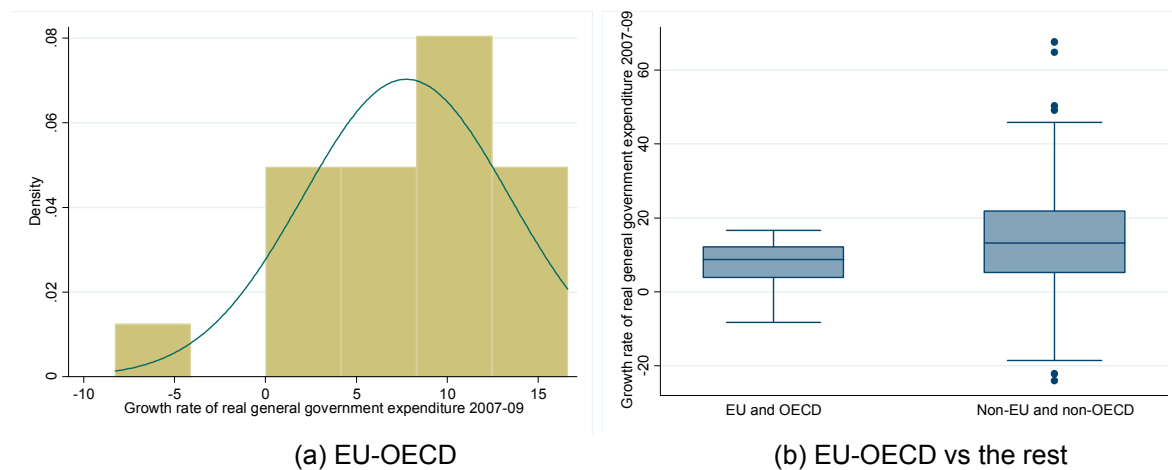
Figure 2. Slovak Government Size
(Percent of GDP)



Source: IMF WEO.

Compared with all EU-OECD members, the Slovak Republic experienced the largest spike. Panel (a) of figure 3 illustrates the probability distribution function of the real growth rate of general government spending. With a real growth rate of about 16.6 percent, the Slovak Republic is at the rightmost end of the distribution. The box plots of panel (b) indicate that the change in government spending during the crisis has been much more dispersed in non-EU and non-OECD countries, but it is still worth noting that the Slovak Republic's real expenditure growth is almost as high as the 75th percentile of the non-OECD sample. As a share of GDP, spending rose by 7.2 percent, which is one of the largest increases in the EU-OECD.

Figure 3. Public Spending During the Crisis

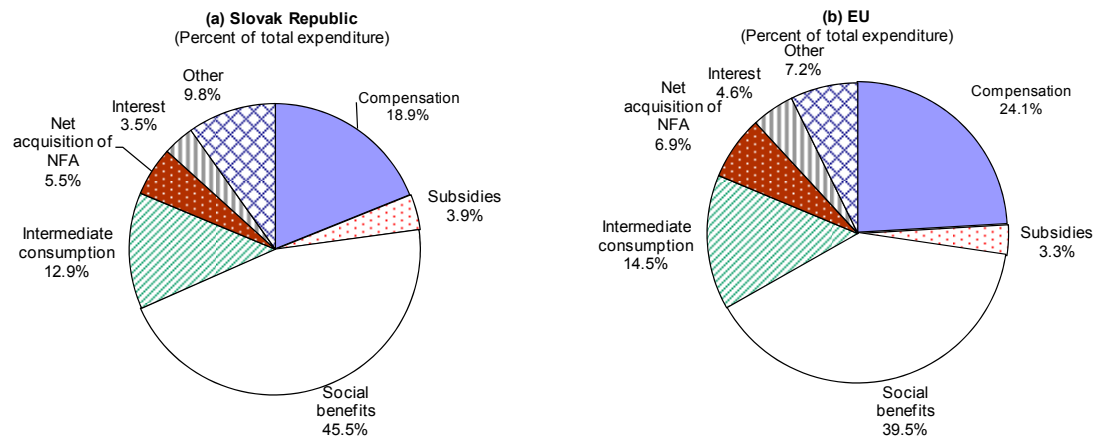


Source: IMF WEO.

A. Public Expenditure Composition

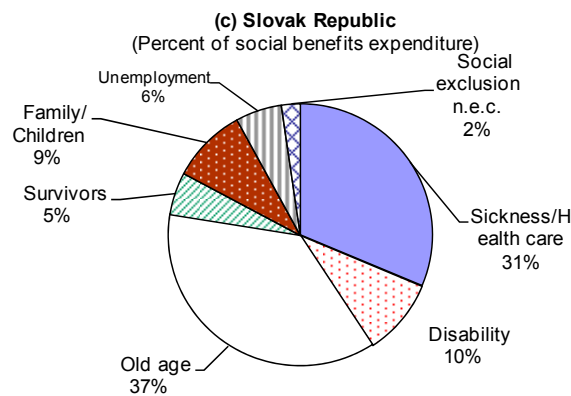
The pie chart in panel (a) of Figure 4 gives a snapshot of the Slovak Republic's general government expenditure in 2009. While subsidies and interest payments are limited (as shown in Table 1), almost half of total expenditure is allocated to social benefits. Such a composition is not very different from the average of the EU countries, represented in panel (b). Indeed, the most important item for the EU average is social benefits, even though these account for 39.5 percent of total expenditure, 6.1 percentage points less than in the Slovak Republic. Another important difference is related to the wage bill, which is 5.2 percentage points smaller in the Slovak Republic. As illustrated by panel (c), sickness/health care and old age benefits cover almost 70 percent of total benefits. Old-age benefits rose by 51.5 percent since 1997, reflecting the substantial weight that demographic aging is progressively placing on public finances.⁷

Figure 4. Expenditure Composition, 2009



Sources: Eurostat, and IMF WEO.

Sources: Eurostat, and IMF WEO.

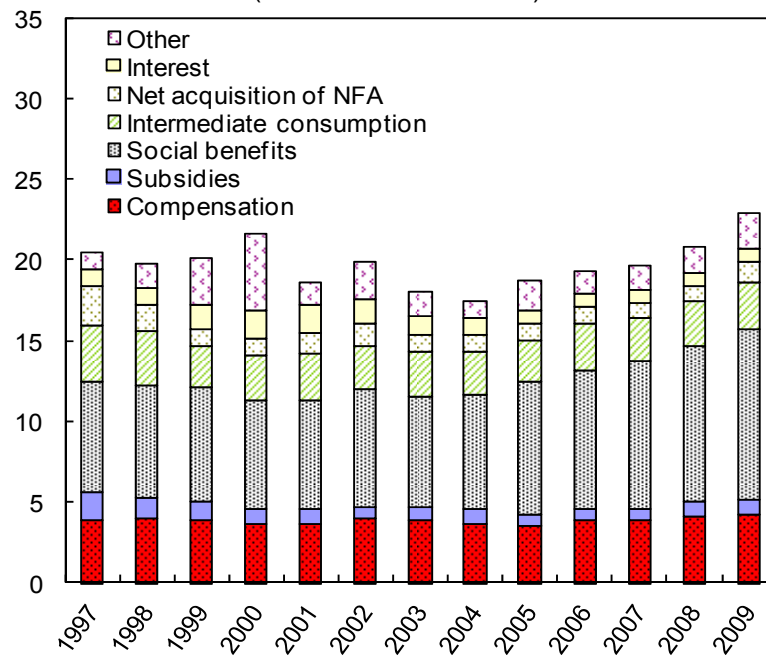


Sources: Eurostat, Ministry of Finance, and IMF WEO.

⁷The rapidly changing age structure and the more general acceleration of the population aging process in the country is a well-documented issue. For further information see <http://esa.un.org/unpd/wpp/index.htm>.

Figure 5 displays the evolution of the expenditure composition of the Slovak Republic in real terms since 1997. The real increase in government spending since 2004 can be almost fully attributed to the surge in social benefits expenditure. Net acquisition of nonfinancial assets (NFA) has been relatively stable in real terms, rising only in 2009 as part of the strategy to counteract the global financial crisis.

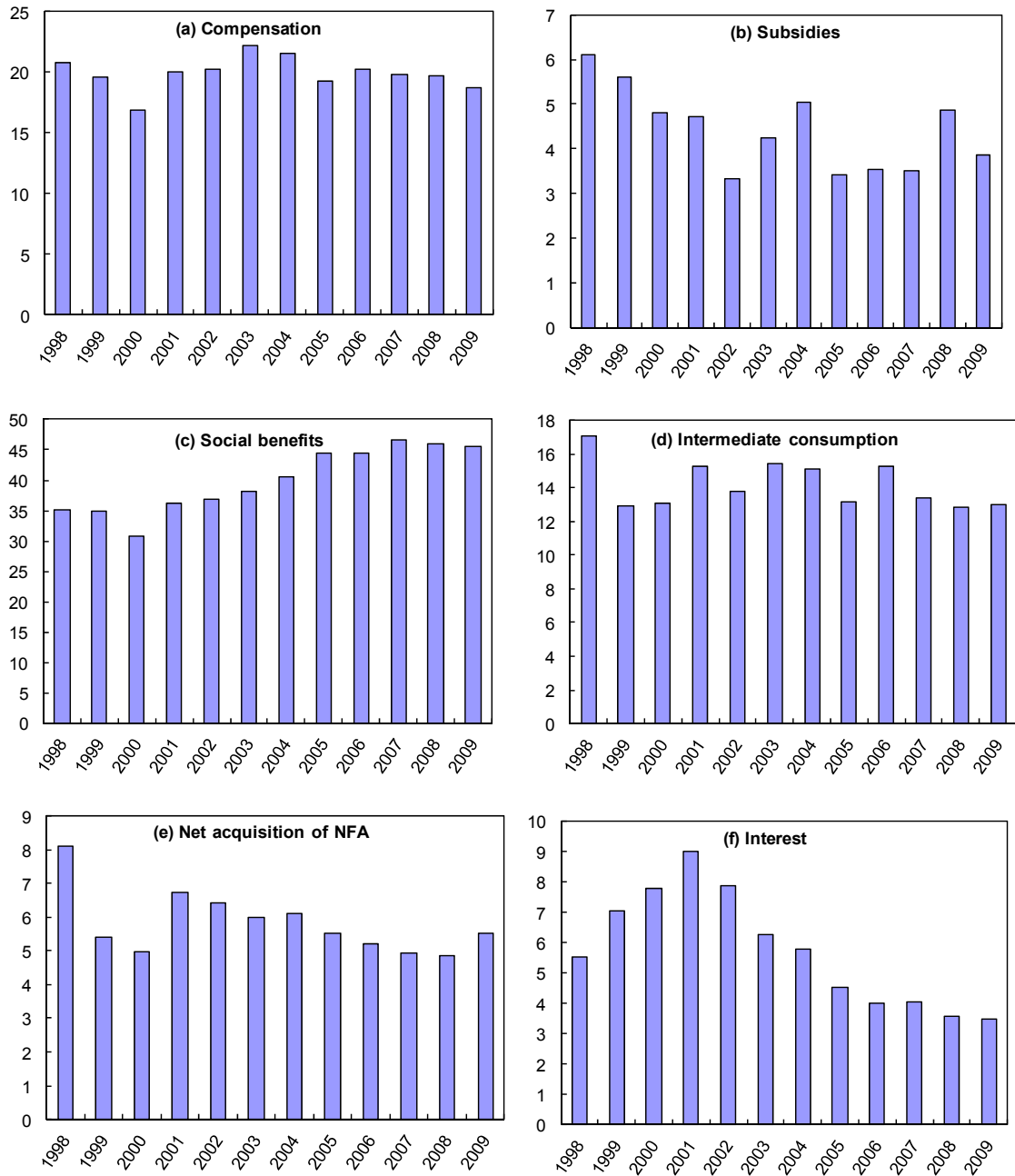
Figure 5. Expenditure Composition in Real Terms
(Billions of SKK of 2005)



Sources: Eurostat, and IMF WEO.

Figure 6 shows the weight of each spending category in total expenditure. By far, the most volatile category is subsidies, even though its relative weight in total expenditure is modest. Following a gradual decline during 1998-2000, subsidies have been oscillating between 3.2 and 5 percent. The share of interest payments in expenditure has been gradually declining, whereas that of social benefits has been increasing.

Figure 6. Expenditure Categories
(Percent of total expenditure)



Sources: Eurostat, and IMF WEO.

We next explain the evolution of “committed” expenditures. Committed expenditures are those over which the government has little discretion. While there is no standard definition for such spending in the literature, for the purposes of this study we define committed outlays as those that cannot easily be cut back or reallocated to other categories. For example, past debts commit the current government to pay interest. Such expenditure often arises as a legacy of the past and may pose problems for fiscal adjustment. Also, social benefits are

amendable only by law and are therefore difficult to change. Finally, a government committed to providing welfare to the poor is compelled to spend on subsidies, which could limit further the share of discretionary spending of the government.

Table 1 shows the total amount of real general government expenditure in the Slovak Republic. Committed spending accounted for more than half of total expenditures since 2004. Uncommitted expenditures decreased by 6.3 percent to 47.1 percent of total expenditures in 2009, the last year in which data are available. This gives less freedom to the government to change the structure of its spending. The decreasing path highlighted in the table is in contrast to the EU average, which shows a progressive increase, although with a smaller variation.

Table 1. Uncommitted Expenditures
(Millions of SKK of 2005)

Concept	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Expenditures	20525	19740	20143	21616	18664	19887	18004	17475	18730	19303	19679	20862	22949
o/w: Interests	1007	1094	1421	1683	1678	1568	1126	1010	848	770	794	742	794
o/w: Social benefits	6762	6940	7054	6641	6771	7308	6854	7119	8313	8586	9201	9577	10448
o/w: Subsidies	1787	1204	1117	1028	882	665	743	866	647	695	689	993	906
Uncommitted Expenditure (in percent)	10968 53.4	10502 53.2	10551 52.4	12264 56.7	9334 50.0	10347 52.0	9281 51.5	8480 48.5	8923 47.6	9253 47.9	8995 45.7	9549 45.8	10802 47.1
EU average (in percent)	49.2	51.0	51.7	52.2	52.5	53.0	52.8	53.0	53.1	53.1	53.1	53.1	52.2

Sources: Eurostat and IMF WEO.

B. Spending Agencies

Table 2 shows public expenditures by agency. The agencies that absorb the most resources are the Ministry of Education, Research, and Sport (15.1 percent), the Ministry of Labour, Social Affairs, and Family (13.6 percent), the General Treasury Administration (11.7 percent), the Ministry of Health (9.7 percent), and the Ministry of Transport, Construction, and Regional Development (9.4 percent). All together, these agencies account for about 60 percent of total expenditures.

The shares of capital expenditure for the Ministry of Education, Research, and Sport and the Ministry of Health are very small, 4.6 and 3.6 respectively. On the contrary, 62.6 percent of expenditures executed by the Ministry of Transport, Construction, and Regional Development are classified as capital and account for 36.3 percent of the country's total capital expenditures. The related Ministry of Construction and Regional Development shows similar percentages. Aggregated, these two cover almost half of the total capital expenditure.

Table 2. Public Expenditure by Agency, 2009

(Millions of EUR of 2005)

Agency	Total (real)	Total (in percent of total expenditure)	Capital (in percent of agency's expenditure)	Capital (in percent of total capital expenditure)
Off. of the National Council	50.6	0.4	51.7	1.4
Off. of the President	3.2	0.0	2.3	0.0
Government Off.	37.9	0.3	28.1	0.6
Off. of the Constitutional Court	3.9	0.0	23.6	0.0
Supreme Court of the Slovak Republic	6.9	0.1	0.7	0.0
General Prosecution	55.2	0.5	6.6	0.2
National Audit Off.	7.6	0.1	13.1	0.1
Slovak Information Service	42.2	0.4	0.0	0.0
Ministry of Foreign Affairs	108.4	0.9	12.2	0.7
Ministry of Defense	847.1	7.3	4.2	1.9
Ministry of Interior	888.7	7.6	14.3	6.7
Ministry of Justice	245.7	2.1	4.7	0.6
Ministry of Finance	325.4	2.8	15.6	2.7
Ministry of Environment	219.7	1.9	64.3	7.5
Ministry of Education, Science, Research and Sport	1,768.9	15.1	4.6	4.3
Ministry of Health	1,128.6	9.7	3.6	2.1
Ministry of Labour, Social Affairs and Family	1,590.3	13.6	0.4	0.4
Ministry of Culture	172.2	1.5	11.8	1.1
Ministry of Economy	238.6	2.0	59.8	7.6
Ministry of Agriculture and Rural Dev.	909.7	7.8	23.5	11.3
Ministry of Construction and Regional Dev.	379.6	3.2	58.9	11.8
Ministry of Transport, Construction and Regional Dev.	1,096.0	9.4	62.6	36.3
Off. of Geodetics, Cartography and Land Register	53.7	0.5	28.9	0.8
Statistical Off.	29.5	0.3	25.0	0.4
Off. for Public Procurement	3.2	0.0	3.9	0.0
Nuclear Regulatory Authority	4.1	0.0	5.4	0.0
Industrial Property Off. of C	2.8	0.0	5.3	0.0
Slovak Off. of Standards, Metrology and Testing	6.6	0.1	3.1	0.0
Antimonopoly Off.	5.0	0.0	0.4	0.0
National Security Authority	7.6	0.1	8.8	0.0
State Material Reserves	17.8	0.2	27.3	0.3
General Treasury Administration	1,362.8	11.7	1.1	0.8
Slovak Academy of Sciences	63.9	0.5	12.6	0.4
Total	11,683.2	100.0	16.2	100.0

Source: Ministry of Finance.

IV. TECHNICAL EFFICIENCY

Measuring the efficiency of spending requires an assessment of the relationship between spending inputs and outputs. The literature on the efficiency analysis begins with Farrell (1957), who draws from the studies of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency which could account for multiple inputs. Farrell (1957) introduces the concept of technical efficiency as the ability of a firm to obtain maximum output from a given set of inputs.

Currently, the most common techniques used for efficiency analysis are Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Ordinary Least Squares (OLS) or quantile regressions are not satisfactory as they estimate the mean or some quantile of the dependent variable conditional on the explanatory variables. Likewise, limited dependent variable models truncate the dependent variable into categories that do not correspond to the minimum or the maximum. In contrast, DEA's and SFA's objective is to estimate the maximum possible production given a set of inputs or the minimum possible cost of a set of outputs.

There are two substantial differences between the DEA and the SFA. While the SFA is based on maximum likelihood or other classical or Bayesian parametric econometric techniques, the DEA is based on non-parametric linear programming methods. In other words, the SFA estimates a continuous, regular relationship that defines the frontier. In describing what later evolved into the SFA, Aigner and Chu (1968) state: "A viable distinction between the average and frontier functions as predictors of capacity [...] derives from a probability interpretation of alternative forecasts [...] the frontier we construct is truly a surface of maximum points." The DEA uses linear programming to fit a linear hull around the data, under the assumption that the hull accurately approximates the underlying frontier.⁸ Aigner and Chu (1968) encouraged the application of linear programming methods, which evolved into the DEA in Charnes and others (1978) (for further details, see Appendix 1).

The second main difference is that the DEA can include more than one output of a producer or decision making unit (DMU). Contrarily, the SFA allows only for one output. The fundamental assumption of the DEA is input-output separability (see Theil, 1980). Where more than one output is used, this means that inputs are used in ratios unrelated to the ratios of outputs. Afonso and St. Aubyn (2007) use principal component analysis (PCA) to overcome the one output limit of SFA. However, PCA suffers from several shortcomings. Hadi and Ling (1998) illustrated that the first $(p - 1)$ principal components can totally fail in accounting for the variation in the response variable, which may fit perfectly the last principal component that is always ignored by the PCA.

⁸Consequently, a larger number of observations contribute to better define the frontier.

It could be argued that DEA is more appropriate where (i) the sample is more homogeneous in terms of quality of production factors; (ii) measurement error is unlikely to pose much of an issue; and (iii) the assumptions of neoclassical production theory (i.e., same shape isoquants) are in question. Conversely, SFA should have the advantage in coping with measurement error and where simple functional forms provide a close match to the properties of the underlying production technology. Ultimately, the case for using DEA or SFA must be decided on a case-by-case basis.

Given a small and broadly technologically homogeneous sample of EU-OECD countries, and the generally good practices (and hence small measurement error) that characterize the data collection process in these countries, this paper opts for DEA. The following two subsections aim at assessing the efficiency of public expenditures in the Slovak Republic for education and health. Note that the analysis is carried out at the national level. This may hide large differences across regions of the country, which is likely the case in the Slovak Republic.

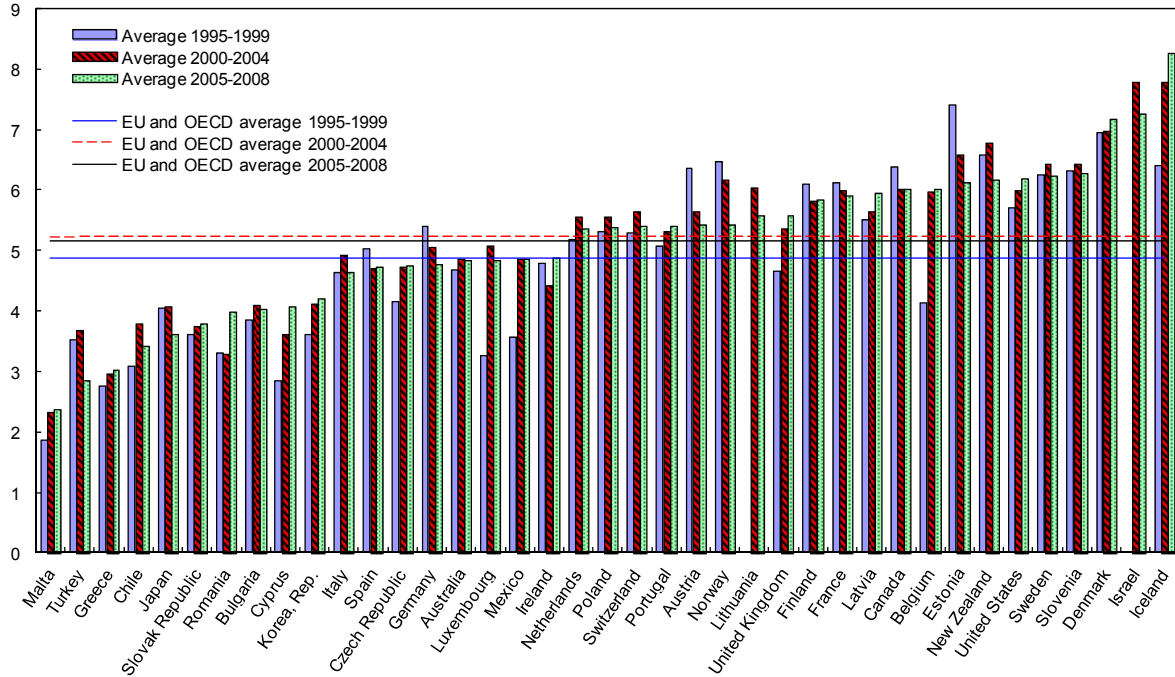
A. Education

Figure 7 shows the size of public education spending in the Slovak Republic (as a share of GDP) compared with other EU-OECD countries.⁹ It is clear that the Slovak Republic spends relatively little on education compared with peer countries. The country's average spending for the period 2005–09 is 3.8 percent of GDP, well below the sample average of 5.1 percent of GDP, and this places the country in the lowest quartile of the sample. While most of the countries show a progressive increase in allocations to education over the last 15 years, the education budget for the Slovak Republic has been relatively flat.

A closer look at the dynamics of education expenditure in the recent past reveals that the Slovak Republic has traditionally spent less than the average of advanced economies, CEE-CIS, and EU-OECD countries (see Figure 8). Education spending declined by 0.6 percent of GDP in 2008 after years of relatively constant spending, compared with an increase in other EU-OECD countries. The latest Eurostat data for 2009 suggest a rebound of education expenditure to 4.3 percent of GDP. However, this spike is inflated by a decrease of 6 percent in nominal GDP.

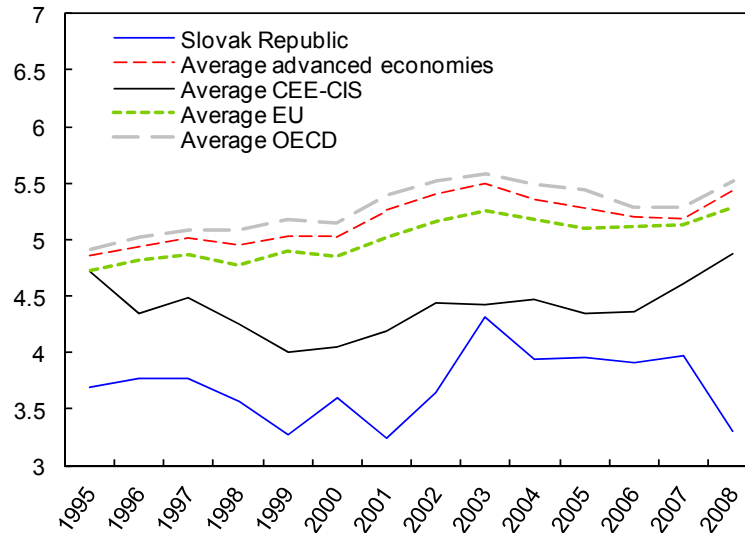
⁹The expenditure data used in this and the following subsections follow the Classification of the Functions of Government (COFOG) developed by the OECD. It classifies government expenditure data from the System of National Accounts by the purpose for which the funds are used.

Figure 7. Education Expenditure in EU-OECD countries
(Percent of GDP)



Source: IMF Fiscal Affairs Department. Available at <http://www.imf.org/external/pubs/ft/sdn/2011/data/sdn1115.xls>.

Figure 8. Education Expenditure
(Percent of GDP)



Source: IMF Fiscal Affairs Department. Available at <http://www.imf.org/external/pubs/ft/sdn/2011/data/sdn1115.xls>.

Table 3 presents selected indicators assessing the education system relative to the Slovak Republic's peers. The data indicate that a high percentage of children are enrolled in public schools (91.2 percent in 2009). However, a downward trend is observable across the years. Since 1998 the ratio dropped by 4 percentage points, implying that there has been a modest migration of pupils toward private institutions. At the same time, it should be noted that the number of primary and secondary students dropped significantly since 1997 (32.8 and 15.1 percent respectively), whereas the number of students in tertiary education doubled. The enrollment rate for the population aged 15-19 (typically corresponding to secondary school) increased by more than 10 percentage points since 2001, reaching 85.1 percent in 2009 and outperforming the EU-OECD average by almost 3 percentage points. Despite a similar rise in the enrollment rate for those aged between 20 and 29 (typically corresponding to tertiary education), the Slovak Republic is still lagging behind the average of the EU-OECD countries by 5.9 percentage points.

Table 3. Selected Indicators of the Education System

Year	In public school (percent)	Enrollment rates		Net graduation rates		Student-teacher ratio			PISA (average)
		15-19	20-29	Upper secondary	Tertiary type A	Primary	Upper secondary	Tertiary type A	
1998	95.2	...	...	...	...	...	...	...	...
1999	95.1	...	...	...	...	19.6	13.8	...	...
2000	94.9	...	...	...	...	18.3	12.8	...	...
2001	94.8	74.4	12.1	...	...	20.7	12.9	...	...
2002	94.6	76.0	12.6	...	...	20.1	13.2	...	...
2003	94.1	79.7	13.2	...	...	19.4	14.0	...	487.3
2004	93.7	83.3	14.5	...	...	18.9	14.2	...	...
2005	92.5	84.7	16.0	82.7	30.1	18.9	14.3	...	...
2006	92.1	84.8	17.3	83.6	34.6	18.6	14.2	...	482.2
2007	91.9	85.5	18.5	84.7	38.9	17.9	14.1	...	...
2008	91.6	84.8	19.2	80.7	57.1	18.6	15.1	...	...
2009	91.2	85.1	20.1	81.1	61.4	17.7	15.1	15.6	...
2009 EU-OECD	88.5	82.2	26.0	82.1	16.5	13.8	11.8	15.1	492.4

Sources: Eurostat and OECD.

We now turn our attention to net graduation rates, which represent the estimated percentage of students from a specific age cohort who will complete the associated level of education, based on current patterns of graduation. Upper secondary education provides the basis for advanced learning and training opportunities and prepares some students for direct entry into the labor market. Net graduation for upper secondary education stabilized at rates higher than 80 percent. While this is comparable to the average of the sample group of countries, the graduation rates for tertiary education clearly outperform the EU-OECD average. This is particularly important as tertiary graduation rates indicate a country's capacity to produce workers with advanced, specialized knowledge and skills. While the remarkable increase in 2008 and 2009 is due to the recent introduction of new university degrees, an increasing number of students have been able to complete tertiary education, although the number of enrolled students is still modest.

Another key indicator that sheds light on the functioning of the education system is the student-teacher ratio. It indicates how resources for education are allocated and is sometimes used to identify the excessive use of inputs. The ratio for primary education decreased from 20.7 in 2001 to 17.7 students per teacher in 2009 (or a 14.5 percent reduction), but it is still 3.9 students higher than the EU-OECD average. A similar picture emerges for upper secondary education, when in 2009 there were 15.1 students per teacher, 3.3 students more for every teacher compared with the EU-OECD countries. This suggests that comparatively less inputs are used. Finally, the student-teacher ratio for tertiary education is essentially in line with the average of the countries in the sample.

As mentioned, PISA scores assess skills in reading, mathematics, and science. In this regard, PISA scores provide a measure of how well knowledge has been transferred to 15-year-old students. Here we take the average of the scores obtained in the three mentioned competence fields. Interestingly, most of the countries that registered higher student-teacher ratios than the Slovak Republic for primary education also have higher average PISA scores. This may suggest inefficiency in the learning process that goes beyond the number of teachers involved in schools' activities.

For the purposes of the DEA, education sector output can be measured by quantity indicators such as course enrolment and graduation rates. However, an approach that takes the quality of teaching and learning into account would be preferable as it would employ a measure of outcomes (i.e., the effective transfer of knowledge and skills). Thus, we use the sum of real primary and secondary education public expenditure per pupil in PPP terms as the input indicator and PISA scores as the output indicator. First, we compute the 5-year averages of the input and output variables for the period 2000–04 and 2005–09. The comparison between the two periods permits a dynamic analysis. Then, we perform a DEA on both time periods allowing for variable returns of scale, reflecting the fact that the production technology may exhibit increasing, constant, or decreasing returns to scale. We measure efficiency in terms of how much the input use of a country could contract, if used efficiently, in order to achieve the same output level (for further details see Appendix 1).

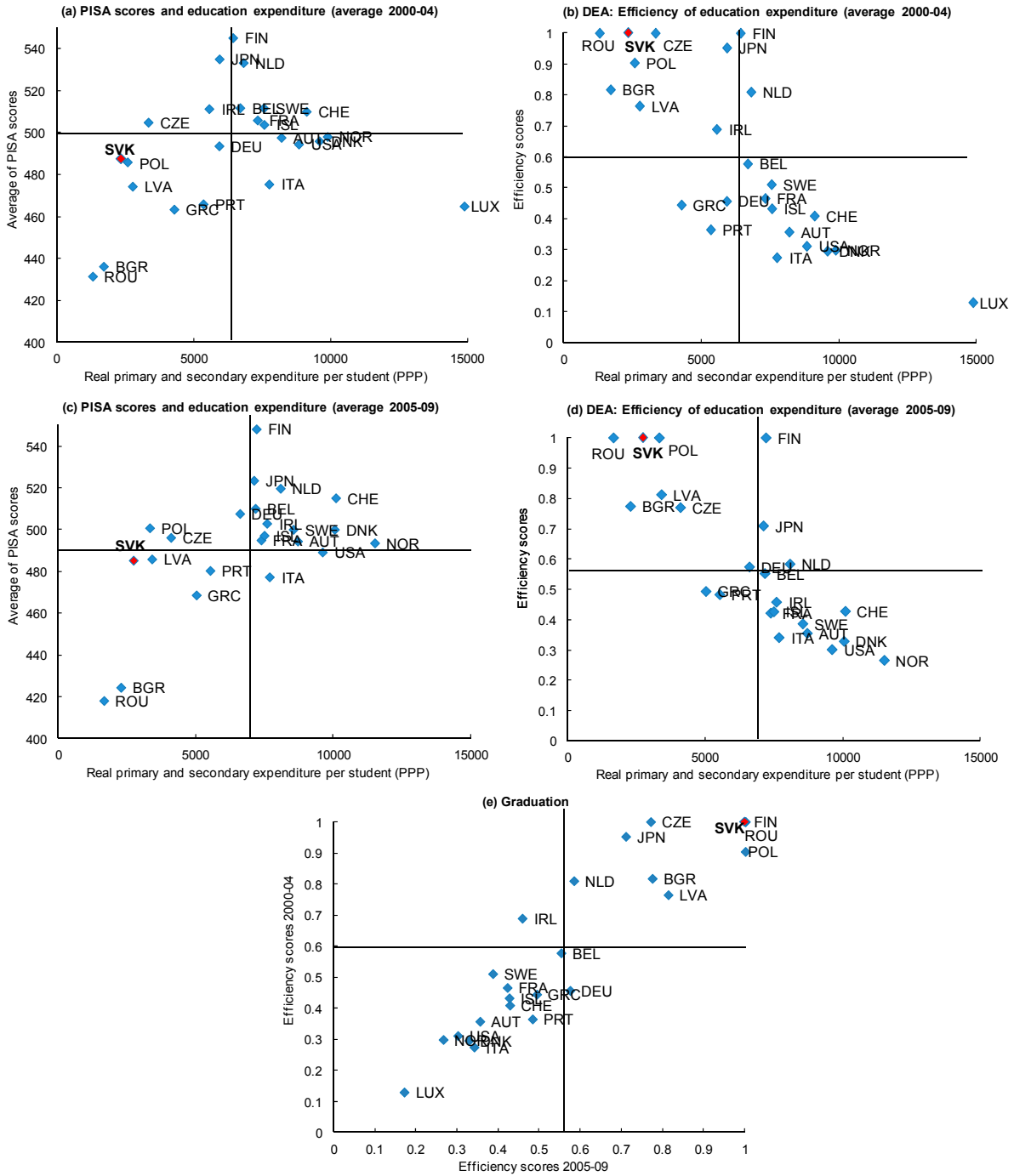
Panel (a) and (c) of Figure 9 display the relationship between real public expenditure in primary and secondary education and PISA scores in the two periods. The Slovak Republic shows almost no variation over time in terms of outcome and it is slightly below the sample average. On the other hand, real spending per student increased by 16.5 percent but remains one of the lowest of the group of countries considered. Panels (b) and (d) depict the production frontiers. The frontier is defined by Finland, Poland, Romania (the latter spends the least on primary education), and the Slovak Republic in 2005-09. With the exception of Poland, which is replaced by the Czech Republic, these are the same countries that define the frontier in 2000–04. These results suggest that the Slovak Republic has been one of the most efficient countries in the use of resources dedicated to primary and secondary education.

While this is an encouraging result, it could be argued that the DEA results may overstate the efficiency of secondary education spending. This is because the PISA scores reflect the skills of 15 year old students who are in the early to middle stages of secondary education. Thus, the satisfactory outcomes may be a result of efficient primary spending, rather than the combination of both efficient primary and secondary education spending.

Panel (e) shows which countries “graduated” to more efficient primary education expenditure. The black lines break the scatter plot into four quadrants and provide a clear way to check whether a country improved its efficiency over time with respect to the sample averages. While most of the countries continue to be inefficient and therefore position themselves in the lower left-hand quadrant, Ireland is in the upper left quadrant, meaning that the efficiency of education expenditure worsened beyond the sample average. Remarkably, only Germany is in the lower right hand quadrant, implying that they managed to move from a below- to above-the-average position. The Slovak Republic, along with Romania and Finland, can be found in the upper right corner, where efficiency is the highest in both periods. Other countries can be found in the upper right quadrant. Among these, only Latvia and Poland reduced the distance from the frontier, while Bulgaria, the Czech Republic, Japan, and the Netherlands worsened their relative position.

While the Slovak Republic appears efficient in the use of education resources, reforms nevertheless could be considered to make the budget more responsive to educational needs. With a falling number of students in primary and secondary education, a reduction in the overall education workforce could free up resources to further improve the quality and the effectiveness of education (e.g., resulting in higher PISA scores) and to target resources to the most needy students. It could also free up resources for other sectors. More generally, taking a medium-term perspective to the budget for the education sector (as in the Czech Republic, Estonia, Cyprus, and Romania) as well as giving a results or performance orientation to it (as in the Netherlands and Slovenia) could help to address these issues. At the same time, reforms aimed at augmenting competition could sharpen price signals and therefore regulate educational supply and demand choices.

Figure 9. Efficiency of Education Expenditure



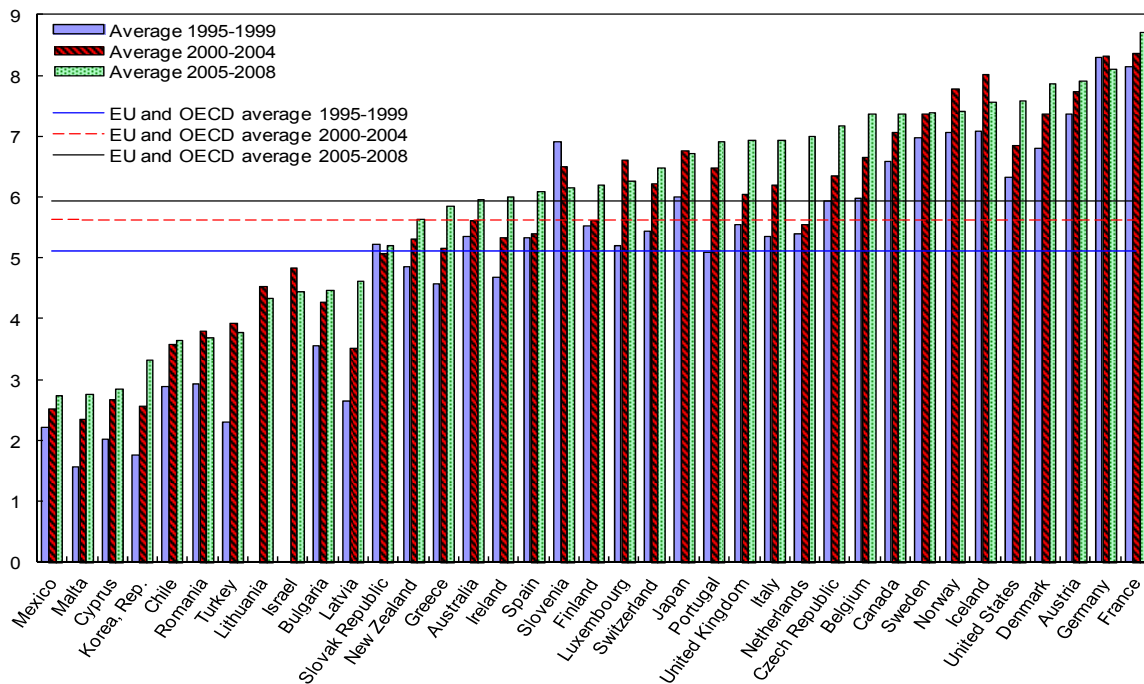
Sources: Eurostat, OECD, and IMF WEO.

B. Health

The Slovak Republic went through important reforms of the health sector during 2003-04. The reforms included (i) the introduction of co-payments for patients, (ii) creation of voluntary health insurance, (iii) establishment of state-owned health insurance companies as joint-stock companies and (iv) conversion of hospitals into non-profit semi-independent entities. These reforms were unpopular and did not succeed in resolving the financial problems of the sector as they were not sufficiently strong to achieve their intended objectives (Verhoeven and others, 2007b). As a result, the financial burden of the sector on public finances did not diminish and the new government that took office in 2006 reversed key elements of the reforms.

Figure 10 shows the amount of public resources allocated to the sector by EU-OECD countries. The Slovak Republic spent relatively little on health—some 5¼ percent of GDP per year, on average, over the last 13 years. During 1995–99, the amount of health expenditures as a share of GDP was in line with the EU-OECD average. But the sample average increased to almost 6 percent of GDP in the period 2005–08. Of the countries in the sample, only Germany reduced its spending on health over the same period, but the reduction was marginal and the country always spent more than 8 percent of GDP (the second highest figure in the sample).

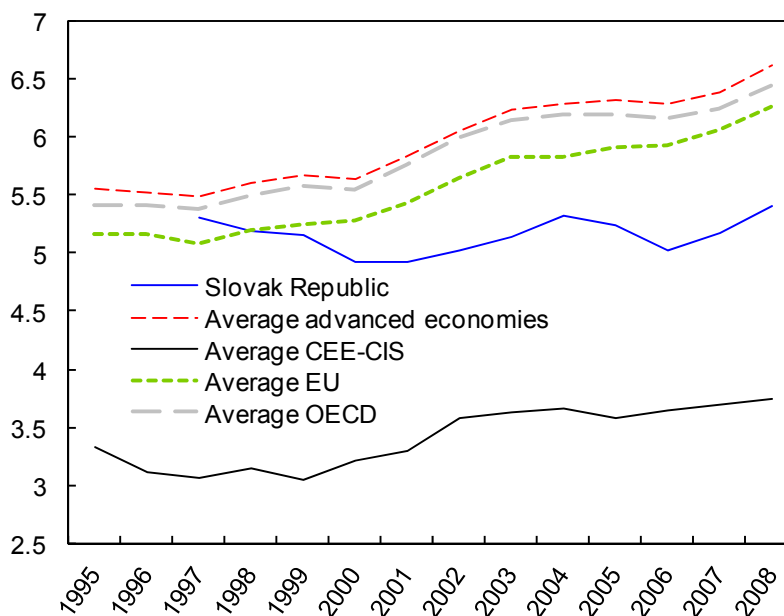
Figure 10. Health Expenditure across EU-OECD countries
(Percent of GDP)



Source: IMF Fiscal Affairs Department. Available at <http://www.imf.org/external/pubs/ft/sdn/2011/data/sdn1115.xls>.

Figure 11 reveals that the Slovak Republic reduced its expenditures by almost 1 percentage point of GDP since the 1997-2000 period. During the same years, advanced economies, EU, OECD, and CEE-CIS, increased their average spending ratio, albeit the latter spends considerably less than the other groups of countries. After 2000, the Slovak Republic's expenditures on health fluctuated between 5.0 and 5.4 percent of GDP, while the other groups of countries continued on an upward trend.

Figure 11. Health Expenditure
(Percent of GDP)



Source: IMF Fiscal Affairs Department. Available at <http://www.imf.org/external/pubs/ft/sdn/2011/data/sdn1115.xls>.

Table 4 presents a list of selected indicators of the Slovak Republic's health sector. The weight of the public sector in the health system decreased considerably during the last decade. Since 2008, public health expenditure as a share of total expenditure fell by 25.9 percentage points. In 2009, only 65.7 percent of the total expenditures are public, and this is 6.5 percentage points lower than the EU-OECD average.

In terms of health care resources, the Slovak Republic shows a persistent decrease in the numbers of physicians, nurses, and hospital beds. The density of nurses is lower than the EU-OECD average, although the density of physicians is in line with the sample average, and the number of beds is higher than the average for EU-OECD members.

Table 4. Selected Indicators of the Health System

Year	Public expenditure on health (percentage of total expenditure)	Health care resources			Health care activities		Health status	
		Physicians (per 1000 population)	Nurses (per 1000 population)	Hospital beds (per 1000 population)	Immunization measles (percentage of children immunized)	Immunization DTP (percentage of children immunized)	Life expectancy at birth (years)	Infant mortality (deaths per 1000 births)
1998	91.6	...	7.4	8.0	99.1	99.1	72.7	8.8
1999	89.6	...	7.2	8.0	99.3	99.1	73.1	8.3
2000	89.4	3.2	7.4	7.8	99.2	98.3	73.3	8.6
2001	89.3	3.2	7.3	7.7	99.1	99.4	73.6	6.2
2002	89.1	3.2	6.9	7.6	99.4	99.3	73.8	7.6
2003	88.3	3.1	6.5	7.2	99.3	99.3	73.8	7.9
2004	73.8	3.1	6.3	6.9	99.6	99.3	74.0	6.8
2005	74.4	...	6.0	6.8	99.5	99.2	74.0	7.2
2006	68.3	...	6.0	6.7	99.4	99.0	74.3	6.6
2007	66.8	3.0	6.3	6.8	99.5	99.4	74.3	6.1
2008	67.8	...	6.2	6.6	99.5	99.2	74.8	5.9
2009	65.7	...	6.0	6.5	98.9	99.1	75.0	5.7
2007 EU-OECD	71.0	3.0	7.9	5.2	93.4	94.8	78.9	4.7
2009 EU-OECD	72.2	3.1	8.2	5.3	93.4	95.2	79.3	4.4

Sources: WDI and OECD.

The indicators for health care outputs relative to peer countries provide a mixed picture. On the one hand, performance on immunizations is above average—less than 1 percent of the children are not immunized against measles and DTP. On the other hand, there is underperformance on life expectancy and infant mortality. Life expectancy is 75 years in 2009, 4.3 years lower than the sample average. Likewise, infant mortality is almost one death higher per 1000 births in the Slovak Republic than in the EU-OECD countries. Thus, as also documented in Verhoeven and others (2007b) and IMF (2011), there seems to be inefficiency in the process of transforming health care resources into health outcomes.

Panels (a) and (c) of Figure 12 present the scatter plots of health expenditures and life expectancy for the 2000–04 and 2005–08 periods, respectively. While the EU-OECD average real health expenditure per capita increased from 1,577 to 1,855 dollars in purchasing parity terms (a 17.7 percent increase), life expectancy recorded a 1 year increase from 72.2 years. The Slovak Republic's additional expenditures were not translated into outcomes at the same rate as in the sample. In fact, the country raised its health expenditure from 761 to 965 international dollars (26.8 percent increase), but experienced a lower increase in life expectancy between the two periods (0.73 years). Accordingly, Joumard and others (2010) indicate large potential gains in life expectancy if efficiency were at the level of the best performers in the sample.

Slovak Republic shows up far from the production frontier during the 2000–04 period and achieved an efficiency score of 0.4, as visible in panels (a) and (b). While this is only slightly below the average of the EU-OECD countries, it implies that to reach the same outcome

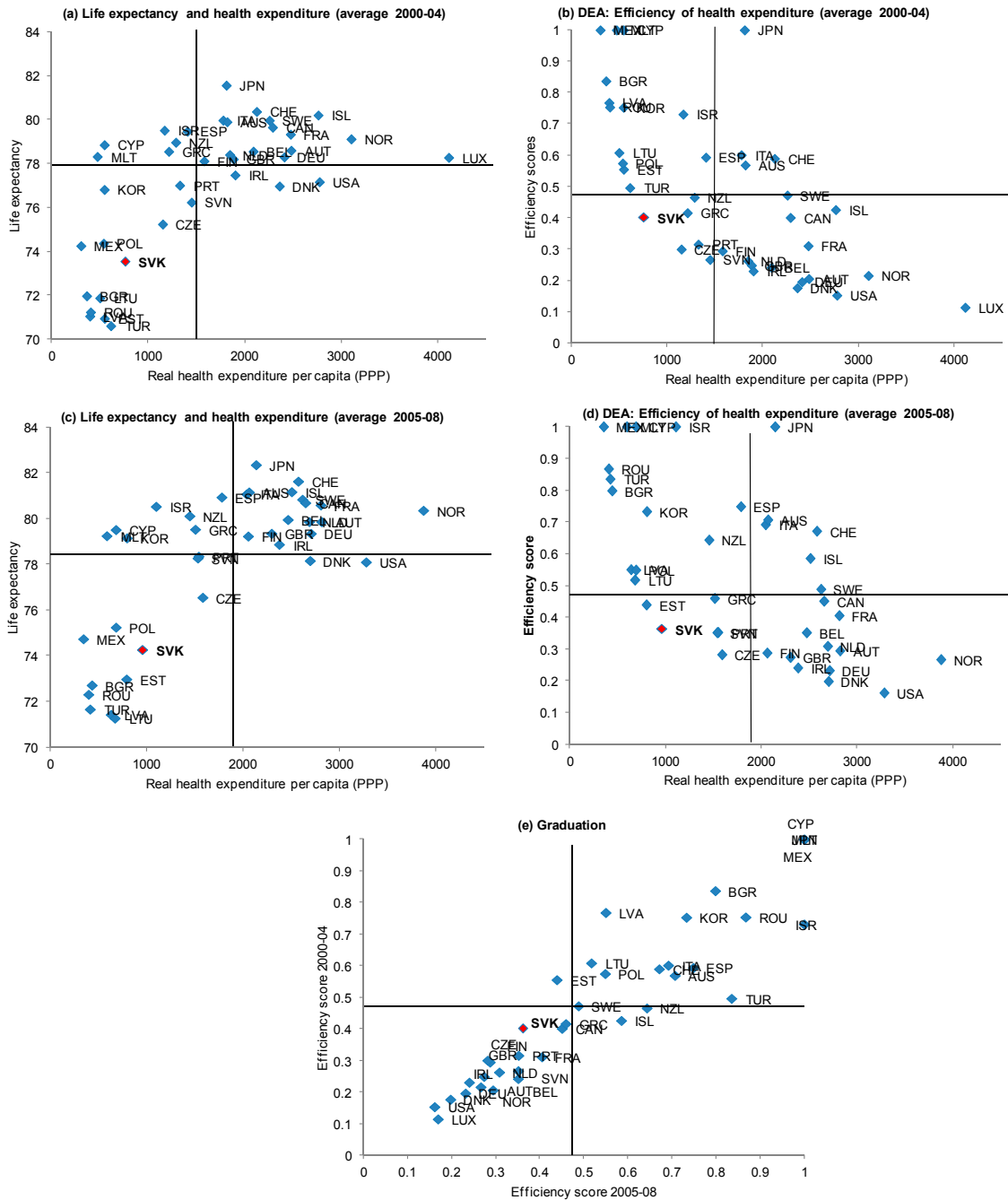
level, the Slovak Republic could have saved up to 60 percent of its financial resources if it operated at the same efficiency level of the most efficient countries in the sample (Cyprus, Israel, Japan, Malta, and Mexico). In other words, the room for savings seems large and is 9.1 percentage points larger than the sample average.

The analysis of the most recent period highlights a worsened performance. As shown in panel (d), while the sample average increased its efficiency by 4.5 percentage points, the Slovak Republic experienced a 4 percentage point reduction. This suggests that the room for savings expanded to 64 percent of the total health expenditures per capita, implying potential budgetary savings of 3.4 percent of GDP (0.5 percent of GDP more than in 2000–04).

Panel (e) displays the country in the lower left quadrant, implying that the Slovak Republic did not manage to catch-up to the EU-OECD average during the most recent period. Moreover, a larger horizontal distance from the sample average with respect to the vertical distance confirms that it lost ground against its peers. While the majority of the countries in the sample stayed in the same quadrant, Estonia and Lithuania worsened their positions and fell into the upper left quadrant, which implies a less efficient production of health outcomes with respect to the sample average. On the contrary, Iceland and the Netherlands are the only “graduated” countries in the lower right quadrant, hence moving to a more efficient production of health outcomes.

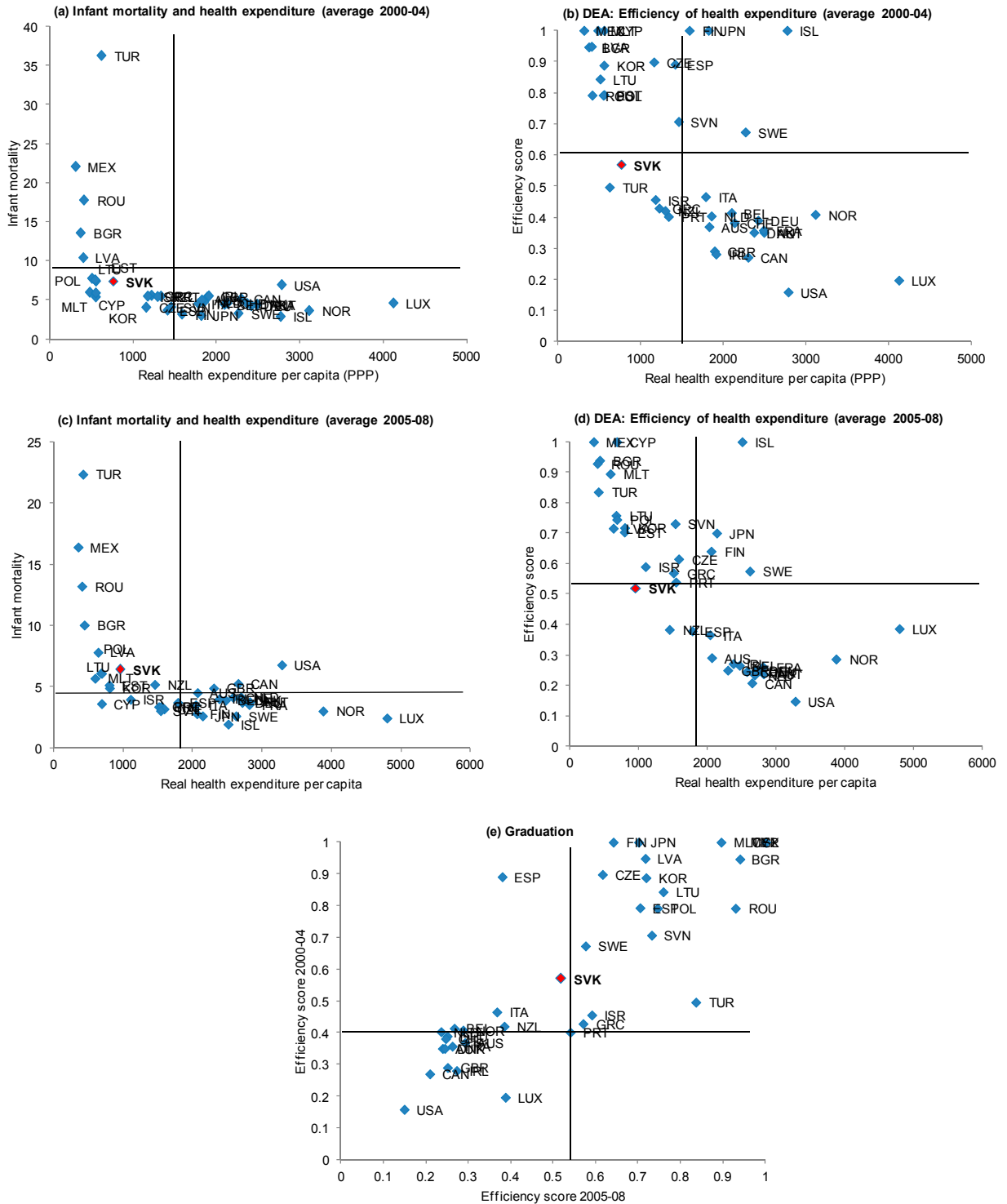
We also ran a DEA with infant mortality as the output indicator. As can be observed in panels (a) and (c) of Figure 13, the Slovak Republic improved its relative position from 2000–04 to 2005–08, reducing infant mortality by 13.2 percent (or by one infant per 1,000 live births). However, this was not sufficient to outperform the EU-OECD average that fell by 18.9 percent. Once again, it seems that the additional spending produced a more modest outcome than in other EU-OECD countries. The efficiency score’s reduction from one period to the other observed in panels (b) and (d) confirms this picture. If the Slovak Republic’s outcome in 2000–04 was achievable with 57 percent of the resources actually utilized, the outcome of 2005–08 became achievable with only 52 percent of them, assuming that the country operated with the same efficiency of the most efficient countries in the sample (Cyprus, Mexico, and Iceland). However, it is worth noting that the efficiency scores of both periods are only slightly below the EU-OECD average. This is also discernible from panel (e), in which the Slovak Republic remains in the lower left quadrant.

Figure 12. Efficiency of Health Expenditure—Life Expectancy



Sources: WDI and IMF WEO.

Figure 13. Efficiency of Health Expenditure—Infant Mortality



Sources: WDI and IMF WEO.

Medium-term consolidation plans limit the possibility of expenditure increases for health and other sectors. At the same time rising income, population aging, and improved medical technologies continue to put upward pressures on health care costs. Thus, fiscal constraints force governments to intensify efforts to increase efficiency. The experience of advanced economies indicates a number of policy options for containing the growth of public health care outlays (Clements, Coady, and Gupta, 2012). For example, Italy, Japan, and Sweden make use of budget caps and central oversight of budget allocations. Germany and Japan strengthened the role of market mechanisms by introducing greater competition and choice. The United Kingdom and Sweden allowed greater competition among hospitals. Extending the use of supplementary and complementary private insurance also has a dampening effect on the growth of health care costs. Australia, Canada, and France rely significantly on private insurance for services not covered by publicly-provided health insurance. To contain spending, payment methods have shifted from traditional fee-for-service methods to case-based payments¹⁰ in Finland, Germany, Italy, and the United Kingdom. Other demand-side reforms include abolishing tax deductions for medical expenses, as in Finland.

In the Slovak context, the opportunities for improving outcomes while keeping spending constant are large (see also Joumard and others, 2010). As suggested in Clements, Coady, and Gupta (2012), budget caps and central oversight of budget would contribute to contain costs, as well as increasing the role of the private insurance and increasing competition could help substantially. Reforms such as allowing freedom to insurers in negotiating and contracting with health providers could help to achieve these objectives. Increasing the role of cost sharing would contribute to raising the awareness of consumers, but this should be done carefully to avoid any deterioration in health outcomes (see Gruber, 2006). Replacing fee-for-service with lump-sum amounts would generate incentives for practitioners to be cost-effective. Other efficiency-enhancing reforms include reducing the cost of hospital care and privatizing hospitals (see Verhoeven and others, 2007b), and containing pharmaceutical costs by encouraging physicians to prescribe the substance or pharmacists to supply the cheapest generic drug. In this regard, ongoing reforms aimed at tightening reference pricing for pharmaceuticals and standardizing the reimbursement for medical procedures classified by diagnosis treatment should help lower health costs.

V. CONCLUDING REMARKS

The Slovak Republic experienced the highest spike in real public expenditure from 2007 to 2009, more than doubling the average increase of 7.7 percent in Europe and other advanced economies. Moreover, the country has a relatively large share of committed expenditure (i.e., subsidies, social benefits, and interest payments), which has increased over time, contributing

¹⁰Third-party payers pay physicians/ hospitals according to the cases treated rather than per service or per bed days.

to a rigid expenditure structure. Compared with the average for the EU-OECD countries, the overall composition of public expenditures shows a larger share devoted to social benefits, accounting for almost half of total expenditures, while the wage bill is considerably smaller. In terms of total expenditures, the already small share of subsidies has declined progressively since 1998 but has been volatile. There has been a steadier decline in the share of interest payments, which fell from 9.0 percent of total expenditures in 2001 to 3.5 in 2009. After a consistent decline since 2001, acquisitions of NFA rebounded in 2009.

Compared with its peer countries, the Slovak Republic spends less on education and health. The DEA suggests that public expenditures in primary and secondary education have produced desirable results in a relatively efficient manner. The health system, however, is inefficient in the process of converting health care resources into health outcomes. This is confirmed by the DEA that places the Slovak Republic a large distance from the efficiency frontier defined by the most efficient countries in the sample. The results suggest that reducing inefficiencies in public health spending could save up to 3.5 percent of GDP without sacrificing health outcomes.

Reforms could help improve the efficiency of public spending in both sectors. In education, reforms could be considered to formulate the budget in a medium-term framework, improve the sector's responsiveness to changes in the school population, and increase competition in the supply of public services. Some efficiency-enhancing reforms in the health sector include allowing greater competition with the private insurance sector, increasing cost sharing, privatizing hospitals, and strengthening incentives for practitioners to provide health services in a cost-effective manner.

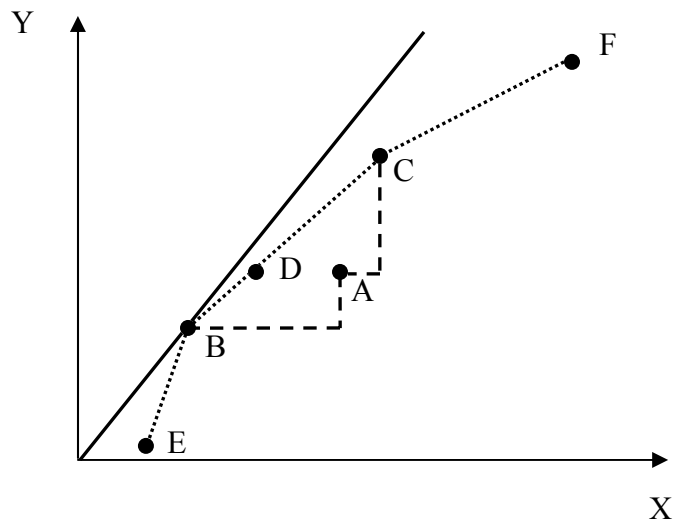
Appendix 1. The DEA Approach

The key constructs of a DEA model are the envelopment surface and the efficient projection path to the envelopment surface (see Charnes and others 1995). The projection path to the envelope surface is determined by whether the model is output-oriented (maximizing the level of output given levels of the inputs) or input-oriented (minimizing the use of inputs to produce a given level of output). The selection of the path depends on the production process characterizing the DMU. The input orientation is better suited to cross-country analysis aimed at expenditure rationalization. With input-oriented DEA, the linear programming model is configured so as to determine how much the input use of a firm could contract if used efficiently in order to achieve the same output level.

Different from parametric techniques, DEA calculates the frontier directly from the data without imposing specific functional restrictions and considers all deviations from the frontier explained by inefficiency. It assumes that different combinations of the observed input-output bundles are feasible. Thus, DEA constructs an envelope around the observed combinations by connecting all the efficient DMUs.

Figure 1 shows the DEA production possibility frontier, where X is the input and Y is the output. While the free disposal hull (FDH) approach builds the frontier with vertical steps-up and assesses efficiency of DMU A only against the peers B and C , DEA evaluates efficiency also against a virtual DMU D , which employs a weighted combination of A and C inputs to yield a virtual output. Therefore, while FDH would have considered A as efficient, DEA puts it behind the efficiency frontier defined by $EBCF$. The input-oriented technical efficiency of A is defined by the ratio YD/YA .

Appendix Figure 1. DEA Production Possibility Frontier



The envelopment surface will differ depending on the scale assumptions that underpin the model. These could be constant returns to scale (CRS) or variable returns to scale (VRS). The latter includes both increasing and decreasing returns to scale.¹¹ The frontier *EBCF* exhibits VRS. In particular, while the segment *EB* is characterized by increasing returns to scale, the segments *BC* and *CF* reflect decreasing returns to scale. The CRS frontier can be visualized by a ray extending from the origin through DMU *B*, which would be the only efficient one.

More formally, Charnes and others (1978) defined a multi-factor productivity analysis model assuming that there are n homogeneous DMUs which efficiency has to be assessed. Each uses different quantities of different m inputs to produce different s outputs. Thus, in the presence of multiple input and output factors the relative efficiency of DMU p is measured with a ratio of a weighted sum of outputs to a weighted sum of inputs:

$$\frac{\sum_{k=1}^s v_k y_{kp}}{\sum_{j=1}^m u_j x_{jp}} \quad (1)$$

where $k = 1, 2, \dots, s, j = 1, 2, \dots, m, y_{kp}$ is the amount of output k produced by DMU p, x_{jp} is the amount of input j used by DMU p, v_k is the weight given to output k, u_j is the weight given to input j . However, without other constraints, (1) would be unbounded. Under the restriction that the efficiencies of all DMUs are less than or equal to one, and that all weights are non-negative, the optimal weights are defined by solving the programming problem:

$$\text{Max } \frac{\sum_{k=1}^s v_k y_{kp}}{\sum_{j=1}^m u_j x_{jp}} \quad (2)$$

subject to:

$$\begin{aligned} \sum_{k=1}^s v_k y_{ki} / \sum_{j=1}^m u_j x_{ji} &\leq 1 \quad \forall i \\ v_k &\geq 0 \quad \forall k \\ u_j &\geq 0 \quad \forall j \end{aligned}$$

The fractional program in (2) is equivalent to following linear one:

$$\text{Max } \sum_{k=1}^s v_k y_{kp} \quad (3)$$

subject to:

$$\begin{aligned} \sum_{k=1}^s v_k y_{ki} - \sum_{j=1}^m u_j x_{ji} &\leq 0 \quad \forall i \\ v_k &\geq 0 \quad \forall k \\ u_j &\geq 0 \quad \forall j \end{aligned}$$

¹¹Cooper and others (2000) provide a discussion of methods for determining returns to scale.

The problem in (3) will need to be solved n times to calculate the efficiency scores of all the DMUs. A score equal to one implies that the maximum output has been achieved with the available inputs. A score lower than one suggests some inefficiency. When we want the model to be input-oriented, the dual problem in (4) should be solved:

$$\begin{aligned}
 & \text{Min } \Theta && (4) \\
 & \text{subject to:} \\
 & \sum_{i=1}^n \lambda_i x_{ji} - \Theta x_{jp} \leq 0 \quad \forall j \\
 & \sum_{i=1}^n \lambda_i y_{ki} - y_{kp} \geq 0 \quad \forall k \\
 & \lambda_i \geq 0 \quad \forall i
 \end{aligned}$$

where λ s represent the dual variables and Θ is the input-oriented technical efficiency score, measuring the extent to which every DMU could reduce inputs to obtain the same output.

References

- Aigner, Dennis, and Shih-fan Chu, 1968, "Estimating the Industry Production Function," *American Economic Review*, Vol.58, pp. 826–39.
- Afonso, António, and Miguel St. Aubyn, 2005, "Cross-country Efficiency of Secondary Education Provision: a Semi-parametric Analysis with Non-discretionary Inputs," European Central Bank, Working Paper No. 494.
- , and Victor Gaspar, 2007, "Dupuit, Pigou and Cost of Inefficiency in Public Services Provision," *Public Choice*, Vol. 132, No. 3, pp. 485–502.
- , Ludger Schuknecht, and Vito Tanzi, 2005, "Public Sector Efficiency: an International Comparison," *Public Choice*, Vol. 123, pp. 321–47.
- , and Vito Tanzi, 2010, "Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets," *Applied Economics*, Vol. 42, No. 17, pp. 2147–64.
- Charnes, Abraham, William W. Cooper, and Eduardo Rhodes, 1978, "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*, Vol. 2, pp. 429–44.
- Chu, Ke-young, and Richard Hemming, 1991, *Public Expenditure Handbook* (Washington: International Monetary Fund).
- Clements, Benedict, 1999, "The Efficiency of Education Expenditure in Portugal," IMF Working Paper 99/179.
- , 2002, "How Efficient is Education Spending in Europe," *European Review of Economics and Finance*, Vol. 1, No. 1, pp. 3–26.
- , David Coady, and Sanjeev Gupta, 2012, *The Economics of Public Health Care Reform in Advanced and Emerging Economies* (Washington: International Monetary Fund).
- Cooper, W. William, Lawrence M. Seiford, and Kaoru Tone, 2000, "Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software," Kluwer Academic Publishers, Boston.
- Debreu, Gerard, 1951, "The Coefficient of Resource Utilization," *Econometrica*, Vol. 19, pp. 273–92.

- ECB, 2006, "The Importance of Public Expenditure Reform for Economic Growth and Stability," ECB Monthly Bulletin, pp. 61–73.
- Farrell, Michel J., 1957, "The Measurement of Productive Efficiency," *Journal of the Royal Statistical Society*, Vol. 120. No. 3, pp. 253–90.
- Gruber, Jonathan, 2006, "The Role of Consumer Copayments for Health Care: Lessons from the RAND Health Insurance Experiment and Beyond," Washington, D.C., the Henry J. Jausser Foundation.
- Hadi, Ali S., and Robert F. Ling, 1998, "Some Cautionary Notes on the Use of Principal Components Regression," *The American Statistician*, Vol. 52, pp. 15–9.
- Hauer, David, 2007, "Benchmarking the Efficiency of Public Expenditure in the Russian Federation," IMF Working Paper 07/246 (Washington: International Monetary Fund).
- IMF, 2011, "Staff Report for the Article IV Consultation," June, <http://www.imf.org/external/pubs/ft/scr/2011/cr11122.pdf>.
- Joumard, Isabelle, Christophe André, and Chantal Nicq, 2010, "Health Care Systems: Efficiency and Institutions," OECD Economics Department Working Papers, No. 769, OECD Publishing.
- Koopmans, Tjalling C., 1951, "Analysis of Production as an Efficient Combination of Activities," in T.C. Koopmans, ed. *Activity Analysis of Production and Allocation* Wiley, New York.
- Mandl, Ulrike, Adriaan Dierx, and Fabienne Ilzkovitz, 2008, "The effectiveness and efficiency of public spending," *Economic Papers*, no. 301, European Commission.
- Sopek, Petar, 2011, "Efficiency of Public Expenditure on Education in Croatia," *Institute of Public Finance*, No. 61, September.
- Spinks, Jean, and Bruce Hollingsworth, 2009, "Cross-country Comparisons of Technical Efficiency of Health Production: a Demonstration of Pitfalls," *Applied Economics*, Vol. 41, pp. 417–27.
- Theil, Henri, 1980, *System-Wide Explorations in International Economics, Input-Output Analysis and Marketing Research*, Amsterdam: North-Holland

Verhoeven, Marijn, Vitoria Gunnarsson and Stéphane Carcillo, 2007a, "Education and Health in G7 Countries: Achieving Better Outcomes with Less Spending," IMF Working Paper 07/263. (Washington: International Monetary Fund).

———, and Sergio Lugaresi, 2007b, "The Health Sector in the Slovak Republic: Efficiency and Reform," IMF Working Paper 07/226. (Washington: International Monetary Fund).