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Abstract

The paper analyses the growth-friendliness of public spending in EU countries over the decade 2007-2016. It looks into the composition, performance and efficiency of public expenditure across countries and specific functions of government. This approach allows for some granularity in the analysis. Using a literature survey, semi-disaggregated composite indicators of performance and an efficiency frontier approach, the analysis provides a rich set of results on the quality of public spending, giving first indications on where room for improvements appears to be large. The overall results turn out fairly mixed, providing a nuanced picture of the growth-friendliness of public expenditure in the EU both in terms of level and change.

JEL Classification: C14, E62, H11, H50.

Keywords: Quality of public finance, public spending, government efficiency, government performance, EU countries, DEA, Malmquist index, economic growth.

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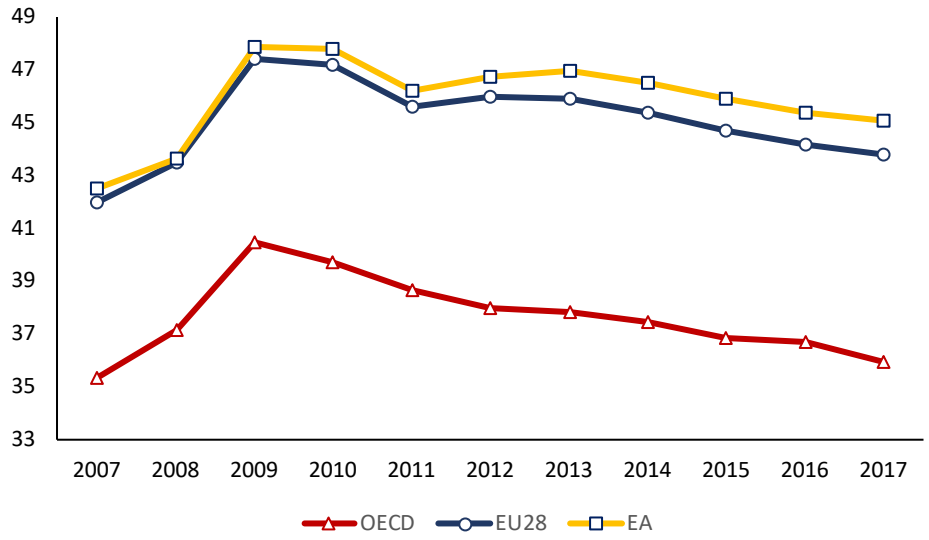
CONTENTS

1. INTRODUCTION

Due to the limited fiscal space in some countries with high public indebtedness, the broad objective of improving the performance of public spending features prominently in the political agenda of national governments. This is seen as a way to improving the prospect of economic growth in the long run, while preserving the equally important aim of containing spending developments to restore public debt sustainability and thereby ensure macroeconomic stability.

Moreover, the public expenditure (excluding interest service) amounts to about half of the GDP in the EU and the euro area on average, reaching almost 55% in France and Finland (Graph 1). Its total size is relatively high in the EU[1] and the euro area compared with other developed countries and is expected not to abate considering the fiscal consequences of ageing population.

Graph 1. **Primary expenditure dynamics (in % of GDP)**



Note: OECD weighted average consider EU members of OECD as well as the following countries: United States, Japan, Australia, Canada, Korea, Iceland, Norway, Mexico and Switzerland.

Source: Authors' elaborations on Commission Spring Forecast 2018 and WDI data.

Therefore, the adequacy of how public money is spent with respect to its objectives is a key issue for national governments and - not least - for citizens who will ultimately finance public expenditures by paying taxes.

Public expenditures support different goals. The government is primarily concerned in providing public good and services (to address market failure or fulfil specific political objectives) and ensuring a level of redistribution perceived as socially equitable. Enhancing economic growth is certainly also one of the goals, since it is one crucial aspect of general welfare and of the process of economic development (European Commission, 2012). More generally, whatever goal pursued, it is essential to ensure that spending is made in a way that is ultimately most conducive to growth or, at a minimum, least harmful to economic growth.

[1] The United Kingdom (UK) is covered by the analysis and the EU aggregate refers to the EU28 because the United Kingdom was still a Member State during the reference period of this paper (2007-2016).

This paper focuses on the growth-friendliness of public spending. It does not cover other relevant goals of public spending such as: macroeconomic stabilisation; social equity and redistribution including the fight against poverty; the satisfaction of users and more broadly economic well-being and quality of life through the supply of public goods (e.g. protection of environment and climate, public security and safety and international peace). These objectives may also indirectly impact long-run growth and general welfare. Conversely, it is incorrect to automatically consider any spending on 'growth-friendly' expenditure functions as effectively productive. For instance, whereas better and more effective infrastructure may enhance growth, this does not necessarily mean that any spending labelled as 'infrastructure' will lead mechanically to higher long-run growth.

Academic literature generally suggests that public spending composition matter for GDP growth. However, no consensus is found, when it comes to identifying the types of public expenditure most conducive to GDP. There is no authoritative definition of what constitutes growth-enhancing spending. Regarding the economic classification of spending, only public investment could be considered growth-friendly, at least in the advanced economy. The functional classification is more promising and more precise since it considers the very purpose of public expenditure. According to the literature some categories of expenditure seem to be associated with a higher GDP, such as education, health and infrastructure.

In this respect, some caveats should be recalled: these functional categories remain aggregated and may conceal large difference across sub-categories. The growth-enhancing effect of public spending will also crucially depend on the ability of the government to achieve outcomes without creating distortions, making the most of limited public resources, and on the quality of governance (Reinhart and Rogoff, 2009; Afonso and Jalles, 2011, Nirola and Sahu, 2019). In particular, Butkiewicz and Yanikkaya (2011), considering three measures of government effectiveness, found how government effectiveness is an important determinant of the growth impact of government spending for developing nations while the results appeared mixed for the advanced economies. Pritchett (2000), instead, raises the attention to the fact that the assumption behind empirical research – government is a cost minimising investor – is uncertain, as the large country differences in public-sector efficacy is amply confirmed (Dabla-Norris et al., 2017). Moreover, further factors could influence the expenditure - growth linkage, such as the financing resources and country fiscal position (Barrios and Schaechter, 2008).

This linkage will also vary according to, inter alia, the return on the specific project being funded, how efficiently public funds are used and the extent of the imbalance in the relative share between public and private capital, giving rise to diminishing marginal returns. The microeconomic literature on "white elephants" (e.g. Keck 1988, Ganuza and Llobet, 2018) explains specific cases of public money wastage.

The paper provides a first indication on the composition, performance (effectiveness) and efficiency of public expenditure at the level of countries and specific functions of government**.** Surveying these three different dimensions of the quality of public expenditures across seven categories of spending and each EU country allows for some granularity in the analysis. Based successively on a literature survey, semi-disaggregated composite indicators of performance and an efficiency frontier approach, the analysis provides a rich set of results on the quality of public spending, giving indications on where room for improvements appears to be large.

These analyses represent useful pieces of evidence-based analysis which may provoke or feed into a wider policy discussion, although no firm policy conclusion can be mechanically derived. In all rigour, this would require in - depth analyses – outside the scope of this paper – focusing on more specific expenditure categories and/or countries taking additional aspects and qualitative evidence into account. As a distinctive feature of the paper and in an attempt to capture the rich dimensions of public expenditure, we use multiple output indicators when looking at both the effectiveness (performance) and efficiency of each functional category of public spending.

The paper is structured as follows. Section 1 presents a review of the literature on the relationship between each expenditure item and long-run increase of GDP and uses the results thereof to evaluate the quality of the composition of public expenditure for EU countries over the horizon 2007-2016. Section 2 measures the performance/effectiveness of government expenditure by countries and over time, updating the analysis by Barrios and Schaechter (2008) based on composite indicators. Section 3 digs deeper and assesses the efficient use of public spending by defining the 'efficiency frontier' for each functional category of public expenditures using a DEA approach. We also evaluate the change in spending efficiency between 2007 and 2016 for each country on the basis of the Malmquist productivity index. The last section concludes.

2. ASSESSING THE COMPOSITION OF PUBLIC SPENDING

2.1. THE IMPACT OF PUBLIC SPENDING ON GDP: A REVIEW OF THE LITERATURE

Table 1 summarises the results of the rich economic literature that examines the complex relation between various categories of public spending and economic performance in the long run, the latter being measured by the GDP. Both composition and size of expenditures play a role. We have surveyed around twenty five papers, focusing either on seminal research or most recent empirical contributions for the advanced economies.

In terms of spending size, the neoclassical theory predicts a negative relationship between public spending and GDP in the medium to long run because of the crowding out of private investment and the distortion due to high taxation (Bergh and Henrekson, 2011). This should be distinguished from the Keynes-inspired literature on fiscal multipliers, which looks into the short-term positive impact of public expenditure on GDP, via its effect on aggregate demand. A reconciliation of the two strands of theory comes from the Armey curve (1995) that, shaping an inverted U relationship between the two variables, implies the existence of a threshold above which the growth turns negative.

In terms of spending composition, the neoclassical growth literature (Solow, 1956 and Swan, 1956) highlighted the role of physical capital accumulation as one of the economic growth drivers[2] (both in the short and long run). By contrast, the endogenous growth theory (Barro 1991, Acemoglu 2009, Aghion and Howitt, 2009) points to other variables including 'intangible investment' in the broad sense such as public R&D and human capital investment[3].

Empirically no consensus is found when it comes to identifying the spending components affecting economic growth both from economic and functional classification perspective[4]. The results from the literature change across regions, time span or adopted technique. As observed by Barro (1990) both sides of the budget – expenditures and revenue – matter for growth. Still, not all the studies pay a specific attention to the different sources of expenditure financing but almost all include in their empirical analysis financing variables to avoid biasing the econometric results.

Focusing on the expenditure side, both the economic and functional classification are considered.[5] Looking at the economic composition, Morozumi and Veiga (2016) suggest that *public capital*

[2] The other two were the changes in labour-force availability and exogenous technological progress.

[3] Population dynamics and institutional characteristics were also considered.

[4] See for a survey Gemmell et al. (2013).

[5] The economic classification considers the final use of the expenditure, such as investment, current consumption (e.g. intermediate consumption and compensation of public employees), transfers (e.g. social benefits or subsidies) or interest expenditure. By contrast, the functional composition considers the broad objective of a given type of expenditure (i.e. education, health, general public services, etc.). This functional classification is derived from the OECD Classification of the Functions of Government (COFOG), which identifies the purpose for which the funds are used.

spending enhances GDP, independently from the financing sources (reallocation from current spending, increase in revenue, and budget deficit deterioration), especially when governments are rendered accountable. The same positive effect associated with public capital spending is confirmed by Bose et al. (2007) while the role of revenues is insignificant.

A negative impact on growth is, instead, associated with *current spending* (Morozumi and Veiga, 2016) or government consumption (Romero-Ávila and Strauch, 2008, Alfonso and Furceri 2010, Gemmell et al., 2011)[6]. The relation is still negative when considering, like in Barro (1991), government consumption ratio to GDP netted out of the ratio of government spending on education and defence, retained more representative of public investment than public consumption.

Table 1. **The economic role of expenditure items to growth: a literature overview**

Expenditure categories	Literature reference	Impact on GDP
	Economic decomposition	
Public consumption/current expenditure	Barro (1991); Romero-Ávila and Strauch (2008), Afonso and Furceri (2010); Afonso and Alegre (2011); Morozumi and Veiga (2016); Gemmel et al. (2016)	-
Social Transfers	Romero-Avila and Strauch (2008); Afonso and Alegre (2011);	-
	Afonso and Furceri (2010)	+
Subsidies	Afonso and Furceri (2010)	-
Public investment/ public capital	Morozumi and Veiga (2016); Bose et al. (2007); Romero-Ávila and Strauch (2008), Afonso and Furceri (2010); Afonso and Alegre (2011); Chu et al (2018)	+
	Functional decomposition	
General public services	Barbiero and Cournede (2013)	+
	Gemmel et al. (2016)	-
Social protection:	Kelly (1997); Barbiero and Cournede (2013)	+
		-
of which pension payments	Feldstein (1974); Docquier and Paddison (2003)	
Education	Glomm and Ravikumar (1997), Voyvoda and Yeldan (2000), Nijkamp and Poot (2004); Blankenau and Simpson (2004), Blankenau et al. (2007), Bose et al (2007); Barbiero and Cournede (2013), Dissou et al. (2016); Gemmel et al. (2016)	+
Health	Wang (2011); Elmi and Sadeghi (2012); Barbiero and Cournede (2013); Gemmel et al. (2016)	+
Infrastructure	Canning and Fay (1993); Easterly and Rebelo (1993); Easterly and Levine (1997); Nijkamp and Poot (2004); Barbiero and Cournede(2013); Gemmel et al. (2016)	+
	Barro (1990)	-
R&D	Szarowská (2017) Svensson, (2008)	+
	Silaghi et al. (2014)	-
Housing	Barbiero and Cournede(2013)	-
	Gemmel et al. (2016)	+
Defense/Military expenditure	Barro (1981); Altpekin and Levine (2012)	+

A detrimental role on GDP is also associated with *subsidies*. Afonso and Furceri (2010) find that their impact is even more negative than that of government consumption. Less clear is the role of *social transfers*: according to Romero-Ávila and Strauch (2008) and Afonso and Alegre (2011), they negatively affect the growth rate of GDP per capita over the business cycle, whereas Afonso and

[6] Röger and In't Veld (2009) and Coenen et al. (2010) running various simulations with DSGE model confirm these results, although it may be argued that the negative impact of current spending is derived by construction.

Furceri (2010) and Cashin (1994) show the opposite, for EU15 and for 23 developed countries respectively.

Looking at the functional composition of expenditure, the results are unclear for *social protection* expenditure, although tilted toward growth-friendliness. Feldstein (1974) and Docquier and Paddison (2003) find a growth-impairing impact for pension payments, which would discourage physical capital accumulation. On the other hand, Kelly (1997) finds a positive (and occasionally significant) growth-enhancing role of social expenditure over a sample of 73 countries over the 1970-89 period, and concludes that this casts doubt on the often-assumed absence of impact on GDP. The rise in productivity induced by improved social cohesion and social welfare could explain this positive link. Barbiero and Cournede (2013) confirm this result, looking for long-term effects of several expenditure items on output growth, via an error-correction model, estimated on 17 OECD countries over the period 1970 to 2008.

Expenditure on *education* has a positive impact (Glomm and Ravikumar 1997; Blankenau et al. 2007; Dissou et al. 2016; Bose et al. 2007). This result is even more pronounced if spending on education is financed by consumption taxes (Blankenau and Simpson, 2004; Voyvoda and Yeldan, 2000). However, conducting a meta-regression analysis on 57 studies on the effect of education on economic growth, Benos and Zotou (2014) identify the existence of a substantial publication selection bias toward a positive impact of education on growth[7].

Expenditure on *health* also appears to boost growth, either on its own (Wang, 2011; Elmi and Sadeghi, 2012) or in combination with other expenditure items in order to take into account potential interdependencies (Barbiero and Cournede, 2013).

Afonso and Alegre (2011) show the existence of a positive effect of *infrastructures* (transportation, water, electric power, etc). In general, positive effects are detected for investment in infrastructure such as transport (Canning and Fay, 1993), transport and communication (Easterly and Rebelo, 1993) and transport, communication and education (Milbourne et al., 2003).

The economic effects of *military expenditure* are more uncertain, although the positive role claimed by Barro (1991) is confirmed, at least for developed countries, by the meta-analysis conducted by Altpekin and Levine (2012) on 32 empirical studies.

In line with the endogenous growth theory (Romer, 1990), investment in intangible assets has been analysed by the empirical literature. According to Szarowská (2017), *public R&D expenditure* is a significant determinant of long-term productivity in EU countries. By contrast, it appears non-significant in CEE countries for the period 1997-2008 (Silaghi et al., 2014). More generally, in a survey of empirical literature, Svensson (2008) finds that, although positive, the effect of public R&D on productivity is lower than that of private R&D spending.

The role of *housing expenditure* is also unclear. While Barbiero and Cournede (2013) observe a dampening effect the opposite is found by Gemmel et al. (2016).

Rather than focusing on a specific category of expenditure, some studies offer a holistic view, comparing the impact on GDP of all of the functional categories of spending. This is also the approach taken in this paper (see section 1.2 and section 2). Kneller et al. (1999), Bleaney et al. (2001), Moreno-Dodson (2008 and Chu et al (2018) distinguish between productive (General public services, Defence, Educational, Health, Housing, Transport and communication) and non-productive expenditure (Social

[7] This means that papers showing significant positive effects of education are more likely to be published (Bom and Ligthart, 2008). If this aspect is taken into account then the growth effect of education is found to be dependent on specific features of the studies: the inclusion of certain variables (education enrollment, education spending, political measures, initial output, and inflation) as well as estimation methods (cross-section instead of panel).

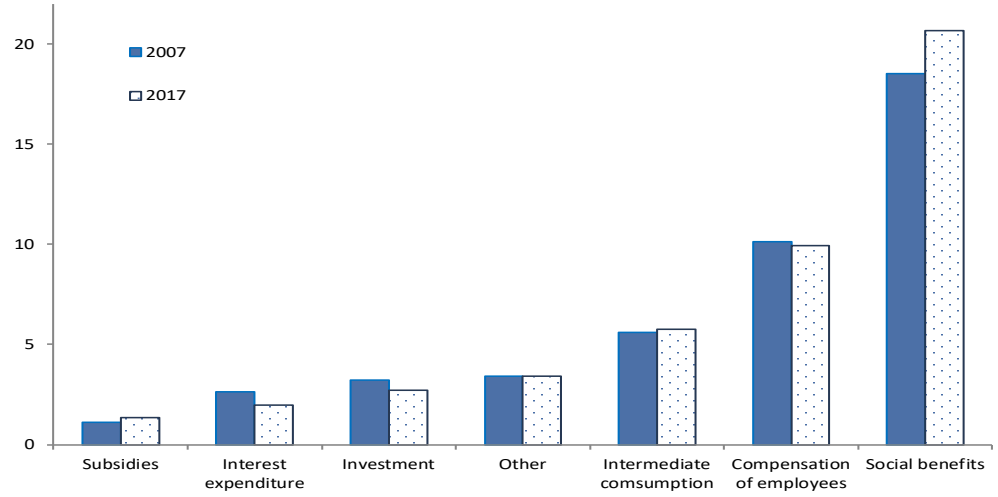
security and welfare, Recreation, Expenditure on economic services[8]). They identify a growth-enhancing effect of productive government expenditure independently from the source of financing[9].

2.2. IS THE COMPOSITION OF PUBLIC EXPENDITURE GROWTH-FRIENDLY?

As mentioned above, the conflicting or equivocal results emerging from the literature make it illusory to find an undisputable definition of growth-enhancing spending. We will therefore focus on the items identified by a large batch of academic papers as most likely associated with economic growth.

Considering the economic classification and focusing on EU as a whole, the growth-friendliest item, that is public investment, only represents 6% of total public expenditure in 2017 and 3% of GDP (Graph 2 and 3). Even adding the expenditure for compensation of employees in education and health (5% of GDP), the growth-friendly components will be (around 8%) still far from social benefits (about 21% of GDP), absorbing the main share of the expenditure In addition, compared with 2007, these items also increased whereas public investment diminished by ½ pp. Social benefits increased by more than 2 % of GDP also because of the crisis. Intermediate consumption also rose though to a lesser extent (0.2 % of GDP). Interest expenditure fell by 0.6 % of GDP. In order to assess the quality of the expenditure, we need to know their ultimate use, which requires a functional decomposition, as studied further below.

Graph 2. **EU composition of public expenditure: economic classification**



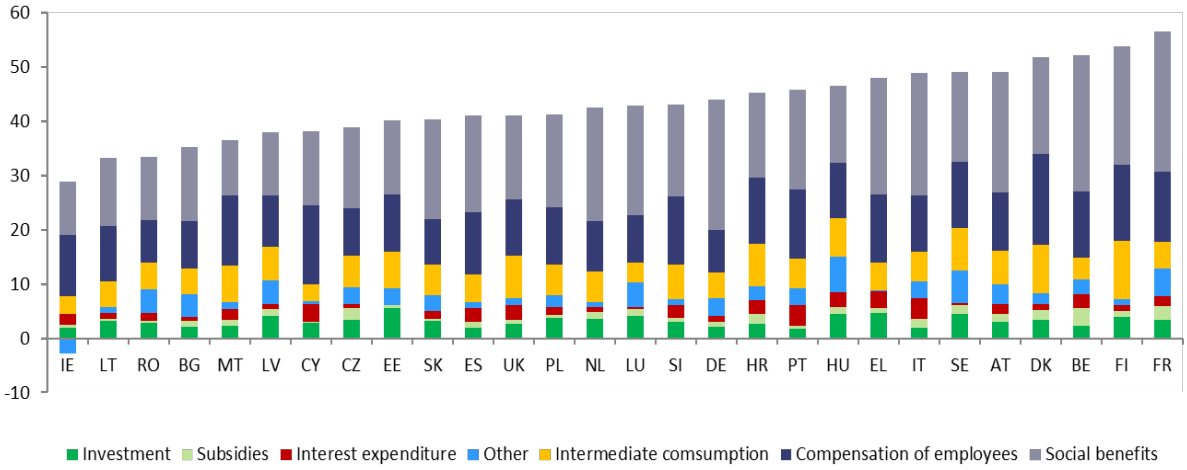
Source: Commission Spring Forecast 2018.

We then consider the functional classification, which is more relevant than the economic classification to study the quality of public spending composition. We consider, as growth-boosting expenditure items, those gathering broad consensus in the literature (see Table 1). In particular, we will refer to public spending on health, education (investment in human capital), transport and communication (investment in infrastructure) as well as R&D (associated with innovation and technological development). We use the second level of Classification of the Functions of Government (COFOG) to construct the growth friendly categories, in particular public R&D, which is computed as the sum of all R&D spending across all COFOG categories (see Table A.4 in the annex).

[8] This category "Expenditure on economic services" encompasses the expenditure on fuel and energy, expenditure on agriculture, forestry, fishing and hunting and the expenditure on mining, mineral resources, manufacturing, and construction.

[9] A similar distinction, although based on a smaller selection of spending categories (public infrastructure investments, education and training, R&D and health care) is also proposed by the European Commission (2012), when assessing and identifying possible actions to enhance the quality of public expenditures within the "Compact for Growth and Jobs", decided by the Heads of State or Government on 28-29 June 2012.

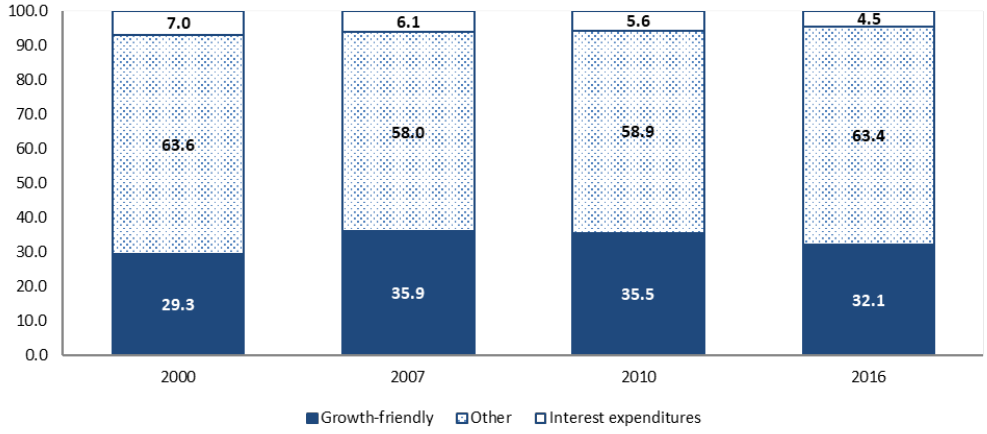
Graph 3. **Composition of public expenditure by country in 2017 (% of GDP)**



Source: Commission Spring Forecast 2018.

According to COFOG data, in 2016 the spending on growth-friendly functions, expressed as a percentage of total expenditure, registered a modest reduction, from 35.5% in 2006 down to 32.6% in 2016 (Graph 4a). This conceals large differences across countries (Graph 4b). Some countries did not experience a substantial change of their spending composition in either direction. Around half of the EU countries, mainly central and northern countries (with RO being the exception) actually recorded a moderate rise in their share of growth-friendly expenditure (about 1 pp on average).
Following these moderate changes, 'growth-friendly' expenditure only represented between 25% (Cyprus) and 40% (Czechia) of total expenditures in 2016. While the country variation is far from negligible, no clear pattern can be found (Graph 4c).

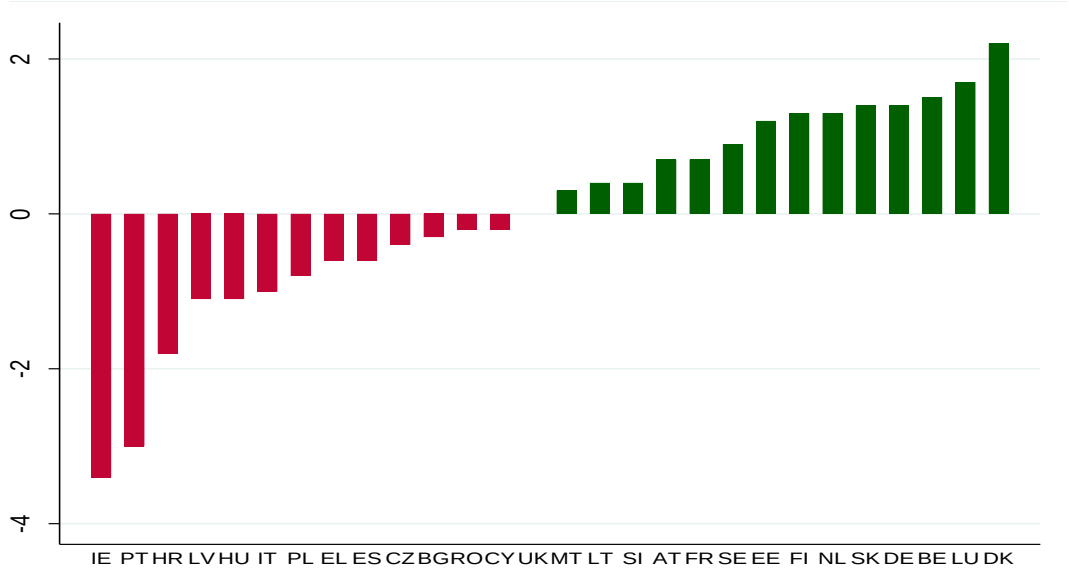
Graph 4a. **EU composition of public expenditure according to growth-friendliness** (Based on COFOG -share of total expenditure)



Note: More growth-friendly: expenditure on education, R&D, health, transport and communication; less growth-friendly: general public services (excluding payments on debt transactions), public order and safety, defence, economic affairs, environment protection, housing and community amenities, recreation-culture and religion; Interest expenditures: payments on debt transactions.

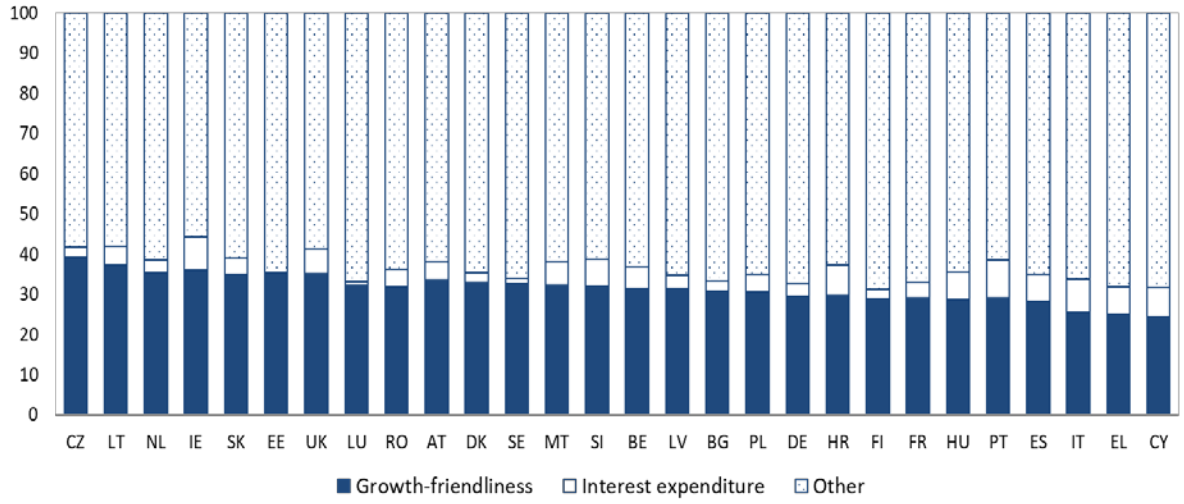
Source: Eurostat.

Graph 4b. **Developments in growth-friendliness of public spending (2007-16) by country (%GDP)**



Source: Authors' elaborations based on Eurostat data.

Graph 4c. **Growth friendliness composition across EU countries (2016)**



Source: Authors' elaborations based on Eurostat data.

3. LOOKING AT THE PERFORMANCE OF EU EXPENDITURE

We focus now on the performance (put another way effectiveness) of public expenditure using COFOG categories. With this term we mean the general ability of public expenditure to reach its various policy targets by funding a large quantity or a high quality of public services. The latter is represented by a set of *output* variables that are associated with a positive effect on growth according to the economic literature. Output variables could capture performance in purely quantitative terms (e.g. proportion of young population with tertiary education) or in more qualitative terms (PISA score

for primary education or survey-based perceived quality of education). All the variables are rescaled so that a high level of output is associated with a good performance.

3.1. DATA AND METHODOLOGY

Following Barrios and Schaechter (2009), we compute a composite indicator, composed of seven sub-indicators: the expenditure composition, education, health, R&D, public infrastructure, public order and safety and general public service. (Table A.1 in the annex). While the first sub-indicator largely depends on productive spending as presented in the previous paragraph, the other six composite sub-indicators measure the *performance* of six individual categories of expenditure with *output* variables that are directly linked to the expenditure in the given category. As an example, in case of education we consider 5 outputs: PISA total score, educational attainment, youth educational attainment, early school leavers and quality of the educational system[10].

A caveat is that a high level of output (capturing the quantity or quality of public services) can be caused by other factors than public spending, such as structural reforms, the existence of an adequate regulation and an appropriate budgetary governance.

Methodologically, the indicators of output should be distinguished from final outcomes (e.g. growth, productivity, quality of life) or environmental variables (e.g. the business cycle, behavioural changes in health consciousness, situation in the labour market affecting the return of educational investment), which can affect both output and outcome. In effect, the link between spending categories and economic growth/other final outcomes or the impact of environmental variables are more difficult to establish. The effect of these output indicators on the ultimate policy objectives (e.g. growth, quality of life) is not directly observed empirically but rather based on theoretical reasoning. The choice of using direct output variables is also motivated by their availability and relatively easy measurement.

Let us take the important and complex example of education, theoretical contributions emphasise different mechanisms through which education affects economic growth (Hanushek and Woessmann, 2008; European Commision, 2010). Education improves the human capital of the labour force, affecting labour productivity and pushing toward a higher equilibrium output level. In endogenous growth theories, education increases the innovative capacity of the economy and thus promotes growth. In particular, education facilitates the implementation of new technologies. Going to the specific outputs of education, according to the literature, if quantity measures are relevant (educational attainment, youth educational attainment, early school leavers), the quality measures are even more (Pisa score, quality of the educational system). Using test scores as a measure of labour-force quality in a sample of 31 countries, Hanushek and Kimko (2000) find that a one-standard-deviation increase in the quality of schooling is associated with an increase in growth seven times larger than the one associated with a one-standard-deviation increase in the quantity of schooling. In this respect, also Benavot (1992) shows how larger emphasis in science and mathematics in the school curriculum can positively influence the development of the economy. The Global Competitiveness Index of the World economic forum also combines qualitative aspects with quantitative measures (secondary and tertiary enrolment rates). Moreover, human capital spillovers may increase productivity beyond the direct effect of education and can interact also with other outputs. Indeed, a better education leads to more informed decisions, affecting both personal choices (i.e. health, political participation, crime participation, etc.) and non-cognitive skills and attitudes (i.e. risk aversion, motivation, etc.) that can influence economic choices.

[10] In this section, while replicating the composite indicator, we will focus on its sub-components measuring the performance of specific spending categories. The sub-indicator relative to the spending composition will also be displayed for sake of completeness: its developments largely confirm the analysis of growth-friendly spending composition presented in the previous section. In contrast with the others, this composite sub-indicator measuring the growth-friendliness of the composition of public expenditure is constructed using policy input indicators, i.e. aggregates directly controlled by the policy maker.

The composite sub-indicators and the overall composite indicator cover the 28 EU Member States over the period 2007 to 2016. This period was largely determined by the availability of data. Moreover, as shown in Table A1 in annex each sub-composite indicator of performance is based on the same variables as used by Barrios and Schaechter (2009) except for the variables that have been discontinued and therefore replaced by related variables from different data sources. These were selected on the basis of four statistical properties: statistical reliability, country coverage, timeliness and time coverage. The data used here are normalised as done in the Lisbon methodology Working Group (LIME) assessment framework (LAF)[11]. This approach allows for an easy interpretation of the results. Specifically, each variable is standardised with respect to its cross-country average and standard deviation.[12] To facilitate the reading and interpretation of the indicator, the LIME methodology (LAF) multiplies the standardised value by 10 as a magnifying-glass coefficient (see Wöhlbier et al. 2018, for an application to tax structure). This resulting score is trimmed for outliers beyond -30 and 30. Assuming a normal distribution of the indicators allows a simple interpretation of the score, as displayed in Table 2.

Table 2. **Distribution and classification of scores**

Continuous score	Classification of score
10 < x < = 30	"very good"
	(over one standard deviation *above* the mean) (≈ top 15% of the normal distribution i.e. 1st sextile)
4 < x < = 10	"good"
	(between 0.4 and 1 standard deviation *above* the mean) (≈ top 35% of the normal distribution minus top 15% i.e. 2nd sextile)
- 4 < x < = 4	"average"
	(between -0.4 and 0.4 standard deviation *around* the mean) (almost one third of the normal distribution around the mean i.e. 3rd & 4th sextiles)
- 10 < x < = - 4	"poor"
	(between 0.4 and 1 standard deviation *below* the mean) (≈ bottom 35% of the normal distribution minus bottom 15% i.e. 5th sextile)
- 30 < = x < = -10	"very poor"
	(under one standard deviation above *below* the mean) (≈ bottom 15% of the normal distribution i.e. 6th sextile)

Source: European Commission (2008); Barrios and Schaechter (2009); Wöhlbier et al. (2018).

The methodology behind the construction of the overall composite indicator and its sub-indicators follows the one developed by Barrios and Schaechter (2009) with one big difference though. All variables are standardised with the average and standard deviation *frozen in the year* 2007 in order to turn this indicator of the "relative" performance of countries for each given year into an indicator apt to measure the evolution of their performance over time (with the performance of 2007 taken as a

[11] See European Commission (2008).

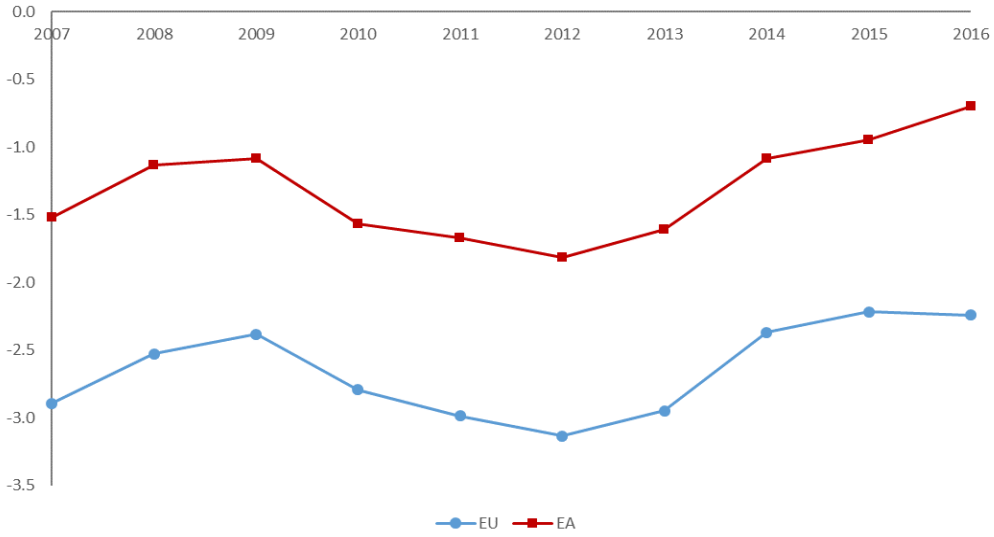
[12] The standardised value is defined by the value of the indicator considered minus its mean and then divided by its standard deviation. The standardisation parameter is the unweighted EU15 average and unweighted EU15 standard deviation. The choice of EU15 is meant to remove the impact of the gradual catching-up process of post-2004 EU countries. The unweighing gives equal weights to policy choices irrespective of the countries' size. Otherwise, this aggregate indicator risks being largely tautological, since the LAF score is defined in relative terms compared with the EU average and standard deviation: so the EU has by construct an "average performance" . On way to go about the issue is to "freeze" the weights in 2007 level, as done here. As in Barrios and Schaechter (2009), the EU average corresponds to EU15 (before 2004 accessions), since more recently acceded Members States are still under catching-up process.

benchmark)[13]. The resulting scores are then aggregated by expenditure category. We considered three standard aggregation methods (unweighted average, random weighting and factor loadings coming from a principal component analysis), which all yielded very similar results. Therefore, results will be discussed based on the principal component analysis method[14], which has the advantage of relying on empirical observations rather than assumptions about the weights. The merit of this approach is also to ensure comparability with past results from Barrios and Schaechter (2009). The overall composite indicator corresponds to the average of the value of composite sub-indicators across all spending categories.

3.2. EVOLUTION IN EXPENDITURE PERFORMANCE IN THE EU AND THE EURO AREA AS A WHOLE

The performance of public expenditures is found to have only marginally improved in the EU and the euro area over the 2007-2016 decade, as captured by the overall composite indicator (see Graph 5), with some reduction during the Great Recession, as could be expected. The indicator for the EU remains somewhat below that of the euro area over the full horizon.

Graph 5. **Performance of Public Expenditures in the EU28 and EA19 - 2007 to 2016**



Source: Authors' elaborations.

As regards the evolution over time, the improvement in the indicator before 2009 largely reversed during the crisis with a modest recovery as of 2014. As a result, the overall spending performance in 2016 turns out to be slightly above its 2007 level for both the EU and the euro area. At the same time, such changes in the composite indicator might be partly driven by the strong cyclicality of some of the variables, such as e.g. public investment.

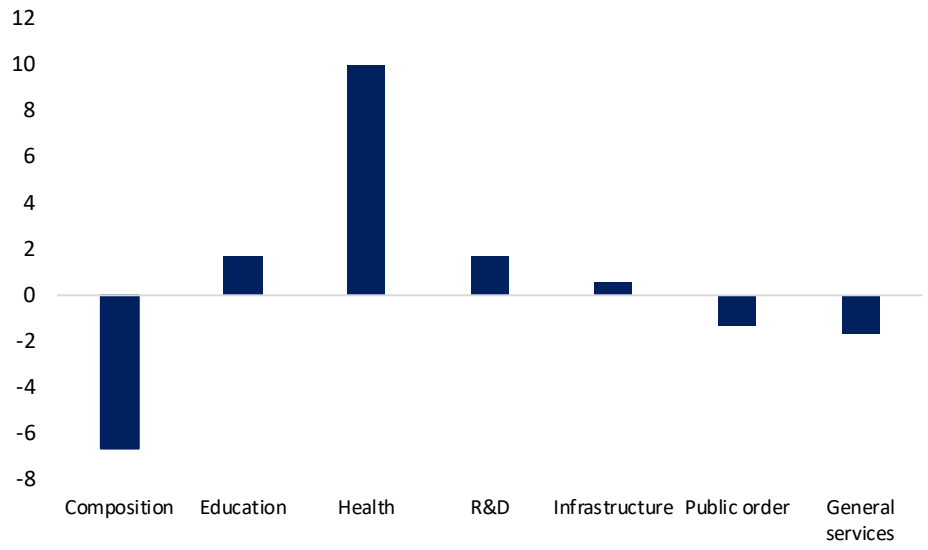
Looking at the evolution of the sub-indicators over time, the analysis suggests a broad improvement in performance in the growth-friendly categories of public expenditure (see Graph 6). Looking closer, the largest improvement regards health-related spending. More moderate improvement is also observable

[13] Otherwise, this aggregate indicator risks being largely tautological, since the LAF score is defined in relative terms compared with the EU average and standard deviation: so the EU has by construct an "average performance" . On way to go about the issue is to "freeze" the weights in 2007 level, as done here. As in Barrios and Schaechter (2009), the EU average corresponds to EU15 (before 2004 accessions), since more recently acceded Members States are still under catching-up process.

[14] In this case the factor loadings of the first factor are taken as weight.

for spending on education, public R&D and to an even lesser extent on infrastructure. By contrast, the indicator of performance deteriorated in the area of public order and general public services. A similar pattern is found for the euro area.These positive developments occurred against the backdrop of deterioration in the growth-friendliness of the spending composition, largely driven by the drop in public investment(see also Graph 4a in the previous section). This seems to suggest that the efficiency of growth-friendly public spending more than offset the decline in their size. This will be analysed in the next chapter.

Graph 6. **Growth-friendliness and performance in specific spending areas in the EU: change over the decade 2007 – 2016 (bars)**



Source: Authors' elaborations.

Overall, the results are encouraging. Even if the overall performance of public expenditure did not improve much over a decade, the performance of growth-friendly spending increased over the same period (especially for education), despite the reduction in their total size. These findings remain indicative though. Some of the sub-indicators may react more slowly to a reduction in spending, given implementation lags and delayed impacts. Still output changes can also refer to factors other than the expenditure but still under government control (i.e. structural reforms, regulations etc.). Similarly, some sub-indicators might be more influenced by factors beyond the control of the government. Further analysis outside the remit of this study would be required to assess the precise nature of these changes and the role of governments in influencing them.

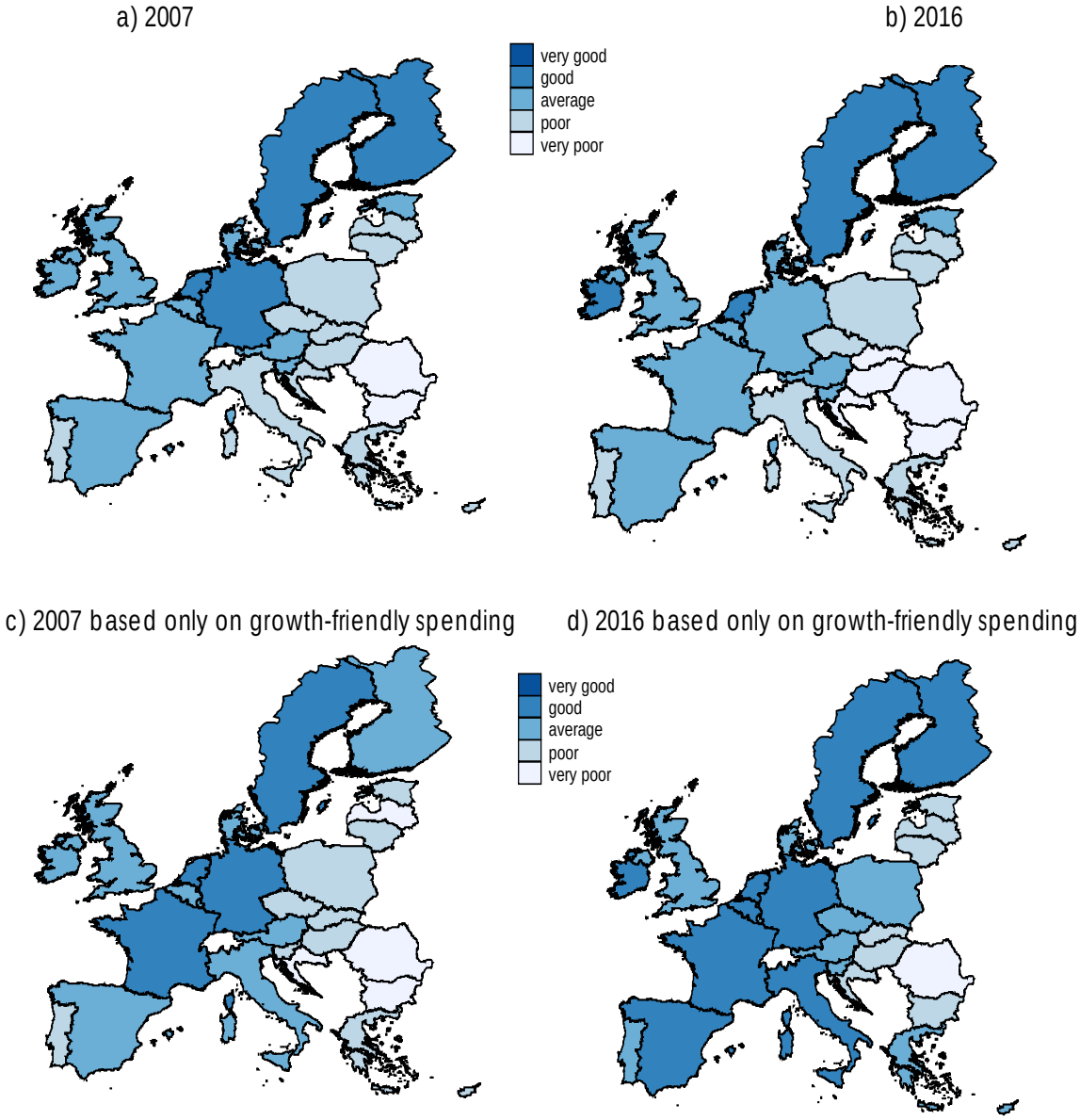
3.3. RESULTS AT MEMBER STATE LEVEL

Country-specific results show some dispersion but also suggest scope for improvement in the performance of public expenditures in the EU. In this respect, for the majority of the EU countries, no major changes have occurred between 2007 and 2016. Specifically, most Member States remain in the category they were in the pre-crisis years (Graph 7).

On the positive side, Luxembourg and Ireland show an improvement passing from average [-4; +4] in 2007 to good performance [+4; +10] in 2016. At the same time, four Member States (HR, HU, SK and

DE) register a deterioration: the first three move from the 'poor' category to the 'very poor' category, while Germany shifted from the 'good' to the 'average' category.

Graph 7. **Composite indicator score by country: 2016 vs. 2007**

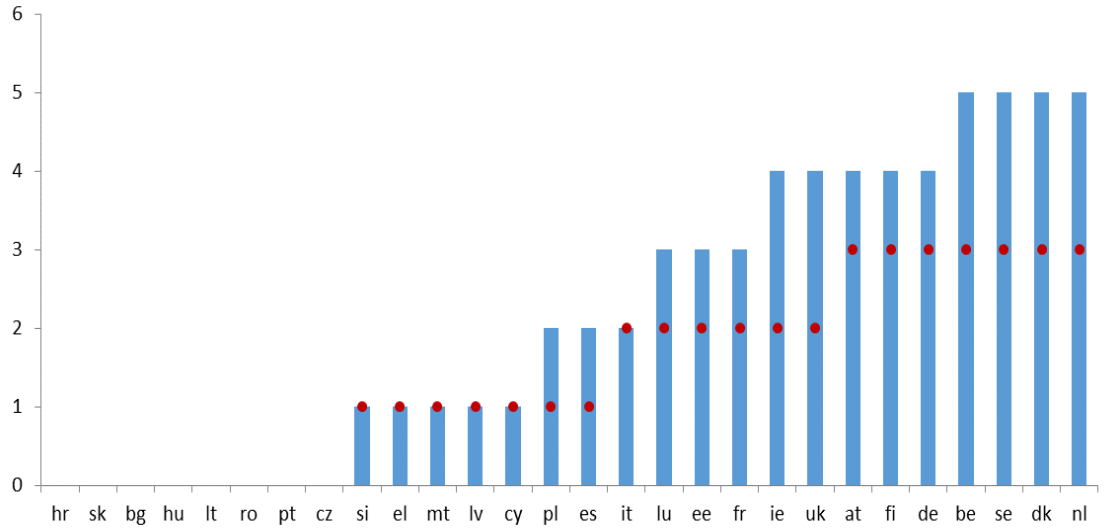


Source: Authors' elaborations.

Compared with the aggregate efficiency, the situation becomes much more favourable when considering the evolution of the performance of growth-friendly public spending by country. Four Member States continue to record a good performance (DE, FR, NL and SE). The performance of seven Member States increased from average to good (BE, CY, ES, IE, IT, FI and MT), while AT, LU and the UK continued to display an average performance. The performance of five Member States improved from poor to average (CZ, GR, PL, PT and SI). The performance of three Member States improved from very poor to poor (BG, HR and LV). No Member State experienced a deterioration in their performance.

As regards specific expenditure categories, no country is found to be among the best performers in all seven spending areas, with four countries (BE, DK, NL, SE) standing among the ten best performers in five out of seven areas (see Graph 8). Eight Member States are not among the ten best performers in any spending area, which suggests clear scope for improvement. Again, the situation appears much more favourable for growth-friendly spending areas (red dots). Seven countries are among the best performers in three growth-friendly spending areas out of four (AT, BE, DE, DK, FI, NL and SE).

Graph 8. **Number of specific public expenditure areas with top ranking, 2016**



Note: The bar shows the number of sub-composite indicators for which Member States rank among the ten best performers in 2016. The dot instead shows the number of productive sub-composite indicators (Education, Health, R&D and Infrastructure) for which Member States rank among the ten best performers in 2016

Source: Authors' elaborations.

4. EFFICIENCY OF PUBLIC EXPENDITURE

Public spending can affect an impact on the aggregate economy. The size of this effect depends also on the efficient way the resources are used. For example, Gonand (2007) refers to the impact on economic growth of increased efficiency of public spending in primary and lower-secondary education. More generally, Angelopoulos et al. (2008) find evidence on how government efficiency critically affects the relation between fiscal size and economic growth.

Efficiency designates the optimal use of resources allocated to produce a certain output (Coelli et al., 2005)[15]. Simply put, this is the ability to achieve an assigned objective, without waste. Public expenditure is considered efficient if, given the available technology, the inputs allocated to the provision of public goods or services produce the highest possible output performance. This is the output-orientated definition. Alternatively, public expenditure is considered efficient if a given level of output performance is produced with the least possible resources. This is the input-orientated definition, which is used in this paper and applies best to public policy: given the scarcity of public

[15] See also for an overview of the efficiency definition and its measures Sickles and Zelenyuk (2019). The link among the inputs (specific categories of public expenditure) and the outputs is based on the literature or on theoretical reasonings. For example, in the case of the health category, Jaba et al (2014) find a significant relationship between health expenditures and life expectancy. Similarly, Jackson (2018), by surveying the literature on the relation between spending and educational attainment, claims that spending matters in order to obtain better results.

money and the distortionary nature of taxation, the key question for policymakers is how to reach a given policy objective, while saving public money. Public expenditure can turn out to be efficient in a country with a relatively low level of output since it devotes very limited resources to it. Inversely, public spending can turn out inefficient in a country with a relatively high level of output if the provision of the output is very costly.

4.1. METHODOLOGY AND DATA

4.1.1. Using two complementary empirical methods

For every function we compute i) the *relative* efficiency of public spending using EU countries data by using non-parametric approach (Data Envelopment Analysis-DEA[16]) on the latest available data at the time of the study (2016) and ii) the Malmquist productivity index to measure the increase or decline in efficiency compared to the pre-crisis period[17] (2007).

First, we use the DEA[18] to compute an efficiency frontier for the 6 functional categories of spending defined by the first level of the COFOG functional classification and used in the previous section[19]. According to Mandl et al. (2008), looking at efficiency by spending areas is more effective than considering the overall public spending efficiency, especially when dealing with cross-country data. Based on linear programming[20], DEA captures efficiency in relative terms, i.e. compared to other observations. The comparison of input-output combinations across Member States allows us to draw a frontier of best-practice countries and to assess the position of Member States relative to this frontier, for every category of expenditure.

In particular, we focus on the technical efficiency (Debreu, 1951 and Farrell, 1957, Sherman and Zhu, 2006), which implies that resources are not wasted in producing a unit of output. The nature of the units under analysis (governments), the relatively broad definition of the government functions as well as the lack of explicit prices, for both input and output, are the reasons behind the choice of a non-parametric method. Alternative approaches (e.g. stochastic frontier, least squares econometric production models, total factor productivity indices) would rely on parametric assumptions and/or would aim at capturing absolute efficiency by estimating an unobserved production function. A merit of this non-parametric methodology is that it does not require any assumption regarding either the functional form linking inputs to outputs or data distribution. It relies only on general axioms of production theory such as: monotonicity, convexity, and homogeneity[21]. In addition, it allows the use

[16] See for an evolution of the Dea methods Charnes et al., (1978), Banker, et al. (1984), Boussofiane et al., (1991) and Yong – Bae and Choonjoo, (2010).

[17] For expenditure education the comparison is made with 2005.

[18] See also on this topic: Boussofiane et al., (1991) and Yong–Bae and Choonjoo, (2010). There are two types of DEA models: input-oriented model, looking for minimisation in inputs, for given output levels, and output-oriented model, maximising outputs for given input values.

[19] Please see Cepparulo et al. (2016) for a first attempt in this direction.

[20] Suppose that there are N decision-making units (here countries), each producing m outputs and n inputs. The decision-making unit j uses the input vector x_j to produce the output vector y_j. The shadow price vectors (i.e. weights) for inputs and outputs are unknown and given by the vectors *u* and *v*. Then the efficiency (productivity) θ of the unit j will be the result of the following optimisation problem:

$$Max_{u\,v}\ \theta = \frac{u'y_j}{v'x_j}$$

$$\text{subject to } \frac{u'y_i}{v'x_i} \leq 1\ with\ i = 1,2,\ldots.N;$$

$$u \geq 0\ and\ v \geq 0$$

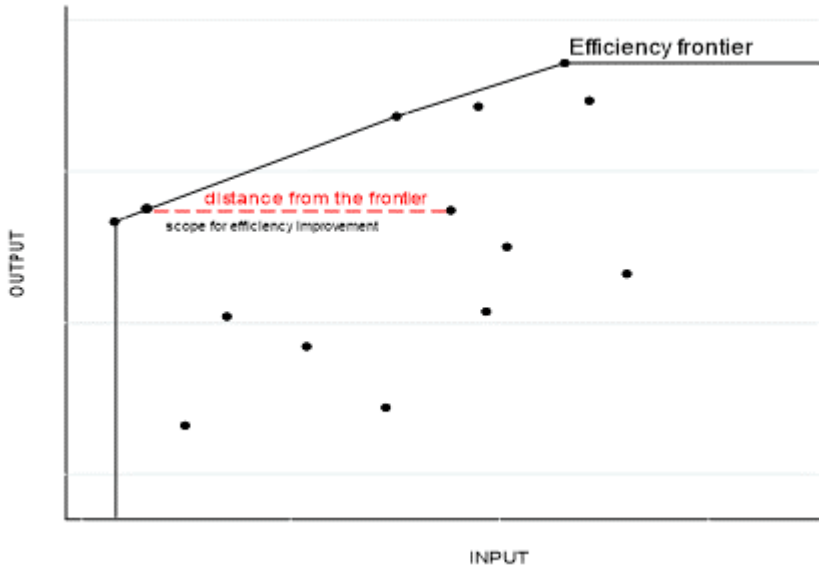
[21] As a working assumption, we consider EU countries as political homogenous units.

of different units of measurement and it does not impose any limits on the number of inputs and outputs to be considered.

Graphically, in the case of a single input-output, output (performance) is measured along the vertical axis in the graph, while input resources are on the horizontal axis, as illustrated in Graph 9. Efficient countries are located along the frontier, while inefficient countries are represented by dots underneath the frontier. Relative distance to the frontier defines the inefficiency or 'efficiency gap'. This implies that a move toward the estimated frontier corresponds to a reduction of inputs with unchanged outputs.

We compute robust efficiency scores[22] to correct estimations by sample bias (Simar and Wilson, 2000; Simar and Wilson, 1998) which implies that the sample may fail to incorporate the most efficient governments, causing upwards biased estimates of input-oriented efficiency. Boostraps at different number of replications (500, 1000, 2000) and intervals of confidence (alpha = 0.1, 0.05 and 0.01) are performed in order to check for consistent results.

Graph 9. **Data envelopment analysis: estimating the efficiency frontier**



Source: Authors' elaborations.

Second, we also use another technique to measure the development in efficiency over time, since the DEA remains a static approach. We compute the input oriented Malmquist productivity indices-MPI (Malmquist, 1953; Caves, Christensen and Diewert, 1982). It is a dynamic non-parametric method comparing both the DEA-generated efficiency frontiers and the distance to them between two time periods. It measures the change in the overall efficiency of spending. A change in efficiency can be due not only to a technical efficiency change (TEC-reaching the efficiency frontier) but also to a technological change (TC-a shift of the efficiency frontier), the index is defined as follows[23]:

$$MPI_{t,t+1} = TEC * TC = \left(\frac{D_{t+1}^{t+1}}{D_t^t}\right)\sqrt{\left(\frac{D_{t+1}^t}{D_{t+1}^{t+1}}\frac{D_t^t}{D_t^{t+1}}\right)}$$

[22] We use the package rDEA — Robust Data Envelopment Analysis (DEA) for the software R.

[23] A simple form is: $MPI_{t,t+1} = \sqrt{\frac{D_{t+1}^t}{D_t^t}\frac{D_{t+1}^{t+1}}{D_t^{t+1}}}$

where D represents the distance of each observation unit, in the input output space, the subscript represents the set of inputs/outputs at a specific time (*t* or *t+1*) and the superscript represents the time when the frontier is set (*t* or *t+1*). *t+1* denotes here a subsequent point in time, not necessarily a consecutive year. The technical efficiency (TEC) change compares the distance to the frontier between *t* and *t+1*, even if the referential - the technological frontier - has shifted in the meantime. The technological change (TC) compares the distance of the observed unit in *t* to the frontierbefore and after the frontier shifts. It also compares the distance to the frontier in *t+1* before and after the frontier shifts, and takes the average of these two measures to capture the impact of the shift in the technological frontier.[24]

4.1.2. Data source and treatment: using multiple output variable

Measuring the efficiency of public spending carries a number of difficulties as regards the timely availability of data as well as the measurement of both input and output variables. In addition, DEA approach is heavily dependent on the specification and definition of inputs and outputs (Sarkis, 2007).

Following the literature (Afonso and Aubyn, 2008; Afonso et al., 2010; Dutu and Sicari, 2016; Afonso and Kazemi, 2017), we consider public expenditure, measured in euro, as input. Expenditure data are mainly taken from the COFOG database (at the first level of disaggregation) but we also use other data sources as far as available. Given that the performance indicators are, in many cases, of structural nature, they are likely to have been influenced by past input over a longer time horizon. Therefore, for the DEA computations, when available (see Table A2), input variables were calculated as the average expenditure on the category over the past ten years. Besides, where the outputs can be influenced also by private input, e.g. in the case of health and R&D, total expenditure (public and private) is considered.

Regarding the output of public spending, there is an inherent difficulty in measuring it. One has to choose indicators that are considered to be relatively strongly influenced by public spending and less by external, so-called environmental factors. In several cases, the indicators used reflect the outcome, rather than the output strictly speaking, which cannot be measured directly. Therefore, the choice of output is based on the choice of reasonable indicators of output, coming out of the literature and also frequently monitored by policy makers when implementing concrete policies. Therefore, we use the database by Barrios and Schaechter (2009), which propose a set of carefully chosen indicators, in line with existing literature. In contrast with Afonso and Schuknecht (2019) concentrating on single output variables, we assess expenditure functions based on multiple individual output variables (see Table A1)[25].

To avoid scaling issues and ensure data comparability, the data are mean-normalised. This is required since multiple outputs are used. Then, as the analysis is based on the working principle that outputs are better when larger in value, we take the inverse where the output variables are built in the opposite way (such as the early school leavers' outputs). Besides, as the DEA method assumes the absence of random noise, measurement errors, and outlier cases in the data, the detection of outliers is performed by adopting a non-parametric approach proposed by Daraio and Simar (2007). Finally, as the choice and the number of inputs and outputs is also relevant in discriminating between efficient and inefficient units, we check, for each expenditure category, the compliance of our sample size with the

[24] In more technical terms, TC is the geometrical unweighted average of two ratios. The first ratio compares the distance of an observed unit in the first period *t* vis-à-vis the 'old' frontier (in *t*) with the distance of the same unit in the same period *t* vis-à-vis the 'new' frontier (in *t+1*). The second ratio compares the distance of the observed unit in the second period *t+1* vis-à-vis the 'old' frontier (in *t*) with the distance of the same unit in the same period *t+1* vis-à-vis the 'new' frontier (in *t+1*).

[25] In short, a category of spending, as inputs, could be related to a combination of outputs, with possible trade-off between individual outputs variables

rules of thumb emerged in the literature[26] (Boussofiane et al.,1991; Golany and Roll,1989; Bowlin, 1998).

4.2. RESULTS

To recall and to ease the interpretation, a DEA-based score of one points to a (relatively) efficient country, located at the frontier. A score between zero and one signals an inefficient country. The difference between 1 and efficiency score represents the efficiency gap, that is, the room for improvement: how much a country can reduce the input to get the same output, that is a given quantity or quality of public services. Therefore, we are not here measuring the quantitative or qualitative performance of spending. We only consider that the government has chosen to provide a given level of public services, which should be produced efficiently.

A Malmquist productivity index greater than one will indicate progress in efficiency (covering both technical efficiency and technological progress) while a value lower than one will imply an efficiency decline. An index equals to one refers to the case when no change occurred.

Looking at the efficiency of specific spending categories, infrastructure (Graph 10, d) appears the type of expenditure for which major efficiency gains can be envisaged (larger differences between 1 and the DEA-efficiency score). Several eastern European countries could significantly increase the efficiency of their infrastructure spending. For those countries, no improvement is observed since the pre-crisis period (2007), with the exception of Czech Republic. Only 10 countries have Malmquist productivity index larger than one (in grey in Table 3). By contrast, the majority is affected by a decline in efficiency, mainly related to an adverse shift in the technological frontier (see Table A3 for the decomposition of the Malmquist productivity index of Table 3). This result can be related to the large investment cutback during the crisis.

Other spending categories where inefficiencies (average distance to the frontier) are still relatively large are research and development, public order and safety and general public services (Graph 10). In the last one, progress has been already observed since 2007 for the majority of the EU countries (Table 3), largely attributable to technical efficiency gain.

Lower albeit still large are inefficiencies in the health sector (Graph 10a) affecting mostly northern European countries, confirming previous findings (Dutu and Sicari, 2016). Efficiency increase regards only 10 countries (driven mostly by higher technical efficiency), while the other countries show a decline, connected to a loss in efficiency of scale.

By contrast, education for secondary and tertiary education (when considering outputs other than Pisa), is the spending category where inefficiencies are the lowest on average. Primary education (Pisa scores) is the spending category where the highest number of countries recorded an increase in overall efficiency from 2007.

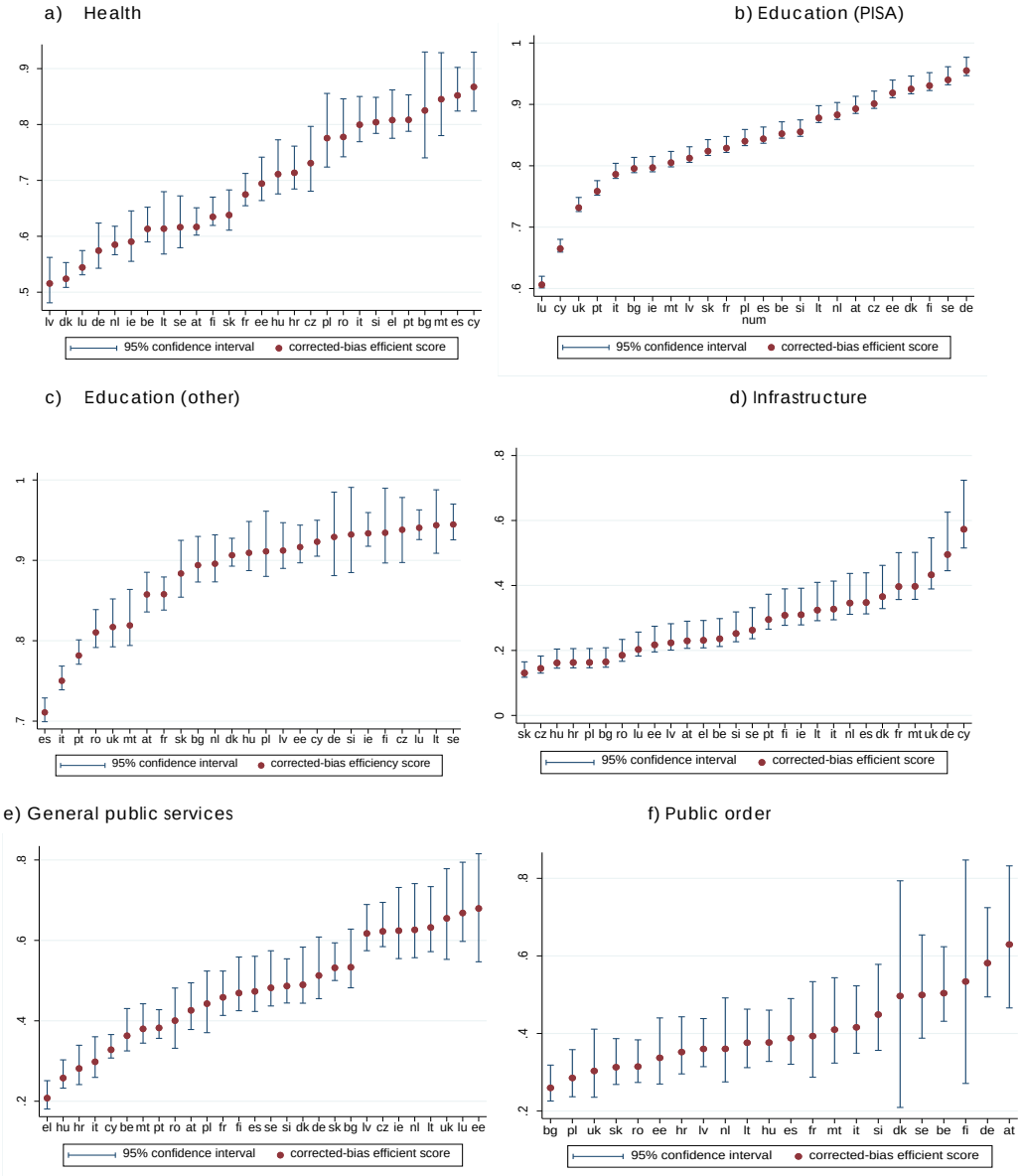
Finally, looking at the recent progress made in terms of spending efficiency (Table 3), it should be noted that the majority of the cases occurred in growth-friendly spending areas, especially in education, health and infrastructure (around 40 out of 65).

DEA-based scores (Graph 10) also allow for a first tentative assessment of spending efficiency *by country*, which should be confirmed, nuanced or invalidated by further in-depth analysis, beyond the scope of this quantitative study. Regarding the five best DEA-based scores (in descending order), no country is efficient in all the public spending categories: only Cyprus, Germany, Finland, Sweden and Malta are comparatively efficient in three spending categories while over two thirds of the countries are at least relatively efficient in one sector.

[26] See for more details on this aspect Sarkis (2007)

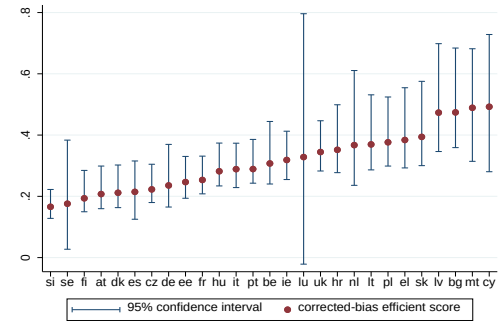
Cyprus, Spain, Malta, Bulgaria and Portugal seem relatively efficient regarding health care spending. Regarding education spending, (relatively) efficient countries are - in descending order - Germany, Sweden, Finland, Denmark and Estonia for primary education (captured by PISA score) and Sweden, Lithuania, Luxemburg, Czechia, Finland and Ireland for secondary and tertiary education (taken together). These results except for CZ are also confirmed by previous findings (Canton et al, 2018). Cyprus, Germany, the United Kingdom, Malta and France appear relatively efficient for infrastructure. Estonia, Luxembourg, the United Kingdom, Lithuania and the Netherlands seem to show high (relative) efficiency regarding general public services. Austria, Germany, Finland, Belgium and Sweden are relatively more efficient regarding public order spending. Regarding R&D, the front-runners are Cyprus, Malta, Bulgaria, Latvia and Slovakia.

Graph 10. **Bias-corrected efficiency for each expenditure category**[27]



[27] Robust efficiency scores shown here are based on 2000 boostrap replications and confidence interval of 0.05.

g) R&D



Source: Authors' elaborations.

A majority of countries experienced a deterioration of their efficiency (Malmquist index) in a majority of spending areas. Around half of the EU countries displayed an improvement in two categories or less, meaning that they experienced some deterioration in at least 5 categories out of 7. One third of Member States show an improvement in 3 out of 7 categories, namely Austria, Bulgaria, Germany, Estonia, Croatia, Italy, Latvia, Malta and Poland. This means that they experienced a deterioration in efficiency in 4 categories out of 7. The few exceptions were Spain, which shows an efficiency gain (Table 3, cells in grey) in 5 out of 7 categories since the pre-crisis period, and Cyprus, Portugal and Luxembourg, which display an efficiency gain in 4 out of 7 categories.

Comparisons with previous studies are limited due to differences in the sample, the horizon, the approach, the output and input data used.

Table 3. **Efficiency development (Malmquist productivity index between 2007 and 2016)**[28]

	Health	Public order	Infrastructure	R&D	Public services	Education (PISA)	Education (other)
AT	1,01	0,91	0,96	0,27	1,22	1,06	0,95
BE	0,97	n.a.	0,64	0,45	1,66	0,96	1,12
BG	0,82	1,71	0,99	0,94	1,52	n.a.	1,07
CY	1,03	n.a.	1,12	0,62	1,60	n.a.	1,18
CZ	0,93	n.a.	1,17	0,78	0,66	1,07	0,93
DE	0,913	0,97	0,58	0,27	1,21	1,07	1,08
DK	0,89	0,45	0,77	0,30	1,36	0,96	0,85
EE	1,09	2,90	1,02	0,58	0,39	n.a.	0,94
EL	n.a.	n.a.	0,57	0,90	2,26	n.a.	n.a.
ES	1,07	1,41	1,15	0,84	1,52	1,09	0,88
FI	0,93	0,61	0,51	0,41	1,25	0,96	1,01
FR	1,02	0,72	0,95	0,34	0,90	1,02	0,98
HR	0,95	1,33	0,91	1,18	1,64	n.a.	n.a.
HU	1,05	n.a.	0,74	0,61	1,53	Outlier	0,96
IE	n.a.	n.a.	1,25	0,53	0,74	0,97	1,12
IT	1,03	n.a.	0,94	0,70	1,29	1,10	0,88
LT	0,99	n.a.	1,08	0,87	1,074	n.a.	0,94
LU	1,05	n.a.	1,22	0,80	0,79	1,07	1,16
LV	0,95	n.a.	0,38	0,89	1,12	1,06	0,97
MT	0,96	0,51	1,15	0,72	1,54	n.a.	1,23
NL	0,94	0,74	1,03	0,33	0,57	0,95	1,11
PL	n.a.	2,62	0,63	0,86	1,22	1,08	0,86
PT	1,01	n.a.	1,31	0,65	1,10	1,07	1.0
RO	0,87	1,84	0,13	Outlier	0,73	Outlier	0,94
SE	0,90	0,694126	0,56	0,26	0,53	1,09	0,96
SI	1,04	n.a.	0,86	0,70	1,68	n.a.	0,83
SK	0,93	2,02	0,49	1.0	0,96	0,95	0,84
UK	n.a.	0,82	0,74	0,57	0,61	0,95	0,98

Note: in grey the countries showing a gain in efficiency.
Source: Authors' elaborations.

[28] For education the years of reference are 2005-2015 based on available data.

5. CONCLUSIONS

The paper provides a first indication on the composition, performance (effectiveness) and efficiency of public expenditure at the level of countries and specific functions of government**.** Reviewing these three different dimensions of the quality of public expenditures across seven categories of spending and each EU country allows for some granularity in the analysis. Based successively on a literature survey, semi-disaggregated composite indicators of performance and an efficiency frontier approach, the analysis provides a rich set of results on the quality of public spending, giving indications on where room for improvements appears to be large.

The overall results turn out fairly mixed, providing a nuanced picture of the quality of public expenditure in the EU both in terms of level and change. In particular, no Member State is found to be among the most performing (effective) or efficient in all seven spending areas. No country is either among the least performing or efficient in all spending areas. No country improves or worsens its situation in all areas. This said and based on the indicators used in the paper, some countries are relatively less efficient than others in a majority of spending areas, signalling some room for improvement.

Regarding the situation in 2016, the total share of growth-friendly spending (education, R&D, health, transport and communication infrastructures) only represents a third of total expenditure. In addition, many countries still have a large scope for increasing the efficiency of their public expenditure. Specifically, inefficiencies (average distance to the efficiency frontier) are still relatively large in infrastructure – possibly due to widening public investment gap during the crisis – and, to a lesser extent, in research and development, public order and safety and general public services. Education for secondary and tertiary education - an important growth-friendly area - is the spending category where inefficiencies are the lowest on average.

Looking at the change over the decade 2007-2016, the average performance of growth-friendly public spending increased in the EU (especially for education), showing a stronger capacity of meeting their objectives, although their total size receded somehow in the EU over the same period. This is in line with the finding that the great majority of the cases of increasing spending efficiency occurred in growth-friendly spending areas, especially in education, health and infrastructure. Primary education (Pisa scores) is the spending area where the highest number of countries recorded an efficiency increase. However, looking at all spending categories and not only at the growth-friendly ones, the overall performance of public expenditure in the EU suffered from the Great Recession and did not improve much over a decade. A majority of EU countries also experienced a deterioration of expenditure efficiency in a majority of spending categories.

Finally, *methodological caveats and limitations should be borne in mind*. It should be stressed that the assessment of spending quality follows a statistical approach exploiting an existing database of quantitative indicators. Thus, one should refrain from drawing strong conclusions on the basis of this assessment, which only represents a – valuable – first step to trigger an informed economic discussion. Concrete policy recommendations should be based on in-depth analysis focusing on specific expenditure areas. Additional aspects, which are specific to expenditure areas and/or Member States and cannot be reflected in this general assessment, need to be taken into consideration. The clear merit of this study remains its ability to analyse all spending areas in a comprehensive way and from various angles (composition, performance and efficiency).

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ANNEX

Table A1. List of variables

dimensions (used for the performance analysis)	**Description**	**Data source**	**Output for efficiency analysis**
COMPOSITION EXPENDITURE	Public investment (%GDP)	AMECO	
	Public investment (% primary expenditure)	AMECO	
	Public Investment / Public Consumption ratio	AMECO	
	Productive expenditure % GDP (Sum of Public spending on transport and communication, R&D, education and health)	EUROSTAT	
	Productive expenditure % primary expenditure (Sum of Public spending on transportation and communication, R&D, education and health)	EUROSTAT	
EDUCATION	PISA total score	OECD	x
	Educational attainment	EUROSTAT	x
	Youth educational attainment	EUROSTAT	x
	Early school leavers	EUROSTAT	x
	Quality of the educational system	WEF	x
HEALTH	Life expectancy at birth	EUROSTAT	x
	Life expectancy at 65	EUROSTAT	
	Health adjusted life expectancy - Females	EUROSTAT	x
	Health adjusted life expectancy - Males	EUROSTAT	x
	Infant mortality	EUROSTAT	
R&D	Patents granted to residents	WIPO	
	Patent applications	EUROSTAT	x
	Number of patent applications	EUROSTAT	
	Technological Readiness	WEF	x
	R&D innovation index	WEF	
	Quality of scientific research institutions.	WEF	x
	Tertiary graduates per inhabitants	EUROSTAT	
	Quality of math and science education	WEF	
PUBLIC INFRASTRUCTURE	Length of motorways	EUROSTAT & CIA	
	Length of railways		
	Fixed line and mobile phone subscribers	WORLD BANK	
	internet users per inhabitants	WORLD BANK.	
	Quality of electricity supply	WEF	
	Overall infrastructure index	WEF	x
PUBLIC ORDER & SAFETY	Persons convicted	UNODC	
	Crime reported by police	EUROSTAT	x
	Business cost of crime	WEF	
	Judicial independence	WEF	

	Organised crime	WEF	
	Reliability of police services	WEF	x
	Security property rights	WEF	
	Persons killed or injured in road traffic accidents	OECD	x
GENERAL PUBLIC SERVICES	Irregular payments and bribes	WEF	
	Corruption perception index	Transparency International	x
	Favouritism in decisions of government officials	WEF	
	Public trust of politicians	WEF	
	Diversion of public funds	WEF	
	Burden of government regulations	WEF	
	Wastefulness of public spending index	WEF	
	Government effectiveness	World Bank	x
	E-government index	UNPACS	x

Note: the variables in grey are those only used for efficiency purposes but not part of the list used for the computation of the composite indicator.

Table A2. Efficiency analysis: shorter list of input variables

INPUT	ORIGINAL DATA SOURCE
Per capita expenditure on Education expenditure by level of education	World Bank
Total R&D expenditures (public+ private)	World Bank
Public order	Eurostat
General public services	Eurostat
Infrastructure	Eurostat
Per capita expenditure on health care(public+ private)	World Bank

Table A3. Malmquist index decomposition

	Health		Public order		Infrastructure		R&D		Public services		Education (PISA)		Education (other)	
	TEC	TC	TEC	TC	TEC	TC	TEC	TC	TEC	TC	TEC	TC	TEC	TC
AT	1.0	1.0	0.9	1.0	1.6	0.6	0.6	0.5	1.2	1.0	1.1	1.0	1.0	0.9
BE	1.0	1.0	.	.	1.1	0.6	0.9	0.5	1.7	1.0	1.0	1.0	1.2	1.0
BG	1.0	0.8	1.6	1.1	1.6	0.6	1.3	0.7	1.5	1.0	.	.	1.1	1.0
CY	1.0	1.0	.	.	1.8	0.6	1.0	0.6	1.7	0.9	.	.	1.3	0.9
CZ	0.9	1.0	.	.	1.9	0.6	1.1	0.7	0.7	1.0	1.1	1.0	1.0	0.9
DE	0.9	1.0	1.0	0.9	0.9	0.6	0.6	0.5	1.3	1.0	1.1	1.0	1.1	1.0
DK	0.9	1.0	0.5	0.9	1.3	0.6	0.6	0.5	1.4	1.0	1.0	1.0	0.9	0.9
EE	1.1	1.0	2.7	1.1	1.7	0.6	0.8	0.7	0.4	1.0	.	.	1.0	1.0
EL	.	.	.	.	0.9	0.6	1.2	0.7	2.3	1.0	.	.	.	.
ES	1.0	1.0	1.4	1.0	1.9	0.6	1.3	0.7	1.5	1.0	1.1	1.0	0.9	0.9
FI	0.9	1.0	0.6	1.1	0.8	0.6	0.8	0.5	1.3	1.0	1.0	1.0	1.0	1.0
FR	1.0	1.0	0.7	1.0	1.6	0.6	0.7	0.5	0.9	1.0	1.0	1.0	1.1	0.9
HR	0.9	1.0	1.2	1.1	1.5	0.6	1.6	0.7	1.7	1.0	.	.	.	.
HU	1.1	0.9	.	.	1.2	0.6	1.0	0.6	1.6	1.0			1.0	1.0
IE	.	.	.	.	2.1	0.6	1.0	0.6	0.7	1.0	1.0	1.0	1.2	0.9
IT	1.0	1.0	.	.	1.6	0.6	1.2	0.6	1.2	1.1	1.1	1.0	1.0	0.9
LT	1.1	0.9	.	.	1.8	0.6	1.2	0.7	1.1	0.9	.	.	1.0	0.9
LU	1.0	1.0	.	.	2.0	0.6	1.6	0.5	0.8	0.9	1.1	1.0	1.3	0.9
LV	1.0	1.0	.	.	0.6	0.6	1.2	0.7	1.2	1.0	1.1	1.0	1.0	1.0
MT	1.0	1.0	0.4	1.2	1.9	0.6	1.2	0.6	1.6	1.0	.	.	1.3	0.9
NL	0.9	1.0	0.9	0.9	1.7	0.6	0.7	0.5	0.6	0.9	1.0	1.0	1.2	1.0
PL	.	.	2.4	1.1	1.0	0.6	1.2	0.7	1.2	1.0	1.1	1.0	1.0	0.9
PT	1.0	1.0	.	.	2.2	0.6	1.0	0.7	1.1	1.0	1.1	1.0	1.0	1.0
RO	1.0	0.9	1.6	1.1	0.2	0.6			0.7	1.1			0.9	1.0
SE	0.9	1.0	0.8	0.9	0.9	0.6	0.5	0.5	0.5	1.0	1.1	1.0	1.0	0.9
SI	1.0	1.0	.	.	1.4	0.6	1.1	0.7	1.6	1.0	.	.	1.0	0.8
SK	0.9	1.0	1.8	1.1	0.8	0.6	1.3	0.7	1.0	0.9	1.0	1.0	0.9	0.9
UK	.	.	0.7	1.1	1.2	0.6	1.1	0.5	0.6	0.9	1.0	1.0	1.0	1.0

Note: TEC corresponds to technical efficiency change and TC to technological change.

Table A4. Correspondence table: COFOG, growth-friendly expenditure and other spending areas covered by the analysis

COFOG	Growth-friendly expenditure	Spending areas à la Barrios and Schaechter covered by the analysis on Performance (PCA) & Efficiency (DEA& Malmquist)
01 General public Service		General public service
0105 R&D		R&D
	R&D	
02 Defense		
0204 R&D	R&D	R&D
03 Public order and safety		Public order and safety
0305 R&D		R&D
	R&D	
04 Economic affairs		
0405 Transport	Transport & Communication	Infrastructure
0406 Communic.	R&D	
0408 R&D		R&D
05 Environmental protection		
0505 R&D		
	R&D	R&D
06 Housing and community amenities		
0605 R&D		
	R&D	R&D
07 Health	Health	Health
0705 R&D	R&D	R&D
08 Recreation, culture and religion		
0805 R&D	R&D	R&D
09 Education	Education	Education
0907R&D	R&D	R&D
10 Social protection		
1008 R&D	R& D	R&D

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