OECD Economics Department Working Papers No. 1278

Public Spending Efficiency in the OECD: Benchmarking Health Care, Education and General Administration

Richard Dutu,

Patrizio Sicari

https://dx.doi.org/10.1787/5jm3st732jnq-en

OECD

Unclassified **ECO/WKP(2016)2**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **11-Feb-2016**

English - Or. English

ECONOMICS DEPARTMENT

ECO/WKP(2016)2
Unclassified

PUBLIC SPENDING EFFICIENCY IN THE OECD: BENCHMARKING HEALTH CARE, EDUCATION AND GENERAL ADMINISTRATION

ECONOMICS DEPARTMENT WORKING PAPERS No. 1278

By Richard Dutu and Patrizio Sicari

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the author(s).

Authorised for publication by Robert Ford, Deputy Director, Country Studies Branch, Economics Department.

All Economics Department Working Papers are available at www.oecd.org/eco/workingpapers

JT03390018

Complete document available on OLIS in its original format
This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

English - Or. English

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the author(s).

Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works.

Comments on Working Papers are welcomed, and may be sent to OECD Economics Department, 2 rue André Pascal, 75775 Paris Cedex 16, France, or by e-mail to eco.contact@oecd.org.

All Economics Department Working Papers are available at www.oecd.org/eco/workingpapers.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

© OECD (2016)

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for commercial use and translation rights should be submitted to **rights@oecd.org**

ABSTRACT/RÉSUMÉ

Public Spending Efficiency in the OECD: Benchmarking Health Care, Education and General Administration

In many OECD countries changes in demography and health conditions are putting pressure on public finance. To prevent further expansion of government spending as a percentage of GDP, public spending efficiency will need to be raised. This paper uses data envelopment analysis (DEA) to assess the efficiency of welfare spending in a sample of OECD countries around 2012, focussing on health care, secondary education and general public services. The DEA model has a two input-one output structure, with at least one of the variables representing a composite indicator controlling for country-specific factors (socio-economic environment and life-style factors, for example). We find wide dispersion in efficiency measures across OECD countries and provide possible quantified improvements for both output and input efficiency.

JEL classification: H11, H51, H52.
Keywords: Public spending, efficiency, DEA, nonparametric, education, health care, administration.

****

Efficience de la Dépense Publique dans l'OCDE: Évaluation des secteurs de la Santé, l'Éducation et l'Administration Générale

Les changements en cours en matière de démographie et de santé dans de nombreux pays de l'OCDE exercent une pression sur les finances publiques. Pour éviter une hausse continue des dépenses publiques en pourcentage du PIB, l'efficience des dépenses publiques devra être augmentée. Ce document utilise l'analyse dite *data envelopment analysis* (DEA) pour évaluer l'efficience des dépenses publiques en 2012 dans un échantillon de pays de l'OCDE dans le domaine de la santé, de l'enseignement secondaire et de l'administration générale. Le modèle DEA a une structure à deux entrées - une sortie, avec au moins une des variables représentant un indicateur composite afin de contrôler les spécificités de chaque pays (environnement socio-économique et les facteurs de style de vie, par exemple). Nous trouvons une grande divergence des mesures d'efficience de la dépense publique au sein de pays de l'OCDE, et mesurons les améliorations possibles pour chaque pays en termes d'efficience.

Classification JEL : H11, H51, H52.
Mots clefs: Dépense publique, efficience, DEA, non-paramétrique, éducation, santé, administration.

TABLE OF CONTENTS

PUBLIC EXPENDITURE EFFICIENCY IN THE OECD: BENCHMARKING HEALTH CARE, EDUCATION AND GENERAL ADMINISTRATION 5

Data envelopment analysis 6
Literature overview 7
Areas of public expenditure 8
Health care 8
Education 10
General services 12
Conclusion 15

BIBLIOGRAPHY 15

ANNEX 17

Figures

1. Government spending and employment 5
2. Example of an efficiency frontier 6
3. Average annual total healthcare spending in OECD countries 9
4. Life expectancy at birth and average annual per capita spending on healthcare in OECD countries 9
5. Potential efficiency gains in health care 10
6. Average annual spending on secondary education in OECD countries 11
7. PISA synthetic scores and average annual secondary education spending per student 11
8. Potential efficiency gains in secondary education 12
9. Average annual general public service spending in OECD countries 13
10. Public administration performance and average annual per capita spending on general services 14
11. Potential efficiency gains in public administration 14

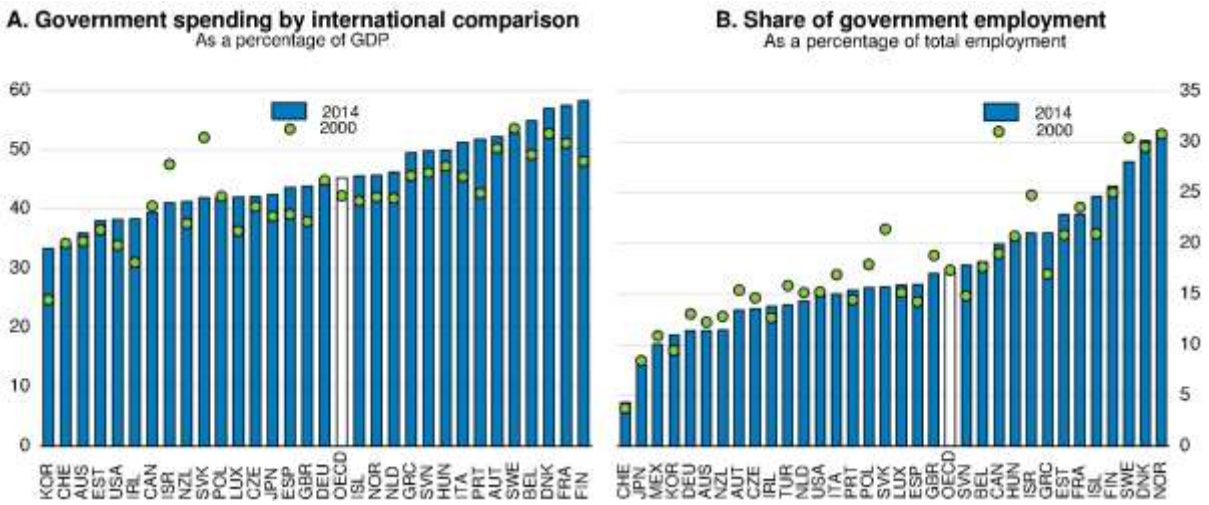
A.1. Confidence intervals for secondary education efficiency in 2012 17
A.2. Confidence intervals for health care efficiency in 2012 18
A.3. Confidence intervals for health care efficiency in 2012 (II) 19
A.4. Potential efficiency gains in health care, 2012 (II) 20
A.5. Confidence intervals for health care efficiency in 2012 (II) 21
A.6. Total current expenditure on health by main source of financing, 2014 22
A.7. Expenditure on educational institutions by source of funding, 2012 22

PUBLIC EXPENDITURE EFFICIENCY IN THE OECD: BENCHMARKING HEALTH CARE, EDUCATION AND GENERAL ADMINISTRATION

By Richard Dutu and Patrizio Sicari[1]

The falling ratios of workers to retirees in many OECD countries are jeopardising their old-age pension systems. Similarly, the rise in life expectancy and chronic medical conditions are pushing up health expenditures, especially for long-term care. Demand for education is also high, as productivity gains will need an increasingly educated workforce to be sustained. While demand for public expenditure keeps rising, government spending in OECD economies already represented 45% of GDP in 2014 (Figure 1). This proportion is up from 35% in 1970 and 24% in 1937 (Tanzi and Schuknecht, 2000).

Figure 1. **Government spending and employment**



Source: OECD, Economic Outlook No. 98 Database

Meeting those demands while keeping public spending under control will require improving public spending efficiency. To help assess the room for improvement, this paper proposes to measure efficiency of public expenditure in three key areas of public policy: health care, education and general administration. Evaluating the efficiency of public expenditure is done using Data Envelopment Analysis (DEA). The idea is to evaluate the relative efficiency with which inputs are turned into output (i.e. 'production efficiency') by comparing a country's outcome in a particular area of public policy with that of the best performing countries. This measure of production efficiency will allow to determine to what extent output – e.g. PISA

1. Richard Dutu is an economist and Patrizio Sicari is a statistician in the Economics Department of the OECD; e-mails: richard.dutu@oecd.org and patrizio.sicari@oecd.org. The authors are thankful to Jens Arnold, Matevz Hribernik, Stéphane Jacobzone, Rafal Kierzenkowski, Peter Jarrett and Petar Vujanovic for their valuable comments and suggestions. Special thanks are due to Krystel Rakotoarisoa for technical preparation.

scores, i.e. the Programme for International Student Assessment which evaluates education systems worldwide by testing the skills and knowledge of 15-year-old students in mathematics, science, and reading – can be increased (compared to best-practice) while keeping inputs constant. Similar attention will be given to measures of input efficiency, which focus on the extent by which the same output can be attained by means of reduced inputs – e.g. education spending.

Our approach is then about measuring production efficiency. But the assessment of public spending efficiency also depends on factors that are not directly examined here, such as regulatory policies and the characteristics of the tax system. How public expenditure is allocated among the various tasks assigned to the government, i.e. the optimal allocation of public funds, also matters. Indeed, the public sector generally operates under a set of institutional arrangements (such as debt break rules or fiscal equalisation schemes) that affect the allocation of public funds across levels of government and between areas of expenditure. Such spending constraints may in the future crowd out other important expenditure categories, such as research or infrastructure. Those other factors are at best indirectly captured here.

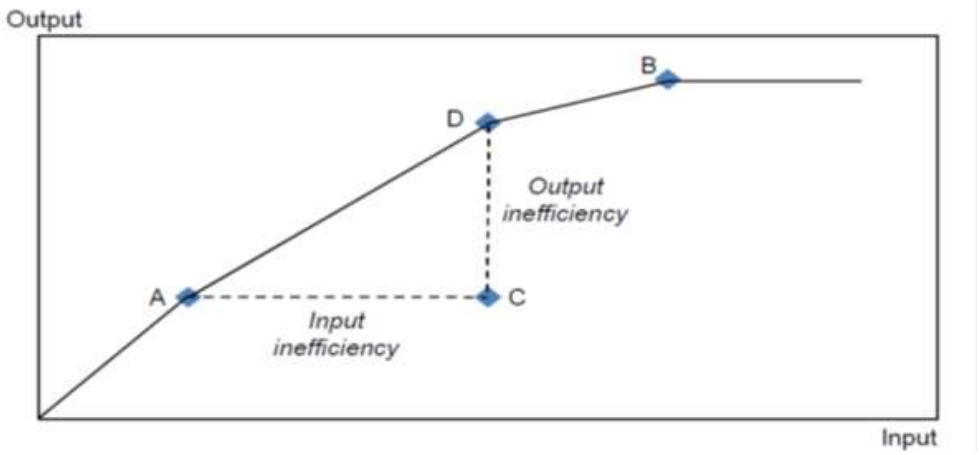
The first part of this paper details the methodology being used and provides a brief literature review. Measures of public spending efficiency, both for output and inputs, are then discussed for the areas of health care, education and general administration.

Data envelopment analysis

Data Envelopment Analysis (DEA) is a non-parametric statistical technique used to assess the relative efficiency of public spending. Using linear programming, a frontier of best-practice countries is constructed based on input-output data, which is then used as a benchmark against which the performance of less efficient units can be assessed. The estimated frontier thus "envelops" all available observations, and each deviation from that frontier is interpreted as an inefficient combination of inputs and/or outputs. Farrell (1957) first suggested that such linear convex hull approach could be used for estimating the frontier of production possibilities and measuring efficiency. Charnes et al. (1978) then formalised the DEA methodology using linear programming to construct the frontier.

A country's relative distance to the DEA-estimated frontier is interpreted as a measure of achievable efficiency gains. When plotting the inputs on the X axis and the output on the Y axis, the vertical distance from the efficiency frontier shows to what extent output could be expanded while keeping inputs constant. Such distance represents 'output inefficiency'. Similarly, the horizontal distance from the frontier measures the extent to which inputs could be reduced without affecting output, i.e. 'input efficiency' (Figure 2).

Figure 2. **Example of an efficiency frontier**



Compared to parametric approaches to measuring relative efficiency, such as Stochastic Frontier Analysis (SFA), DEA does not require assumptions on the underlying production function, even if it still assumes that the latter is common to all units. In addition, DEA can be used to construct efficiency measures by taking into account multiple inputs and outputs, which is precluded from SFA. Concerning the shape of the efficiency frontier, non-increasing returns to scale are assumed. The analysis itself is conducted in the language R using the FEAR package (Wilson, 2006).

DEA models have their own drawbacks, however. DEA estimates of relative efficiency depend on the composition and size of the sample, as well as on the choice of the input and output variables to be included. Efficiency estimates are likely to be biased by the presence of outliers, measurement errors and statistical noise. Moreover, when the DEA approach is applied to a large number of inputs and/or outputs relative to a limited number of decision units (small sample), the number of efficient units will be overestimated, implying smaller estimates of inefficiency. Another drawback of the DEA approach is that it may underestimate inefficiencies by implicitly assuming that countries on the frontier are efficient even though they, too, may have room for savings or better outcomes. Finally, a measure of efficiency in health care (or any other areas of public spending) that aggregates across regions and institutions may hide important within-sector efficiency differentials (Agasisti and Zoido, 2012; Kalb et al., 2012).

This paper applies DEA to a sample of OECD countries, for which the quality of production factors is expected to be more homogeneous and measurement errors possibly less pronounced. As such, the paper places itself in a stream of previous OECD studies (Sutherland et al., 2007; Joumard et al., 2010; Hribernik and Kierzenkowski, 2013), of which it represents an update. Following Hribernik and Kierzenkowski (2013), efficiency is assessed with reference to spending on health care, secondary education and general public administration. An approach based on spending areas rather than overall public spending efficiency is generally considered more effective when dealing with cross-country data (Mandl et al., 2008). Assessing efficiency and effectiveness of aggregate public expenditure is indeed made difficult by multiple – sometimes conflicting – objectives as well as by diverging ways of quantifying output across spending areas. For that reason it is often preferable to focus on specific areas of public expenditure. From a public policy point of view, it also makes it easier to identify sectoral public policies that work. Switzerland, for instance, performs well in general public administration, but relatively worse than the OECD average in education and health in terms of input efficiency. It may then come out with a reasonable overall input efficiency score, which however hides some key differences across areas of public expenditure.

In order to limit the above described small sample size bias the applied DEA models have a "two input - one output" structure, with at least one of the variables representing a composite indicator, usually with the scope of controlling for factors that do influence the outcome variable but are not directly related to the health and education systems (socio-economic environment and life-style factors, for example). The small sample bias is further corrected by bootstrapping the DEA efficiency scores following Simar and Wilson (2005), which allows us to produce confidence intervals around the point estimates[1].

Literature overview

The vast majority of the literature on public spending efficiency focusses on cross-country public spending efficiency in health care and education. Herrera and Pang (2005) apply DEA to assess the efficiency of public expenditure in both sectors for a sample of 140 developing countries between 1996 and 2002. They find that efficient spending is associated with lower expenditure levels, wage bills and public provision of services, as well as with lower income inequality. With specific reference to education spending, Afonso and St. Aubyn (2005) use a two-stage procedure and regress DEA output scores on environmental variables as independent variables for a sample of 25 countries (mostly OECD members) to assess the efficiency of publicly provided secondary education. They find that inefficiency is strongly related to GDP per capita and adult educational attainment. Other studies applying DEA (and SFA) to

assess the efficiency of secondary education include Sutherland et al. (2007), while St. Aubyn et al. (2009) apply a similar approach to public tertiary education systems.

Several papers have attempted to measure aggregate public spending efficiency. Using a sample of 23 advanced OECD economies and a sample including the new EU member states, Afonso et al. (2005, 2006) compute efficiency scores based on the use of composite indicators of public sector performance and effectiveness[2] as output variables. Afonso et al. (2005) find diminishing marginal returns of higher public spending, showing that – on average – advanced economies with smaller public sectors display a more efficient provision of public services. Disentangling between areas of public expenditure, we provide a more detailed picture, showing for instance that Switzerland has an efficient general administration sector, but could do better in education and health care. Afonso et al. (2005) also show that input inefficiencies are usually larger than output-related ones. In our paper, again, this depends on the area of public expenditure under consideration.

As for studies on the efficiency of health-care expenditure specifically, Joumard et al. (2010) find that measured efficiency is heavily influenced by the institutional framework. The allocation of resources between in- and out-patient care, the payment schemes and the possible existence of incentives for providers are all institutional features that are likely to have a strong impact on efficiency scores. Medeiros and Schwierz (2015) find ample evidence of widespread inefficiency in the health-care systems of EU countries. Their DEA-based analysis shows that average healthy life expectancy in the European Union could be increased by 6.1 years at birth by moving to the efficiency frontier. Afonso and St. Aubyn (2010), applying the same two-stage procedure used in Afonso et Aubyn (2005) highlight that inefficiency in health-care expenditure is strongly related to factors that, in the short/medium term, are beyond the direct control of the government policy action: GDP per capita, adult educational attainment, obesity and smoking habits.

Areas of public expenditure

Health care

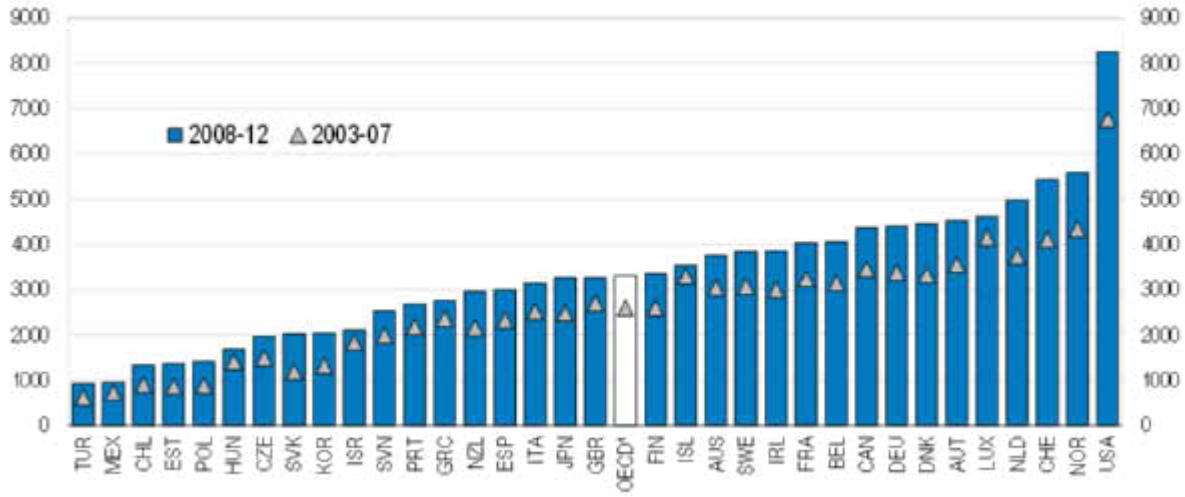
The calculation of efficiency scores for health care is undertaken using life expectancy at birth as a proxy of the health system's outcomes. Life expectancy has the advantage of being a very broad measure of population health and is correlated with other indicators of health status. In addition to Joumard et al. (2010) and Hribernik and Kierzenkowski (2013), we also conduct the DEA using health-adjusted life expectancy, i.e. measuring the average number of years that an individual is expected to live in a healthy state (see Appendix A.1). Since life expectancy is likely to be driven also by factors that do not necessarily have a direct causal link to the health-care system, the variable representing the monetary value of inputs (total per capita expenditure on health care) is complemented by a second input variable capturing the effects of the socio-economic environment and lifestyle factors. GDP per capita, adult educational attainment, nitrogen oxide emissions, fruit and vegetables as well as alcohol and tobacco consumption are the variables aggregated (with equal weights) into the latter composite environment indicator.

Life expectancy has increased significantly in the OECD over the past few decades, jumping from 69.9 years in 1970 to 80.4 years in 2013. Most recently, life expectancy has increased by 2.6 years in the last 10 years. At the same time the monetary value of health-care inputs, measured by average annual total health-care spending in OECD countries, increased by 28% on average between 2003-07 and 2008-12 (Figure 3). Note that in some countries such as the United States a large share of healthcare spending is privately funded (Figure A.6). The relationship between the output and the monetary input is represented in Figure 4.

The results from the estimation show significant potential efficiency gains on both the output and input side. Regarding output efficiency, several Eastern European countries such as Slovakia and Hungary (and to a lesser extent Poland, the Czech Republic and Estonia) could, in theory, significantly raise their life expectancy by simply holding their monetary inputs constant while spending it more efficiently, i.e. according to best practise in the sample. By doing so Hungary could increase its life expectancy by 7%, i.e. from 75 years currently to 80 years. At the other end of the spectrum, countries like Japan, Iceland, Switzerland and Korea are already close to the frontier and have little room for increasing life expectancy by spending more efficiently. It is also worth noting that the vast majority of countries managed to increase their output efficiency over the period studied (Figure 5).

Figure 3. **Average annual total health-care spending in OECD countries[1]**

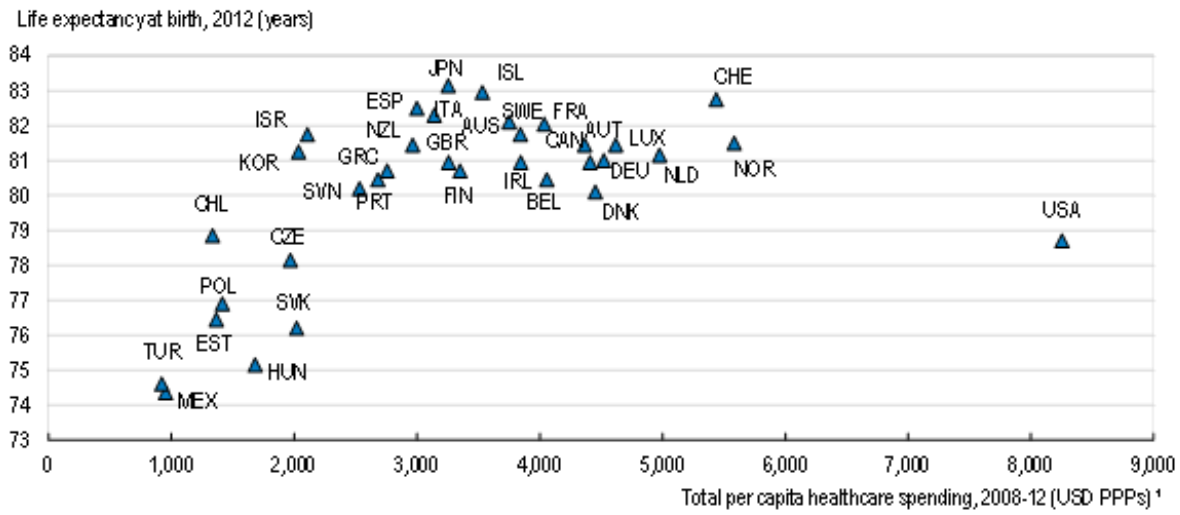
USD PPP per capita, current prices



1. Unweighted average of displayed countries.

Source: OECD Health Statistics Database.

Figure 4. **Life expectancy at birth and average annual per capita spending on health care in OECD countries**

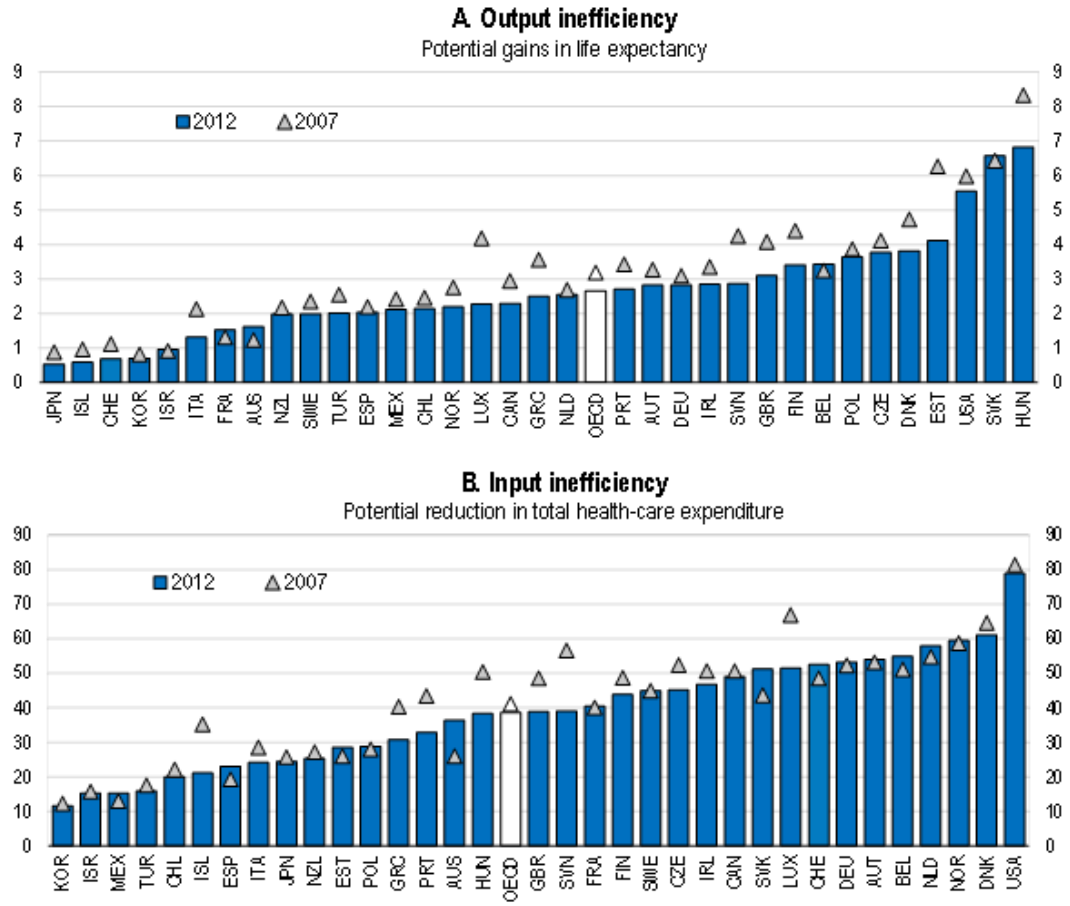


1. Total health spending in US dollars at purchasing power parities. Average over the period.

Source: OECD Health Statistics 2015.

Regarding input inefficiency, the striking feature relates to the potential reduction in total health-care expenditure. For instance, given below-average life expectancy in the United States combined with by far the highest PPP per capita spending on health care, the country could in theory achieve the same life expectancy by cutting its expenditure by nearly 80%. By contrast, given the relatively high life expectancy in Korea and a somewhat modest amount of PPP per capita spending on health, the country could save only 10% of its current expenditure while maintaining its life expectancy unchanged if it was to fully exploit efficiency gains as frontier countries do. Alternatively, countries like Mexico and Turkey perform well simply by being the lowest spenders yet achieving acceptable levels of life expectancy. Such results should not be taken at face value, however. This is apparent in confidence intervals, especially for countries that are closer to the frontier (Figure A.1), but also in the sheer scale of the predicted potential gains. Nevertheless, at the very least, they provide a ranking of how countries perform (or a gap analysis) in terms of input efficiency regarding public spending on health care.

Figure 5. **Potential efficiency gains in health care in per cent**



Source: OECD calculations.

Education

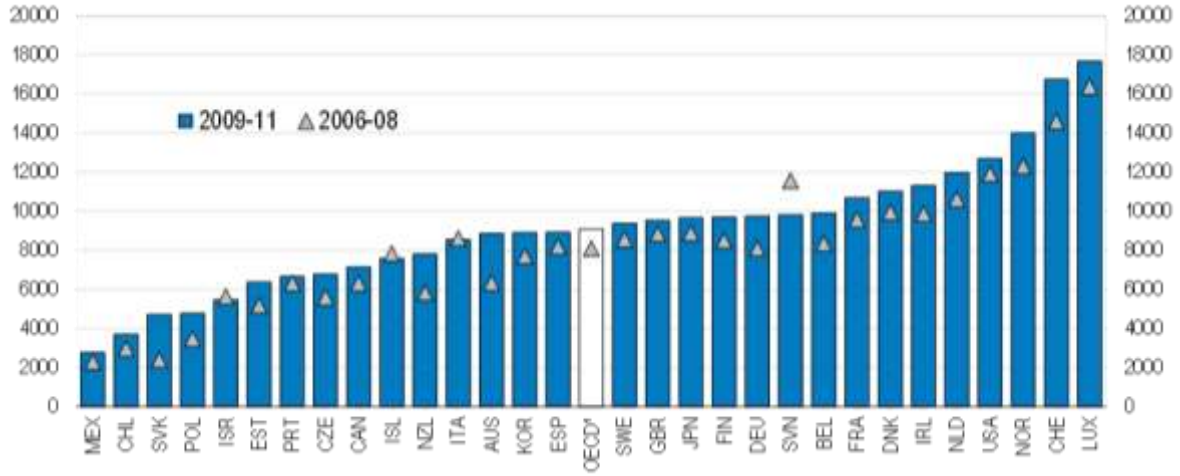
The specification used to compute DEA scores with reference to the efficiency of education spending draws on previous work from Sutherland et al. (2007) and Schwellnus (2009). A synthetic PISA score, obtained by averaging the country-scores across the reading, mathematics and science dimensions, is included as an output variable. PPP-measured spending per student in secondary education and the PISA index of economic, social and cultural status (ESCS) are used as input variables, the latter with the aim of controlling for the family background. Because 2011 is the latest year available for education expenditure

data, averages over the periods 2009-11 and 2006-08 were used for expenditure to capture its effects on performance and smooth its developments.

The synthetic PISA score for the OECD as a whole increased marginally from 499.2 to 499.7 between 2009 and 2012. Some countries scored significant gains, such as Poland (+3.9%), some lost ground such as Ireland and the Slovak Republic (-3.3%). Slovenia and the Netherlands received the same synthetic score. While there is limited variance in synthetic PISA scores (the coefficient of variation is 5%), that is not the case for education expenditure whose coefficient of variation reaches 42%. While the OECD average is at about USD 9000, at USD 18 000 Luxembourg spends about six times as much as Mexico and Chile per student (Figure 6). With the exception of Slovenia, all countries have increased their spending per student between 2006-08 and 2009-11. Note that spending on primary education may also impact on PISA scores, but it is not included in our monetary input. With a few exceptions, the source of funding for most of education spending is public (Figure A.7). The relationship between the monetary input and the output is represented in Figure 7.

Figure 6. **Average annual spending on secondary education in OECD countries**

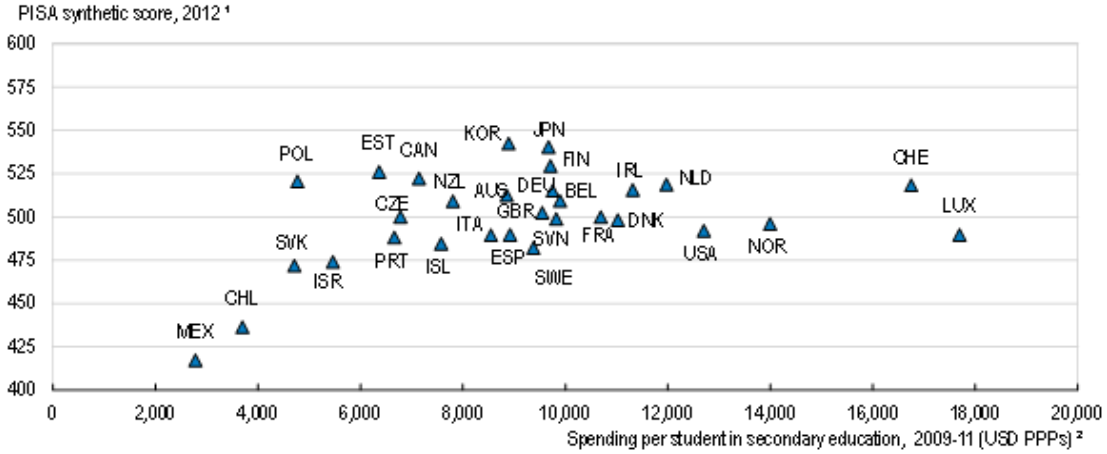
USD PPP per student, current prices



1. Unweighted average of displayed countries.

Source: OECD Education Statistics Database.

Figure 7. **PISA synthetic scores and average annual secondary education spending per student**



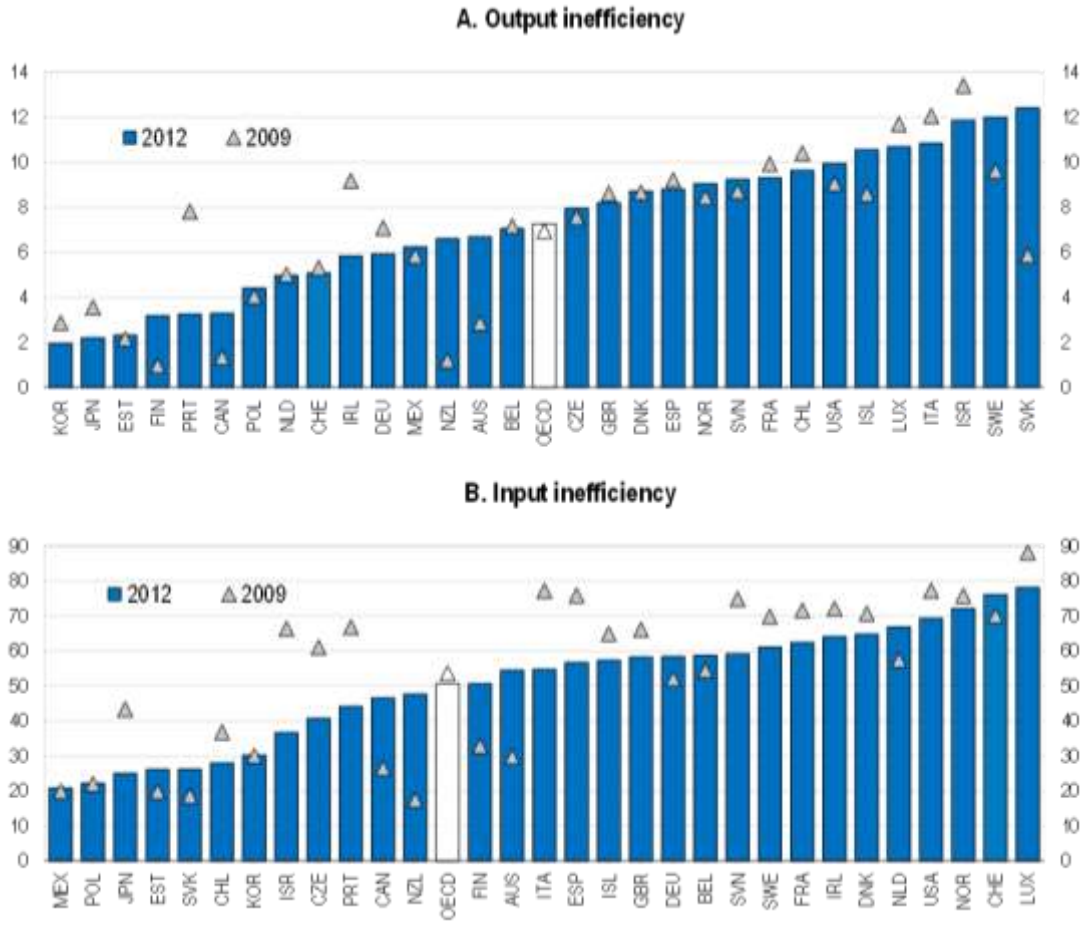
1. Mean score of reading literacy, mathematics and science.
2. In US dollars at purchasing power parities, average over period.

Source: OECD Education Statistics and OECD (2013), *PISA 2012 Results: What Students Know and Can Do - Student Performance in Reading, Mathematics and Science* (Volume 1).

Measured in percentage, potential gains in terms of output efficiency are larger than for health care (Figure 8). In Israel, Sweden and Slovakia, on average PISA scores could be raised by 12% if they were to match countries that are doing best for similar levels of spending. By contrast, Korea and Japan would gain little, as with health care. In terms of input efficiency, potential savings are again large. In Switzerland, the United States and several countries from northern Europe, significant efficiency gains could be achieved by spending less and better. By contrast, several countries at the lower end of the per capita income spectrum (Mexico, Poland, Estonia, Slovakia and Chile) are already quite efficient, given their limited amount of spending per student. Note that both Korea and Japan are part of this group, probably due to their high ratios of PISA scores to education spending per student over the period. Finally, note that on average OECD countries managed to improve their input efficiency.

Figure 8. **Potential efficiency gains in secondary education[1]**

Per cent



Source: OECD calculations.

General services

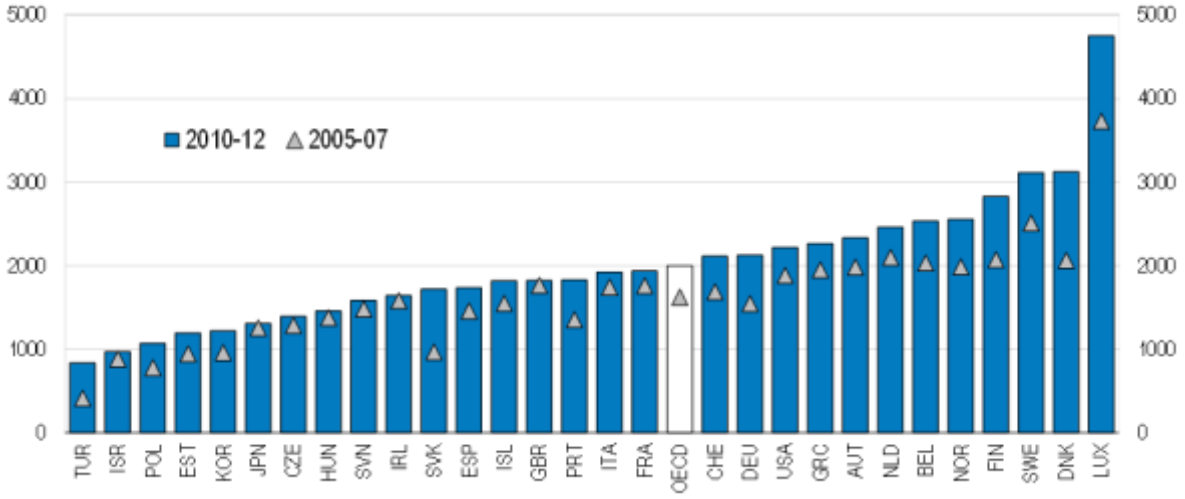
To measure the efficiency of public administration, a composite performance indicator is used as in Afonso et al. (2005, 2010). It is constructed by aggregating (using equal weights) indicators from the World Economic Forum's Global Competitiveness Report (data on the quality of justice, the pervasiveness of corruption, government inefficiency and bureaucracy) and the OECD's PMR database (the level of administrative burden). Latest OECD's PMR indicators can be found in OECD (2013). Input variables include total public per capita spending (in PPP terms) on general services, order and safety (excluding spending on interest payments), and GDP per capita used as an environmental variable. In this context,

issues of data availability limit the size of the sample to 29 OECD countries. The same approach was also applied by Forthun and Hagemann (2010) and Hribernik and Kierzenkowski (2013). An interesting discussion on some of the limits of governance indicators can be found in Arndt and Oman (2006).

Of all three areas of public policy, this is where the variance in spending per capita is the lowest. Putting Luxembourg aside, all countries lie within the PPP USD 1 000-3 000 interval, by contrast to PPP USD 3 000-18 000 for education, for instance (Figures 9 and 10). Output inefficiency scores suggest that there is much scope to improve the outcome keeping spending unchanged, especially in several Southern and Eastern European countries. By contrast, Switzerland, Japan and a few northern European countries would not be able to gain much. In terms of input efficiency, there is again a large group of countries that could reduce their spending significantly while maintaining their score, simply by following best practise. This is especially true for Spain, Italy, the United States and Luxembourg. By contrast, Japan, the United Kingdom, Switzerland and Turkey are already quite efficient in turning a limited amount of inputs into the highest possible output (Figure 11). Finally, note that both output and input efficiency deteriorated between 2005-07 and 2010-12 for the OECD on average.

Figure 9. **Average annual general public service spending in OECD countries**

USD PPP per capita, current prices[1]

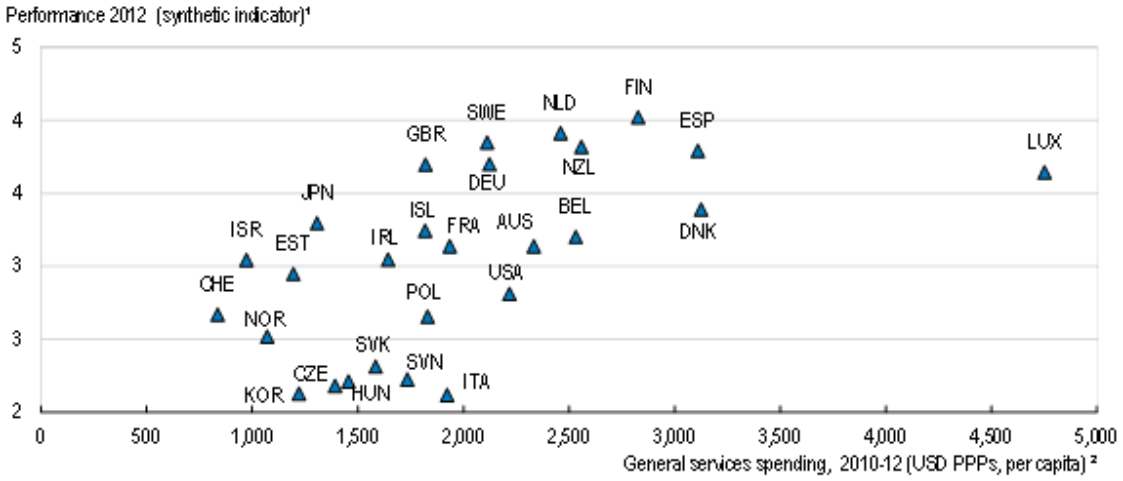


1. Excluding interest payments.

2. Unweighted average of displayed countries.

Source: OECD National Accounts Database.

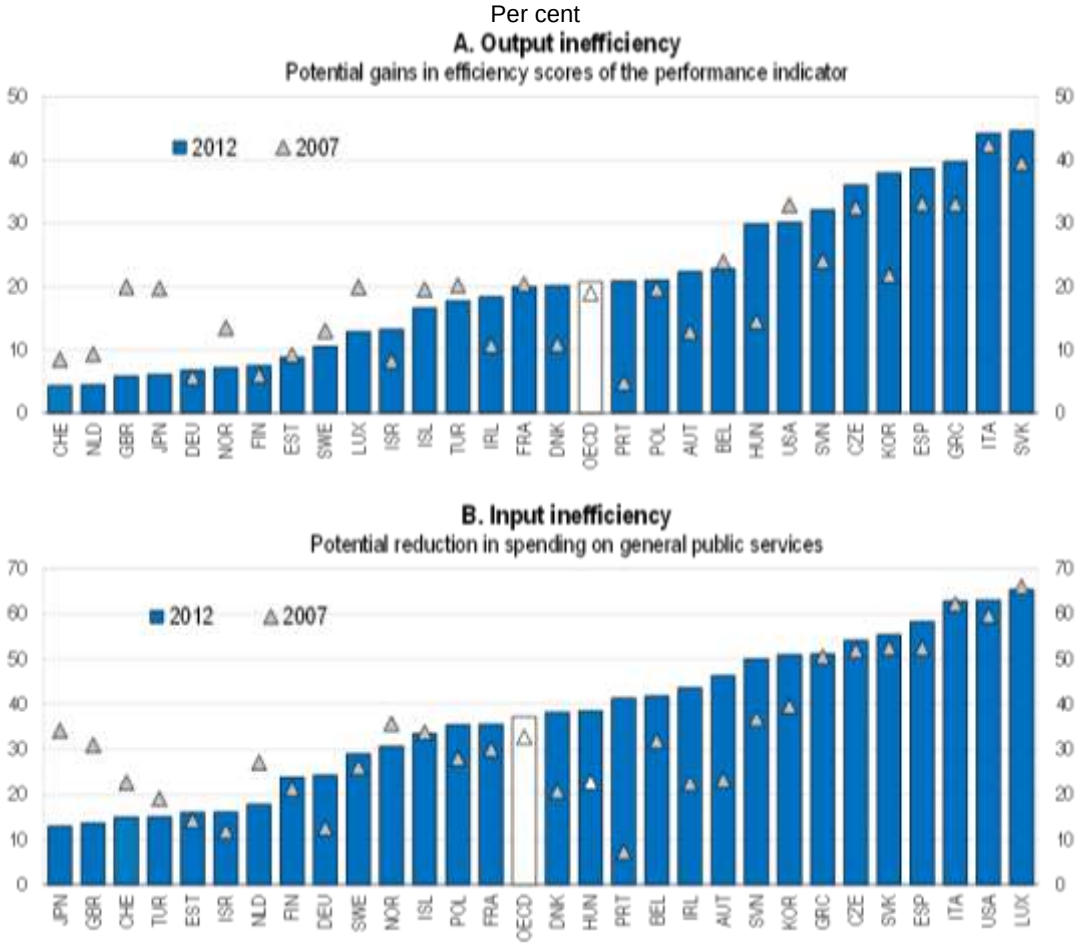
Figure 10. **Public administration performance and average annual per capita spending on general services**



1. The composite performance indicator for public administration outcome is based on OECD's Product Market Regulation (PMR) Indicator (for 2008 and 2013) to proxy the levels of bureaucracy (33% of indicator), and on results from the 2014 WEF survey on the quality of justice, level of corruption and government inefficiency (data for 2009 and 2013).
2. In US dollars at current purchasing power parities, average over period.

Source: OECD National Accounts Statistics and OECD Product Market Regulation Statistics (databases); and WEF (2014), The Global Competitiveness Index 2014-2015 Data Platform, World Economic Forum.

Figure 11. **Potential efficiency gains in public administration¹**



Source: OECD calculations.

Conclusion

This paper uses data envelopment analysis (DEA) to assess the efficiency of welfare spending in a sample of OECD countries around 2012, focussing on health care, secondary education and (frequently overlooked) general public services. We find wide dispersion in efficiency measures across OECD countries and provide quantified improvements for both output and input efficiency. Due to the limit inherent to the DEA analysis and the data (e.g. governance indicators), such results should not be taken at face value. Nevertheless, they provide a ranking of how countries perform (or a gap analysis) in terms of input efficiency regarding public spending. The results call for more in-depth analysis of the performance of public intervention, especially for (but not limited to) the countries showing on the lower part of the rankings. OECD's country-specific *Economic Surveys* often provide such analysis (e.g. OECD, 2015).

NOTES

1. Each resampling with replacement will generate different efficiency estimates and when the number of re-samples is large the standard errors of these estimates could be used to derive the confidence intervals.

2. The composite indicators were constructed by including information on general administration, education (enrolment rates in secondary school and education achievement), health (life expectation at birth, infant mortality rates), income distribution, inflation (as a proxy for economic stability) and the 10-year average unemployment rate (as a proxy for economic performance).

BIBLIOGRAPHY

Afonso, A., L. Schuknecht and V. Tanzi (2005), "Public sector efficiency: an international comparison", *Public Choice*, 123(3-4), pp. 321-347.

Afonso, A., L. Schuknecht and V. Tanzi (2010), "Public sector efficiency: evidence for new EU member states and emerging markets", *Applied Economics*, 42(17), pp. 2147-2164.

Afonso, A., and M. St. Aubyn (2005), "Non-parametric Approaches to educational and Health expenditures efficiency in OECD countries", *Journal of Applied Economics*, 8(2), pp.227-246.

Afonso, A., and M. St. Aubyn (2006), "Cross-country efficiency of secondary education provision: A semi-parametric analysis with non-discretionary inputs", *Economic Modelling*, 23 (3), pp.476-491.

Agasisti, T. and P. Zoido (2015), "The Efficiency of Secondary Schools in an International Perspective: Preliminary Results from PISA 2012", *OECD Education Working Papers*, No. 117, OECD Publishing.

Oman, C. and C. Arndt (2010), "Measuring Governance", OECD Development Centre Policy Brief 39, OECD Publishing.

Charnes, A., W.W. Cooper and E. Rhodes (1978), "Measuring the efficiency of decision making units", *European journal of operational research 2*, pp. 429-444.

Farrell, M.J. (1957), "The measurement of productive efficiency", *Journal of the royal statistic society*, Series A, CXX, Part 3, pp. 253-290.

Forthun, C. and R.P. Hagemann (2010), "Sustaining the Momentum of Fiscal Reform in Hungary", *OECD Economics Department Working Papers*, No. 802, OECD Publishing.

Herrera, S. and G. Pang (2005), "Efficiency of public spending in developing countries: An efficiency frontier approach", *World Bank Policy Research Working Paper*, No. 3645, World Bank, Washington D.C.

Hribernik, M. and R. Kierzenkowski (2013), "Assessing the Efficiency of Welfare Spending in Slovenia with Data Envelopment Analysis", *OECD Economics Department Working Papers*, No. 1058, OECD Publishing.

Joumard, I., C. André and C. Nicq (2010), "Health care systems: Efficiency and institutions", *OECD Economics Department Working Papers*, No. 769, OECD Publishing.

Kalb, A., B. Geys and F. Heinemann (2012), "Value for Money? German local government efficiency in a comparative perspective", *Applied Economics*, Vol. 44, pp. 201-218.

Mandl, U., A. Dierx and F. Ilzkovits (2008), "The effectiveness and the efficiency of public spending", *European Commission Economic Papers*, No. 301, European Commission.

Medeiros, J. and C. Schwierz (2015), "Efficiency estimates of health care systems", *European Commission Economic Papers*, No. 549, European Commission.

OECD (2013), Product Market Regulation Database, www.oecd.org/economy/pmr.

OECD (2015), *OECD Economic Survey of Switzerland 2015*, OECD Publishing.

Schwellnus, C. (2009), "Achieving Higher Performance: Enhancing Spending Efficiency in Health and Education in Mexico", *OECD Economics Department Working Papers*, No. 732, OECD Publishing,

Simar, L. and P.W. Wilson (2005), "Estimation and Inference in Two-stage, Semi-parametric Models of Production Processes", *Journal of Econometrics*, Vol. 136, No. 1.

St. Aubyn, M., A. Pina, F. Garcia and J. Pais (2009), "Study on the efficiency and effectiveness of public spending on tertiary education", *European Commission Economic Papers*, No. 390, European Commission.

Sutherland, D., R. Price, I. Joumard and C. Nicq (2007), "Performance Indicators for Public Spending Efficiency in Primary and Secondary Education", *OECD Economics Department Working Papers*, No. 546, OECD Publishing.

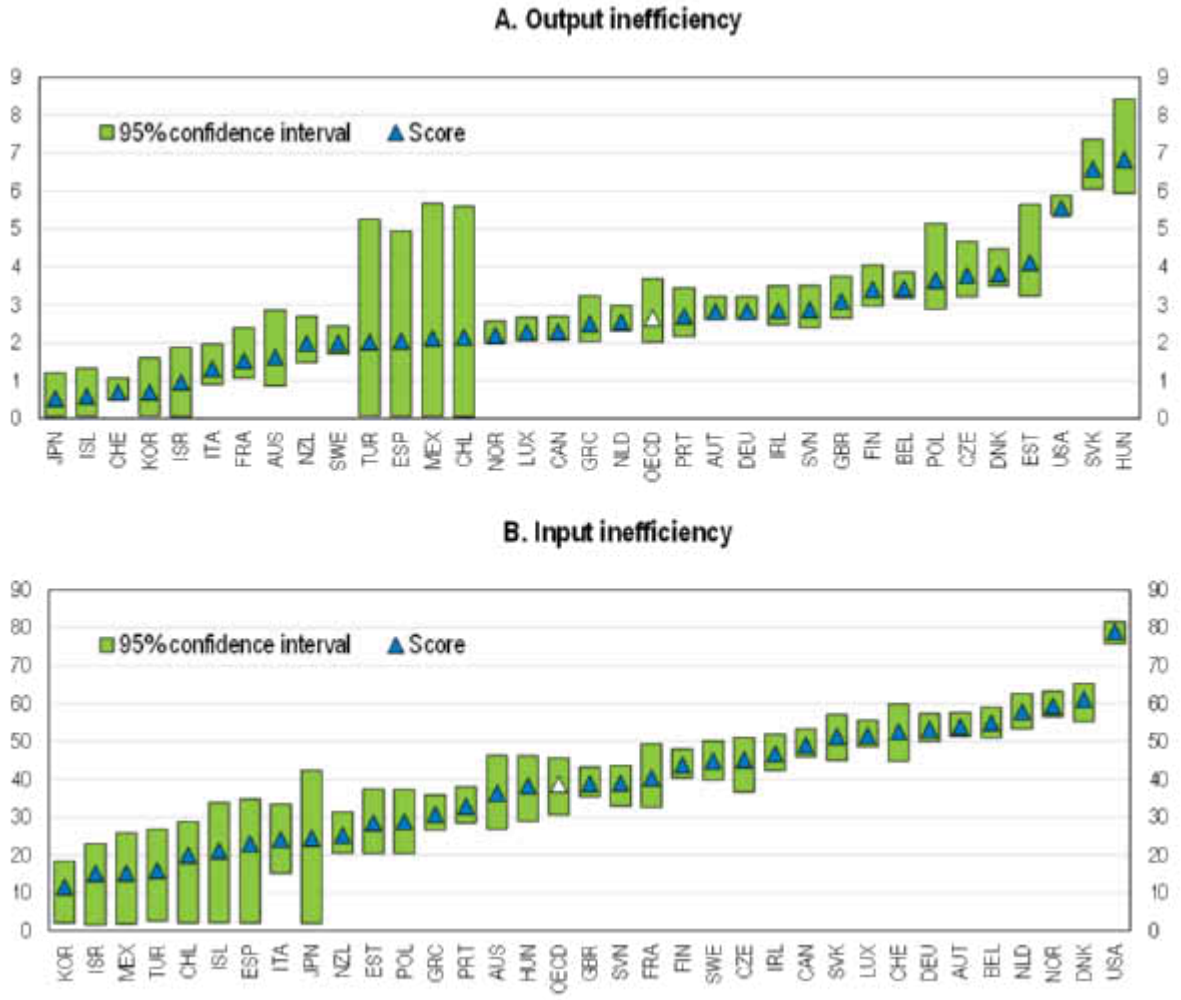
Tanzi V. and L. Schuknecht (2000), *Public Spending in the 20th Century: A global Perspective*, Cambridge University Press, New York.

Wilson, P. W. (2008), "FEAR: A software package for frontier efficiency analysis with R", *Socio-Economic Planning Sciences*, Vol. 412, pp. 247-254

ANNEX

Figure A.1. **Confidence intervals for health care efficiency in 2012**

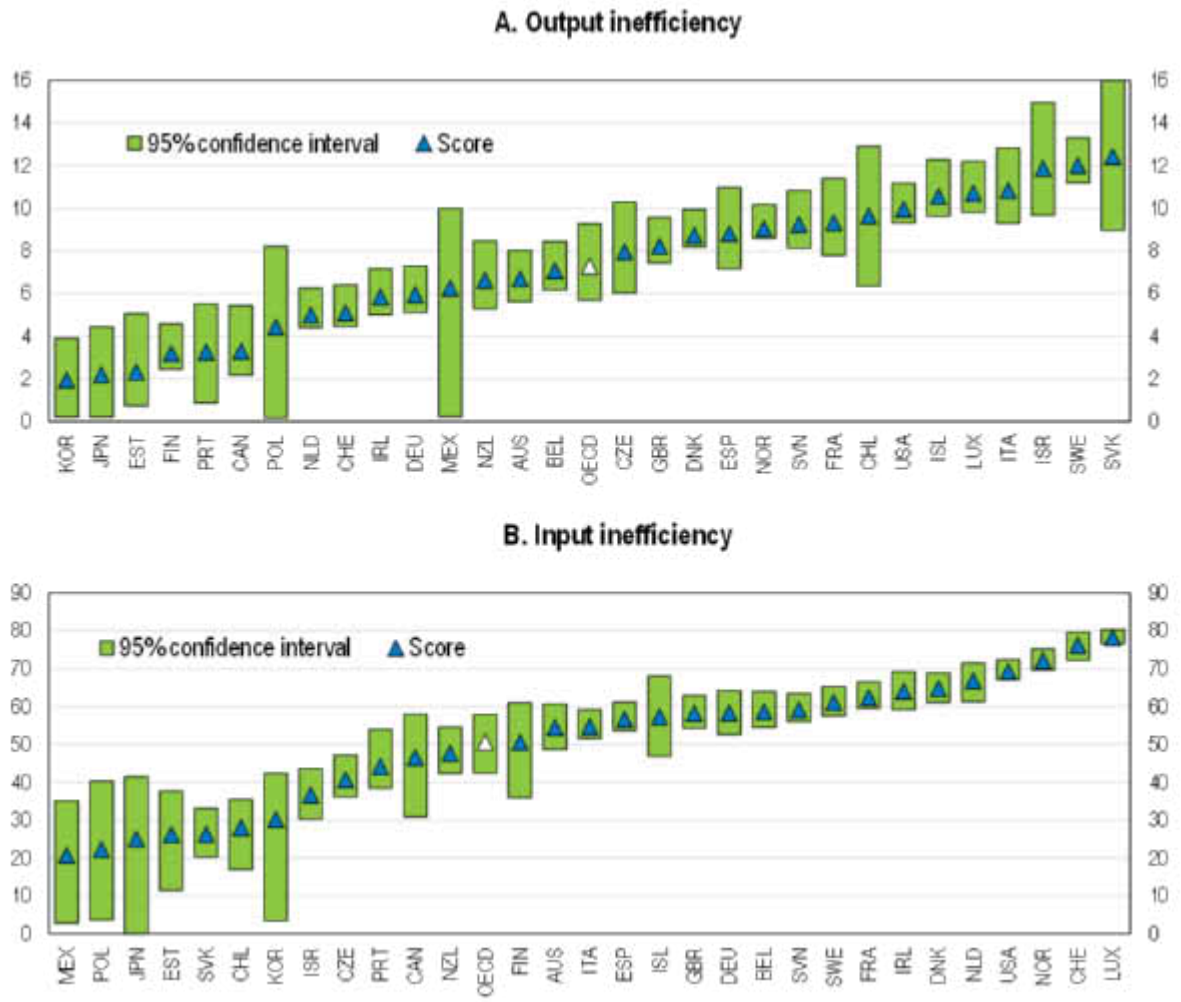
Per cent



Source: OECD calculations.

Figure A.2. **Confidence intervals for secondary education efficiency in 2012**

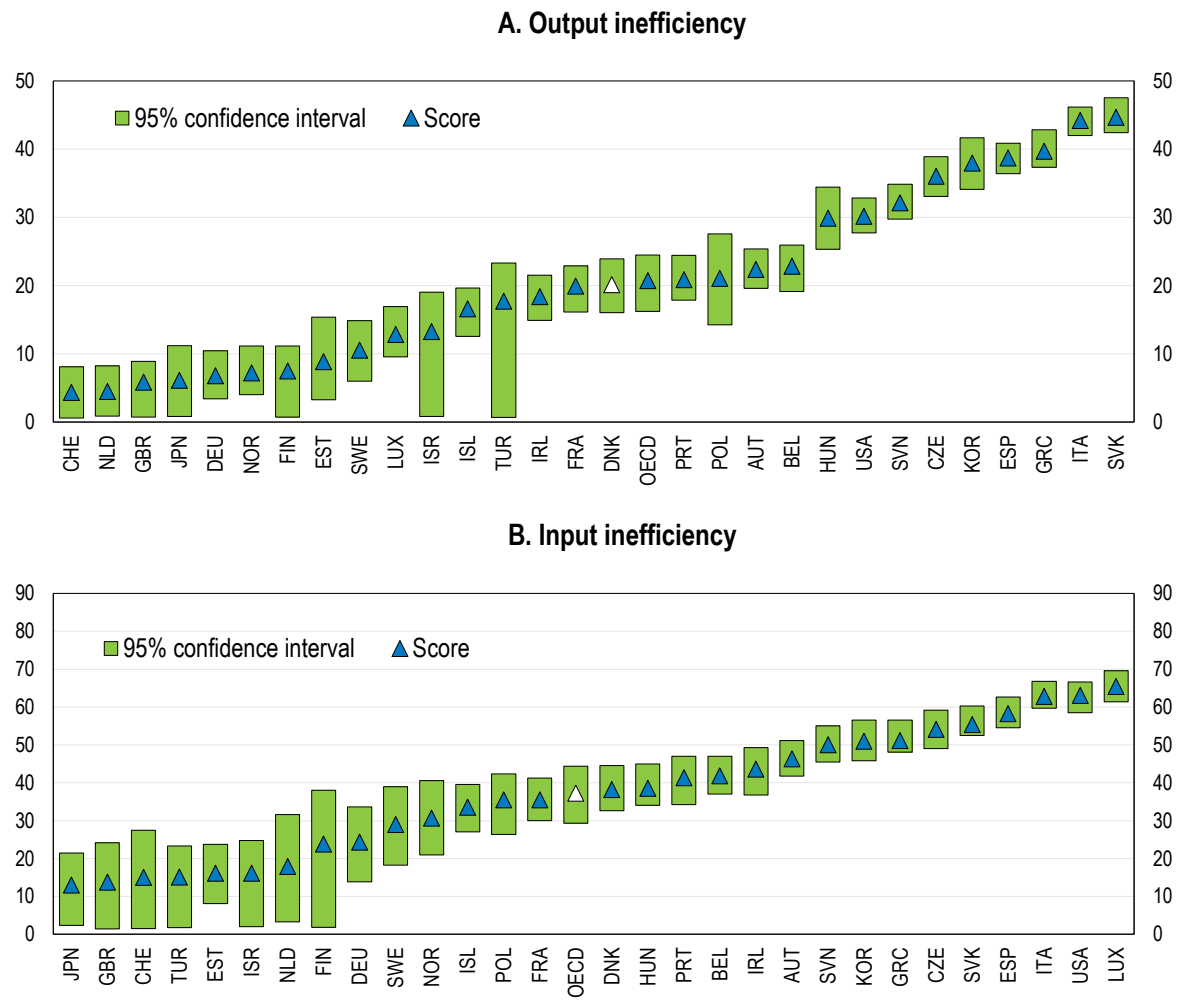
Per cent



Source: OECD calculations.

Figure A.3. **Confidence intervals for general public services efficiency in 2012**

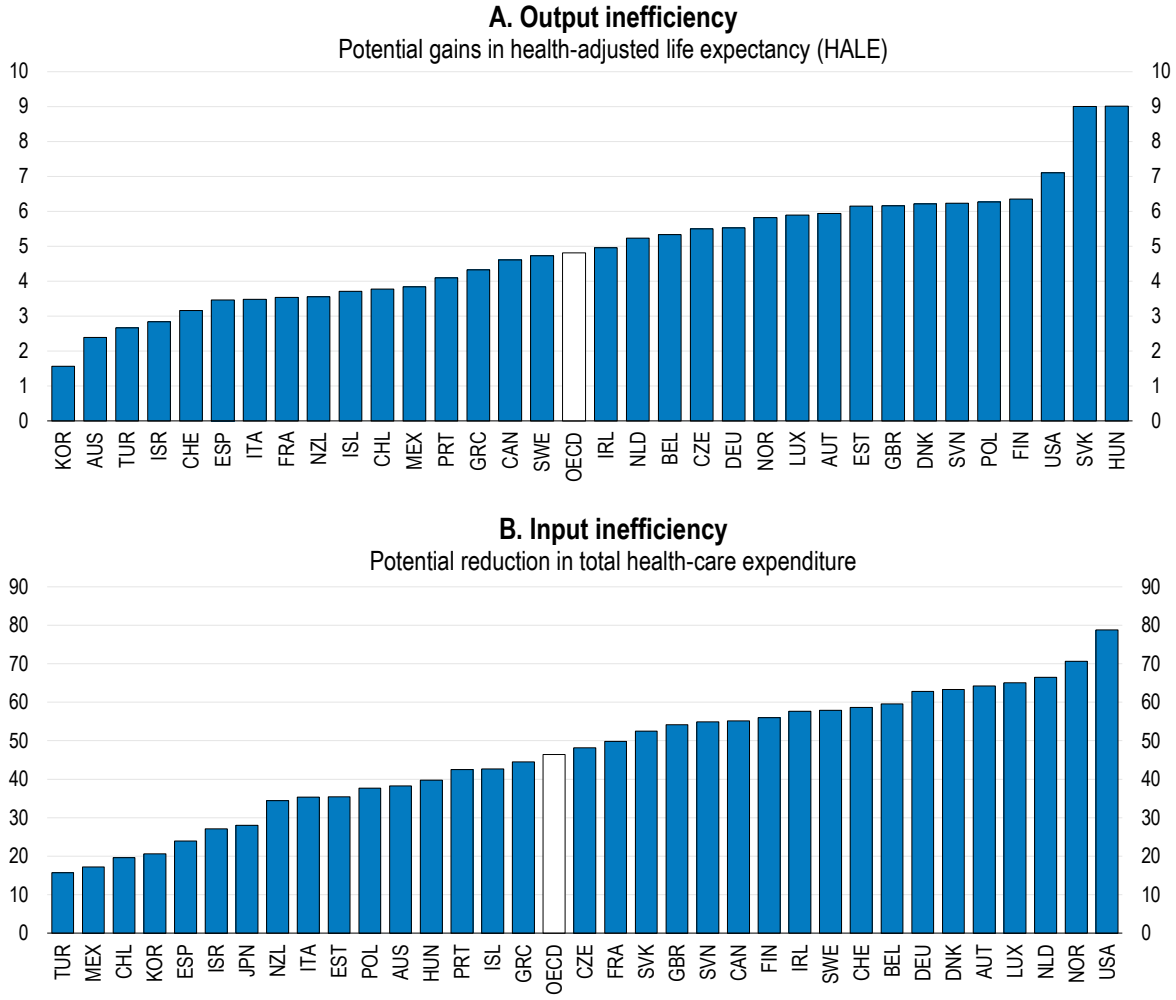
Per cent



Source: OECD calculations.

Figure A.4. **Potential efficiency gains in health care, 2012 (II)**

Per cent

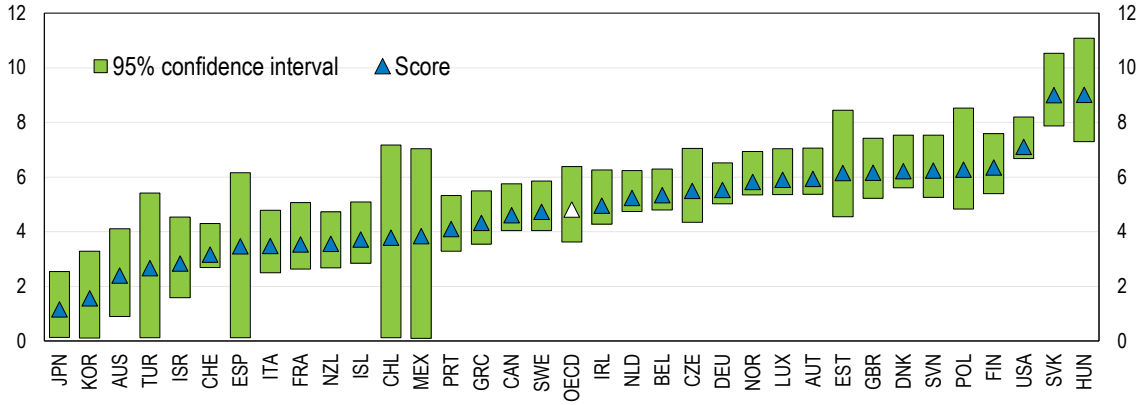


Source: OECD calculations.

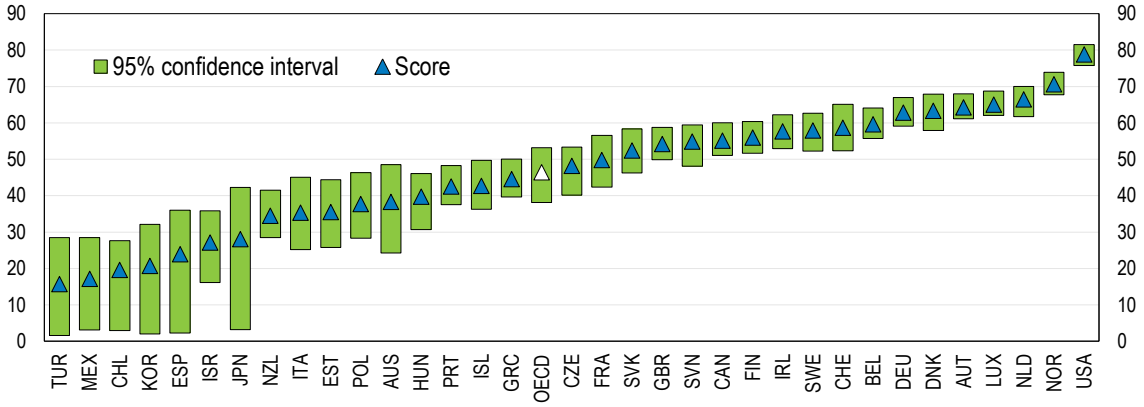
Figure A5. **Confidence intervals for health care efficiency in 2012 (II)**

Per cent

A. Output inefficiency



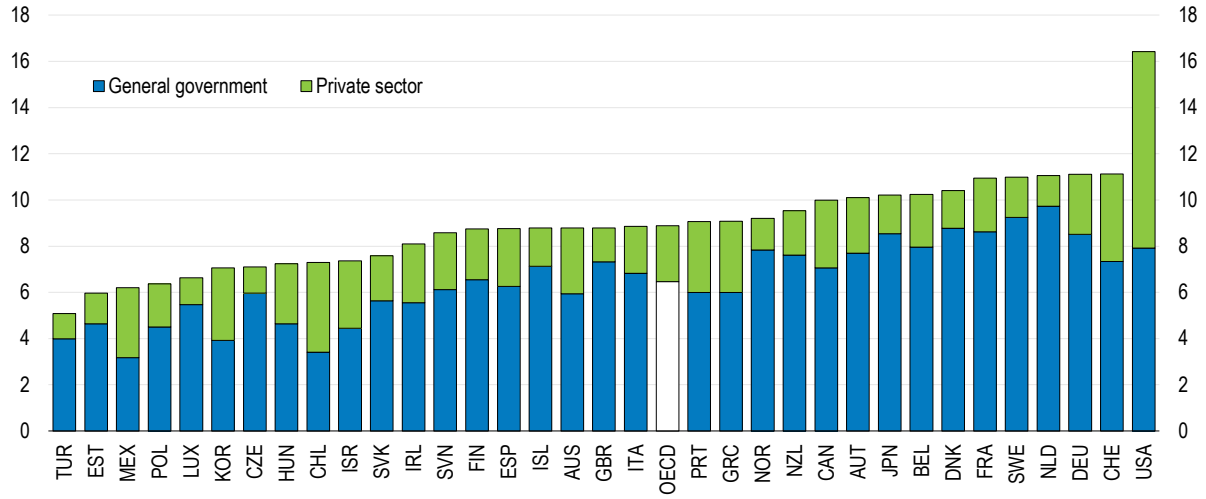
B. Input inefficiency



Source: OECD calculations.

Figure A.6. **Total current expenditure on health by main source of financing, 2014[1]**

As a percentage of GDP

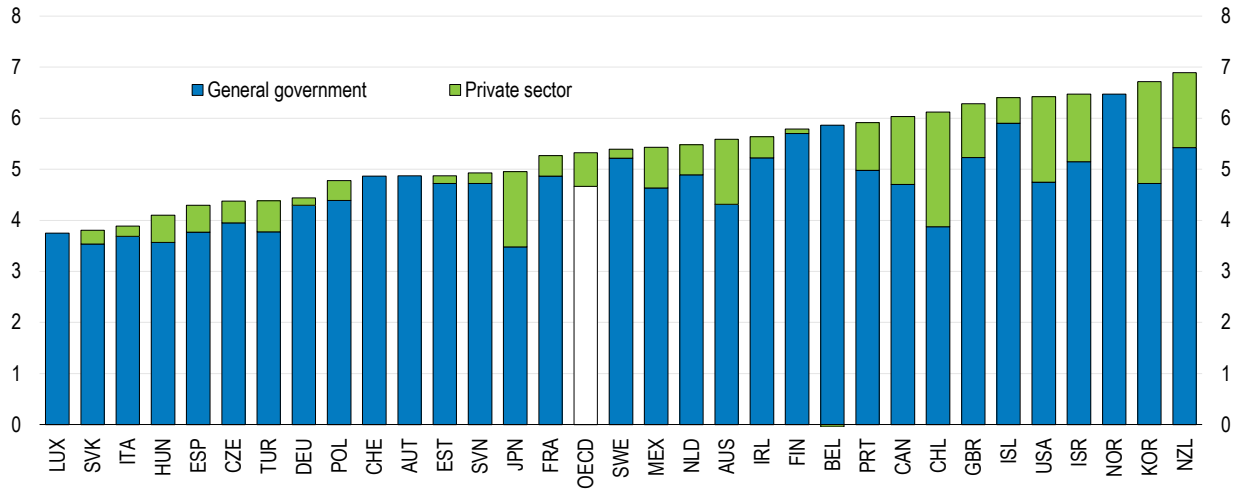


1. Or latest available observation.

Source: OECD Health Database 2015.

Figure A.7. **Expenditure on educational institutions by source of funding, 2012**

Primary to tertiary education, as a percentage of GDP



Including public subsidies to households attributable for educational institutions, and direct expenditure on educational institutions from international sources.

Net of public subsidies attributable for educational institutions.

Source: OECD, Education at a Glance 2015.

Table A1.1. Variables used in the estimates: Education

	PISA synthetic score[1]		Spending per student in secondary education (USD PPP)[2]		Environment variable (ESCS index)[3]	
	2009	2012	2006-08	2009-11	2009	2012
Australia	518.8	512.5	6,337	8,856	0.344	0.248
Belgium	509.3	509.3	8,352	9,896	0.196	0.145
Canada	526.6	522.2	6,320	7,142	0.503	0.413
Chile	439.3	436.3	2,980	3,696	-0.568	-0.579
Czech Republic	490.5	500.0	5,590	6,779	-0.086	-0.066
Denmark	499.2	498.2	9,953	11,022	0.297	0.426
Estonia	513.6	526.1	5,186	6,365	0.152	0.112
Finland	543.5	529.4	8,494	9,708	0.371	0.365
France	496.9	499.8	9,577	10,691	-0.133	-0.038
Germany	510.2	515.1	8,096	9,749	0.182	0.195
Iceland	500.9	484.5	7,828	7,574	0.718	0.783
Ireland	496.9	515.6	9,876	11,312	0.047	0.127
Israel	458.6	474.1	5,622	5,463	-0.024	0.172
Italy	485.9	489.5	8,603	8,545	-0.123	-0.054
Japan	529.4	540.4	8,890	9,670	-0.009	-0.072
Korea	541.2	542.4	7,703	8,891	-0.153	0.012
Luxembourg	481.7	489.6	16,386	17,695	0.188	0.074
Mexico	419.9	417.3	2,291	2,779	-1.218	-1.109
Netherlands	518.8	518.8	10,625	11,975	0.273	0.234
New Zealand	524.1	509.2	5,835	7,809	0.086	0.040
Norway	500.4	495.9	12,316	13,995	0.471	0.462
Poland	501.1	520.5	3,477	4,772	-0.281	-0.209
Portugal	489.7	488.0	6,323	6,663	-0.317	-0.483
Slovak Republic	488.1	471.9	2,386	4,715	-0.093	-0.184
Slovenia	498.8	498.9	11,564	9,819	0.075	0.067
Spain	484.3	489.6	8,186	8,922	-0.314	-0.190
Sweden	495.6	482.1	8,552	9,374	0.330	0.275
Switzerland	**517.0**	**518.4**	**14,597**	**16,750**	**0.078**	**0.172**
United Kingdom	500.1	502.5	8,845	9,547	0.204	0.272
United States	496.4	492.1	11,908	12,699	0.171	0.174
OECD[4]	499.2	499.7	8,090	9,096	0.046	0.059

1. Mean score of reading literacy, mathematics and science.

2. In US dollars at purchasing power parities, average over period.

3. Economic, social and cultural status index (ESCS).

4. Unweighted average of data shown in the table.

Source: Calculations based on OECD Education Statistics; OECD *Education at a Glance 2014* ; OECD (2013), *PISA 2012 Results: What Students Know and Can Do - Student Performance in Reading, Mathematics and Science* (Volume 1); OECD (2013), PISA 2012 Results: Excellence through equity - Giving Every Student the Cahnce to succeed (Volume II).

Table A1.2. Variables used in the estimates: Healthcare

	Life expectancy at birth (years)		Total healthcare spending (USD PPP per capita) [1]		Environment variable [2]	
	2007	2012	2003-07	2008-12	2007	2012
Australia	81.4	82.1	3,039	3,752	0.630	0.635
Austria	80.3	81.0	3,560	4,523	1.148	1.167
Belgium	79.9	80.5	3,151	4,057	0.943	0.958
Canada	80.5	81.5	3,450	4,365	1.229	1.218
Chile	77.9	78.9	901	1,336	0.316	0.349
Czech Republic	77.0	78.2	1,486	1,969	0.796	0.789
Denmark	78.4	80.1	3,320	4,453	0.807	0.818
Estonia	73.2	76.5	860	1,367	0.893	0.901
Finland	79.6	80.7	2,593	3,351	1.148	1.135
France	81.2	82.1	3,240	4,038	0.741	0.739
Germany	80.1	81.0	3,383	4,410	0.997	1.023
Greece	79.7	80.7	2,364	2,758	0.932	0.857
Hungary	73.6	75.2	1,409	1,682	0.572	0.587
Iceland	81.5	83.0	3,296	3,533	0.811	0.782
Ireland	79.7	81.0	2,997	3,844	0.889	0.818
Israel	80.6	81.8	1,838	2,109	1.667	1.688
Italy	81.5	82.3	2,518	3,140	1.165	1.146
Japan	82.6	83.2	2,486	3,257	1.140	1.127
Korea	79.4	81.3	1,326	2,036	1.147	1.162
Luxembourg	79.5	81.5	4,148	4,618	1.175	1.203
Mexico	74.2	74.4	730	954	0.769	0.783
Netherlands	80.3	81.2	3,740	4,976	0.964	0.947
New Zealand	80.2	81.5	2,156	2,966	0.852	0.851
Norway	80.6	81.5	4,341	5,584	1.254	1.294
Poland	75.4	76.9	881	1,415	0.883	0.933
Portugal	79.2	80.5	2,172	2,683	0.825	0.816
Slovak Republic	74.5	76.2	1,195	2,022	0.992	1.017
Slovenia	78.3	80.2	1,999	2,534	1.168	1.145
Spain	81.2	82.5	2,327	3,001	0.460	0.421
Sweden	81.1	81.8	3,075	3,842	1.713	1.703
Switzerland	**82.0**	**82.8**	**4,110**	**5,436**	**1.327**	**1.374**
Turkey	73.7	74.6	622	923	1.091	1.122
United Kingdom	79.7	81.0	2,704	3,259	1.118	1.073
United States	77.9	78.7	6,753	8,255	1.439	1.422
OECD [3]	79.0	80.2	2,593	3,307	1.000	1.000

1. Total health spending in US dollars at purchasing power parities. Average over the period.

2. GDP per capita, educational educational attainment of the adult population, nitrogen oxide emissions, fruit and vegetable consumption (latest data available), tobacco and alcohol consumption (15-year lag).

3. Unweighted average of data shown in the table.

Source: Calculations based on OECD (2015), *OECD Health Statistics, OECD National Accounts Statistics* and *OECD Environmental Statistics* (databases); OECD (2014), *Education at a Glance* .

Table A1.3. Variables used in estimates: General public services

	Performance[1] (synthetic indicator)		General services spending[2] (USD PPP per capita)		Environment variable (GDP per capita)[3]	
	2007	2012	2005-07	2010-12	2007	2010
Austria	3.7	3.1	1,982	2,333	39,240	44,892
Belgium	3.2	3.2	2,033	2,533	36,634	41,684
Czech Republic	2.3	2.2	1,285	1,393	26,622	28,679
Denmark	3.8	3.4	2,062	3,125	38,685	43,565
Estonia	2.7	2.9	944	1,195	21,795	24,689
Finland	4.1	4.0	2,069	2,827	37,509	40,209
France	3.1	3.1	1,759	1,935	34,064	37,347
Germany	3.8	3.7	1,546	2,124	36,737	42,730
Greece	2.4	2.0	1,948	2,267	29,025	25,462
Hungary	2.4	2.2	1,376	1,456	19,270	22,494
Iceland	3.2	3.2	1,550	1,819	39,007	40,464
Ireland	3.5	3.0	1,581	1,643	46,655	45,210
Israel	3.0	3.0	883	972	27,056	31,648
Italy	2.2	2.1	1,740	1,923	33,531	35,334
Japan	2.9	3.3	1,255	1,307	33,319	35,601
Korea	2.6	2.1	961	1,222	27,872	32,022
Luxembourg	3.4	3.6	3,727	4,752	80,903	91,754
Netherlands	3.8	3.9	2,098	2,459	43,349	46,389
Norway	3.6	3.8	1,986	2,558	55,850	65,098
Poland	2.2	2.5	781	1,071	16,894	22,869
Portugal	3.1	2.7	1,355	1,830	25,224	26,932
Slovak Republic	1.8	1.8	966	1,718	21,344	25,725
Slovenia	2.6	2.3	1,480	1,585	27,670	28,455
Spain	2.5	2.2	1,457	1,734	32,800	32,774
Sweden	3.7	3.8	2,510	3,111	40,565	43,869
Switzerland	**3.6**	**3.8**	**1,689**	**2,111**	**46,990**	**55,916**
Turkey	2.2	2.7	414	837	13,896	18,002
United Kingdom	3.3	3.7	1,763	1,820	37,425	37,383
United States	2.7	2.8	1,881	2,218	47,987	51,435
OECD[4]	3.0	3.0	1,623	1,996	35,101	38,573

1. Composite peformance indicator for public administration outcome based on OECD's Product Market Regulation (PMR) Indicator (for 2008 and 2013) to proxy the levels of bureaucracy (33% of indicator) and results of the 2014 WEF survey on the quality of justice, level of corruption and government inefficiency (data for 2009 and 2013).

2. Excluding interest payments.

3. In US dollars at current prices and current purchasing power parities.

4. Unweighted average of data shown in the table.

Source : Calculations based on OECD (2015), *OECD National Accounts Statistics* and *OECD Product Market Regulation Statistics* (databases); and WEF (2014), *The Global Competitiveness Index 2014-2015 Data Platform* , World Economic Forum.