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Public sector efficiency in Europe: Long-run trends, recent developments and determinants

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Working Paper
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Public sector efficiency in Europe: Long-run trends, recent developments and determinants

Abstract

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- We find that countries with small public sectors tend to be more efficient no matter which efficiency techniques we use. Because of the relatively long time span of our data, our study contributes to the literature by analyzing the effect of the financial crisis on the efficiency of the public sector in European countries. We show that after the crisis, the public sector efficiency increased especially in countries with small public sectors, while it stayed constant or worsened in countries with big public sectors.
- Finally, we analyze in more depth the impact of fiscal decentralization and fiscal rules on the public sector efficiency. We conclude that while decentralization is fostering efficiency, fiscal rules do not have any effect. Moreover, fiscal rules combined with decentralization may harm efficiency, consistently with the ratchet effect.

Keywords

- Public sector, efficiency, order-m, input-oriented efficiency, output-oriented efficiency, decentralization, fiscal rules

Public sector efficiency in Europe: Long-run trends, recent developments and determinants*

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Abstract

This paper investigates the efficiency of the public sector in a sense of public performance and expenditures. For 23 European countries and for the period between 1995 and 2015 we construct a measure of public sector performance that consist of nine distinct indices for each area of public policy, such as administration, health education, economic performance, security and infrastructure. We use several efficiency techniques (FDH, order-m) and investigate input- and output-oriented efficiency of the public sector. We find that countries with small public sectors tend to be more efficient no matter which efficiency techniques we use. Because of the relatively long time span of our data, our study contributes to the literature by analyzing the effect of the financial crisis on the efficiency of the public sector in European countries. We show that after the crisis, the public sector efficiency increased especially in countries with small public sectors, while it stayed constant or worsened in countries with big public sectors. Finally, we analyze in more depth the impact of fiscal decentralization and fiscal rules on the public sector efficiency. We conclude that while decentralization is fostering efficiency, fiscal rules do not have any effect. Moreover, fiscal rules combined with decentralization may harm efficiency, consistently with the ratchet effect.

JEL Classification: C14, H50, H72

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1. Introduction

Transparency of government budgets and practices across the globe has increased tremendously during recent centuries. This development has led to an increased interest not only by economists, but also by the public with regard to the use of resources by the state and regarding the question whether the state can use these resources more efficiently.

Additionally, the member states of the European Union agreed on the Stability and Growth Pact, which should lead to fiscal discipline and limits expenditure increases of individual countries. Additionally, not only capital, but also labor became more mobile, especially within the European Union, which comes along with more pressure on European governments revenues. All in all, those

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developments increase the importance of public sector efficiency (see, e.g., Tanzi and Schuknecht, 2000; Heller, 2003; Joumard et al., 2004).

Academics and especially international organizations such as the ECB or the OECD have made progress in this regard by paying more attention to the costs of public activities. The increase of general tax burdens in most European countries and the developments mentioned above led to a change in the analysis. As argued by Afonso et al. (2010), "they have been shifting the focus of analysis from the amount of resources used by ministry or programme (inputs) to the services delivered or outcomes achieved."

The adequate measurement of public sector efficiency is a complicated empirical issue. The measurement of the costs of public activities, as well as the calculation of efficiency via choosing cost and outcome variables of certain public policy areas is not straightforward, as will be discussed later on.

Our paper focuses not only on new methodological techniques to measure input as well as output-oriented efficiency scores but we also calculate efficiency scores for all years between 1995 and 2015 for 23 European economies. We can, therefore, analyze efficiency developments over a panel of countries during 20 years. We are especially interested in the efficiency developments of countries during the crisis and its aftermath. Compared to Afonso et al. (2005) or Afonso et al. (2010) we use similar performance indices (with different methodology), but we use more output variables, which makes our results less dependent on a single outcome variable. Finally, having constructed a dataset of efficiency measures we can look at its determinants in a regression analysis. Unlike Adam et al. (2014) and Hauner and Kyobe (2010), who focus only on education and health sectors, we analyze the overall performance of the government in ten sectors. We focus on two determinants: fiscal decentralization and existence of fiscal rules. While the question of decentralization has been looked at by Adam et al. (2014) and Hauner and Kyobe (2010), to our knowledge, this paper is the first to formally analyze whether fiscal rules affect the general public sector efficiency in a cross-country set-up.

The paper is structured as follows: next section provides a brief overview of the literature. In Section 3 we present the used method and data. in Section 4 we discuss the obtained results concerning the performance and efficiency of the public sector. Section 5 looks at the determinants of efficiency. Finally, in Section 6 we draw our conclusions.

2. Literature review

Some cross-country studies on public service efficiency or productivity concentrate on public sector (in)efficiencies. Most prominent are the studies of Afonso et al. (2005), Afonso et al. (2010), Verhoeven et al. (2007) and Angelopoulos et al. (2008).

Afonso et al. (2005) constructed Public Sector Efficiency (PSE) and Performance (PSP) composite indicators for 23 industrialized countries for the year 2000. They concluded that small public sector economies are the most efficient. Additionally, they show that the PSE scores of the most efficient countries were more than twice as high as the most inefficient countries' PSE scores.

Afonso et al. (2010) analyse public sector efficiency in the EU New Member States compared to that in some Asian emerging markets. They use several measurement techniques to calculate efficiency scores and rankings. Afonso et al. (2010) conclude that expenditure efficiency across new EU member states is rather diverse especially as compared to the group of top performing emerging markets in Asia. Their analysis suggests that higher income, civil service competence and education levels and the security of property rights facilitate the prevention of inefficiencies in the public sector.

Angelopoulos et al. (2008) use a sample of 64 countries, both developed and developing, in 5-year time-periods over 1980-2000. They construct a measure of public sector efficiency in each country and each time-period by calculating an output-to-input ratio. Additionally, they use an estimate of technical efficiency of public spending for 52 countries for the time-period 1995-2000 with a stochastic frontier analysis. They found evidence of a non-monotonic relation between fiscal size and economic growth that depends critically on the size-efficiency mix.

There are also studies on the regional or local level, such as Borge et al. (2008) for Norway, Borge et al. (2008) and Beidas-Strom et al. (2017) for the UK, and Giordano and Tommasino (2013) for Italy. The study by Beidas-Strom et al. (2017) is unique, since it is the first study that tries to examine how public sector efficiency has changed sub-regionally post the global financial crisis following a large fiscal consolidation episode and across most spending categories or sectors.

Another strand of literature related to this work considers socio-economic, institutional and political determinants of fiscal outcomes. According to fiscal federalism literature, for instance, carefully-designed decentralization could boost efficiency in the public sector. It has been shown that diverse fiscal outcomes is affected by decentralization through diverse channels: reducing excessive spending (as in, e.g., Jin and Zou, 2002; Cassette and Paty, 2010; Ashworth et al., 2013; Prohl and Schneider, 2009), reducing excessive borrowing (as in, e.g., Goodspeed, 2002; Sorens,

2016), affecting subnational tax base due to the "flypaper effect" (in line with Rodden, 2002), or through efficiency of public goods' provision (along the lines of Oates, 1972; Tiebout, 1956). Yet, there are comparatively few works that measure the link between the actual efficiency and decentralization measures for cross-country samples.

At the cross-country level, Adam et al. (2014) look at several determinants of public-sector efficiency for health and education sectors, with a particular focus on fiscal decentralization, and find an inverted-U relationship between the two. Similarly, Enikolopov and Zhuravskaya (2007) look at the decentralization-governance nexus and find a significant relationship, however without estimating efficiency scores, but looking at World Bank governance indices and World Development Indicators as proxies. More recently, Goel et al. (2017) show a relationship between decentralization and *perception* of governance' quality. Also, Hauner and Kyobe (2010) analyzed public sector performance and efficiency in the health and education sectors for a large panel of countries and with a broad set of controls. Control variables used for cross-country efficiency comparisons will be described in more detail in Section 5.

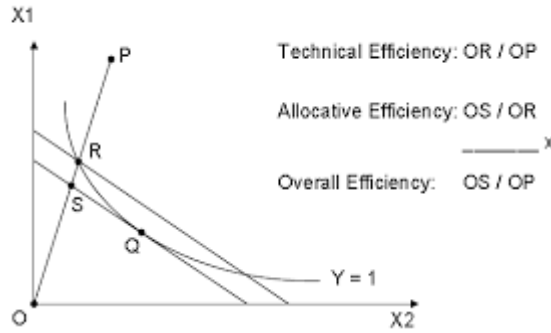
Much more literature has looked at the determinants of public sector efficiency at the local level - Da Cruz and Marques (2014) provide an extensive survey of this literature. In particular, many works look at political determinants (e.g., De Borger et al., 1994; De Borger and Kerstens, 1996a), fiscal autonomy (e.g., De Borger and Kerstens, 1996b; Geys et al., 2010), income (see, e.g., Bruns and Himmler, 2011) (the latter paper also interested in the impact of transparency proxied by local newspaper circulation) and many other determinants.

3. Methodology and Data

3.1. Methodology

As proposed by Farrell (1957), the total economic efficiency can be considered as a product of two primary scalar measures of efficiency, the technical efficiency and the allocative efficiency. Technical efficiency (TE) measures the efficiency that stems from the efficient usage of available inputs. $(1 - TE)$ determines that portion of inefficiency that could be eliminated by proportional reduction of inputs.

Figure 1: Technical vs. Allocative Efficiency



Nevertheless, even if technical efficiency is achieved in an economy, the overall economic efficiency can be still very low, if the available resources are poorly distributed. Allocative efficiency is dealing with this kind of (in-)efficiency, i.e. with the optimal distribution of resources. A low allocative efficiency might arise from a unilateral use of the available resources, i.e. for example if all the expenditures would be devoted to public infrastructure, while all the other sectors (e.g. health or defense) would be ignored. Even if all the expenditures for public infrastructure would be used efficiently, this would lead to an unbalanced economy, hence to low allocative efficiency.

Our paper focuses on the technical efficiency of the public sector. In the literature we can distinguish between two main measurement categories for studying efficiency: The macro approach estimates the efficiency of total spending, while the micro approach aims at measuring the efficiency of a particular part of the public sector. Tanzi and Schuknecht (1997) measure the efficiency of the public expenditures, addressing the question whether higher overall public spending leads to higher social welfare. This method was further developed by Afonso et al. (2005), who define public sector performance as a composite indicator - an outcome of different public policies. The overall performance of public sector takes the performance of all important government areas into account. The performance of the government area j of country i (of total n areas) can be defined as a function of m socio-economic indicators (I):

$$PSP_{i,j} = f_j(I_k), \forall j \in \{1, \dots, n\}, k \in \{1, \dots, m\}. \quad (1)$$

The improvement in the public sector performance of area j depends on the progress of relevant socio-economic variables:

$$\Delta PSP_{i,j} = \sum_{k=1}^m \frac{\delta f}{\delta I_k} \Delta I_k. \quad (2)$$

The performance areas can be divided into two categories: into process or opportunity indicators and into traditional or Musgravian indicators. The first part of the indicators reflect the quality of

the interaction between fiscal policies and the market processes, i.e. the effect of public policies on the individual opportunity/realization. On the other hand, the Musgravian tasks for government comprise allocation, distribution and stabilization.

As the public sector variables do not take the expenditure side into account, for the computation of public sector efficiency the public sector performance is weighted by the amount of relevant public expenditures that is used to achieve it:

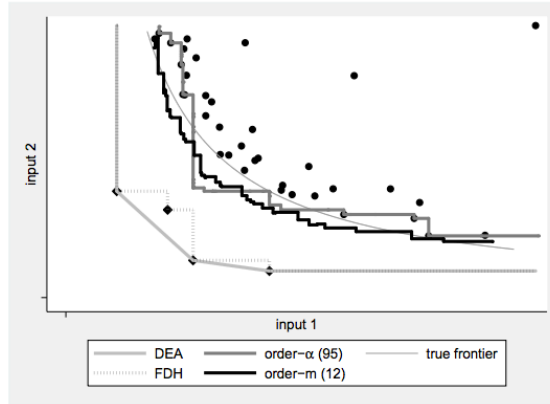
$$PSE_i = \sum_{j=1}^n \frac{PSP_{i,j}}{PEX_{i,j}}, \quad (3)$$

where $PEX_{i,j}$ denotes the public expenditure of country i on area j . For the comparison of public sector efficiency across countries there are different methods in the literature. For a general overview on Economic Efficiency and Frontier Techniques, see Murillo-Zamorano (2004).

Afonso et al. (2010) highlights three different approaches. The simplest one is a comparative method that compares the public sector efficiency by normalization. The method indicates only one efficient country (or more if they are equally efficient). Nevertheless, this method has some caveats as it is not easy to identify the effects of public sector spending on outcomes and separate the impact of public spending from other influences. The other two major methodological approaches are the parametric and the non-parametric approach. The first approach augments a classical regression model by a non-positive error term capturing inefficiency in production (stochastic frontier). The main restriction of this method is the assumption on the functional form and on the distribution of random errors. The second, non-parametric approach, envelops non-parametrically a given sample of data by a piecewise linear hull (e.g. Data envelopment analysis – DEA, Free Disposal Hull – FDH). DEA assumes a convex technology and employs linear programming for enveloping the data, while FDH is based on the principle of weak dominance that release this convexity assumption. To the main criticisms of these deterministic approaches belong the lack of a well-defined data generating process and that the methods are vulnerable to outliers. To control for the last caveat, the partial frontier approaches - order- m and order- α - generalize FDH by allowing super-efficient observations to lie outside the estimated production possibility frontier² (see Tauchmann (2011)). The methods are graphically demonstrated in Figure 2.

²Order- m approach is benchmarking the decision making units by expected best performance in sample of m peers, while order- α uses the $(100-\alpha)$ th percentile of input consumption among available peers as benchmark.

Figure 2: Comparison of the methods



3.2. Data

The analysis presented in this paper uses a set of variables for 23 European countries. The source of the variables used in this paper is the Quality of Government (QoG) (Teorell et al., 2017) dataset covering the time period between 1995 and 2015. Despite the unavailability of some variables for the whole time period, due to a large variety of variables that are used for generation of the performance index (PSP) in several areas, the impact of the missing data points is rather negligible.

The 20 years time span allows us to identify not only long run or structural changes of public policy, but also short run changes as well as the development of performance and efficiency over time. As already mentioned, we use several indicators to derive public sector performances in the examined areas of the economy. Table 1 shows the socio-economic variables, that are used for setting-up the Public Sector Performance Indices for several policy areas on which government has a significant influence. Those indices reflect the outcomes of public policies. Detailed information on the data used can be found in Table 1.

Table 1: Variables for the Public Sector Performance Indicators (PSP)

Indicator	variable	type	data source
Administration	Public Services (Quality)	Index	QoG Dataset
	Independence of the Judiciary	Index	QoG Dataset
	Absolute legal institutional quality	Index	QoG Dataset
	Level of the shadow economy	% of GDP	QoG Dataset
	Corruption Perceptions Index	Index	QoG Dataset
	Public sector corruption index	Index	QoG Dataset
Education	Regulatory Quality	Index	QoG Dataset
	Labor force with primary education	% of total labor force	QoG Dataset
	Quality of primary education	Index	QoG Dataset
	Quality of the educational system	Index	QoG Dataset
	Youths who are not in Education nor in Employment: Aged 20-24	% of age group	QoG Dataset
	Pupil-teacher ratio in primary, secondary and tertiary education (headcount basis)	Average	QoG Dataset
Health	PISA score	Average over all fields	QoG Dataset
	Life Expectancy, Both sexes, Age 0-1 years	years	QoG Dataset
	Healthy life years at birth: Males	years	QoG Dataset
	Healthy life years at birth: Females	years	QoG Dataset
	Infant Mortality	in %	QoG Dataset
	Crime, violence or vandalism in the area	Cases per population	QoG Dataset
Public Security	Organized crime	Index	QoG Dataset
	Reliability of police services	Index	QoG Dataset
	Air Quality	Index	QoG Dataset
Environmental Protection	Environmental Health	Index	QoG Dataset
	Environmental Performance Index	Index	QoG Dataset
	Pension Generosity Index	Index	QoG Dataset
Social Security	Poverty Gap	Index	QoG Dataset
	Poverty Rate 50%	in % of population	QoG Dataset
	Armed forces personnel	% of total labor force	QoG Dataset
Defence	Quality of overall infrastructure	Index	QoG Dataset
	General Government Net Lending	in % of GDP	QoG Dataset
	GDP per capita growth	in %	QoG Dataset
Economic Indicator	General Government Debt	in % of GDP	QoG Dataset
	Real GDP Growth	in %	QoG Dataset
	Stability of economic growth	Index	QoG Dataset
Stability	Stability of Inflation	Index	QoG Dataset
	Political Stability	Index	QoG Dataset
	General Government Debt	Index	QoG Dataset
Inequality	Income Inequality: Gini Coefficient	Index	QoG Dataset

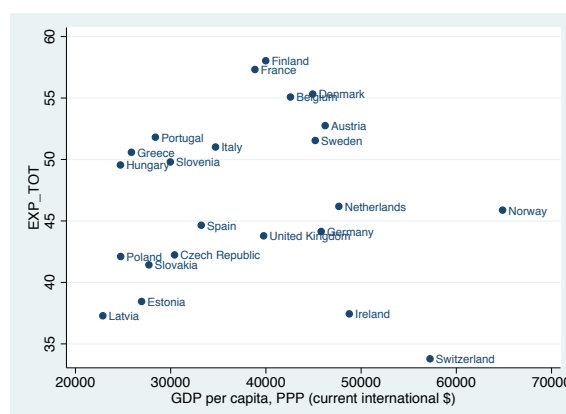
Most parts of the indices reflect stocks that usually change very slowly over time. Although the changes in the short run might be relatively small, the calculation of public sector performances and public sector efficiency for each year allows us to study the development over longer period. Additionally, we can analyze the performance of countries during specific time periods such as the financial crises in Europe and its aftermath.

To define Public Sector Efficiency, we need to relate the Public Sector Performance of a specific area with the corresponding expenditures. Table A.10 in the Appendix summarizes the used expenditure variables for the examined areas.

4. Empirical Results

Are wealthy countries or countries with relatively large public sector more efficient? A bird eye view on wealth level (measured as GDP per capita PPP) and on the government size (measured as the total government expenditure as percentage of GDP) reflects large differences among the analyzed countries (see Figure 3). The divergence in expenditure ratios in 2015 was relative high in the sample, from the lowest level of 34 percent in Switzerland to the highest level of 57 percent in Finland. GDP per capita (PPP) also varies broadly between approximately 23.000\$ in Latvia and 64.000\$ in Norway.

Figure 3: Size of the government and GDP per capita (PPP)



Hence, we decided to categorize the countries in our analysis into five sub-groups:

- **High income economy (HI) with small public sector (SPS):** Netherlands, Germany and United Kingdom
- **High income economy (HI) with large public sector (BPS):** Finland, France, Denmark, Belgium, Austria and Sweden

- **Middle income economy (MI) with small public sector (SPS):** Spain, Czech Republic, Poland, Slovakia, Estonia, Latvia
- **Middle income economy (MI) with large public sector (BPS):** Portugal, Italy, Greece. Slovenia, Hungary
- **Special cases:** Ireland, Norway, Switzerland

4.1. Public sector performance (PSP)

The easiest way to compare the performance of the public sector is by the comparative method of the public sector performances across countries. As highlighted in Section 3, public sector performance is a function of the relevant socio-economic indicators (see Equation 1) and hence can be computed by weighting the available socio-economic indicators.³ Table 2 shows the total set of studied areas and the overall indicators they consist of. All the indicators within an area are given the same weight. The total public sector performance is then computed as a composite indicator of all investigated areas ($PSP_{i,j}$ of all areas j having the same weight). In order to compare the obtained values of public sector performances across countries, the measure is normalized, such that the average of the performance indices is equal to one. The results are highlighted in Table 2.

The studied performance indicators show partially significant differences across countries. Scandinavian countries show a very good performance in the overall index: Norway, Estonia and Finland, but also Switzerland are more than 15 percent above the average performances of all examined countries. On the other hand, Greece and Italy are the worst performers, reaching only 79 and 84 percent of the average index. Some sub-indices show even higher differences across the performances of different areas. Concerning education, it is interesting to see the relatively good performance of the new EU member countries. Czech Republic and Estonia are around 20 percent above the average performances of the countries in the sample. Among the worst performers belong the South European countries with Spain reaching only 72 percent of the average performances.

The performance in the area of administration is dominated by Austria that lies over 30 percent above the average performance. On the other end of the ranking are the new EU member countries together with the South European economies. Generally one can see a better performance of high income countries. The sub-sector of health with a top performer of Finland shows relatively small

³Note that our choice of the areas and indicators are different from the ones defined by the Afonso et al. (2005).

differences across countries, with the exception of the relatively low performance of some East European countries like Slovakia, Hungary or Poland. Switzerland, Norway and Czech republic perform well in the economic performance sub-index. The relatively poor performance of the South European countries could have been expected, since these countries still have problems with their public debt. As these countries became vulnerable to economic shocks, the performance in the stability area in these countries show a similar poor performance. On the other hand, Switzerland shows a very good and sustainable economic performance.

Table 2: Public Sector Performance Index and Ranking 2015

	Education		Administration		Health		Distribution		Environment		Security		Eco. Perfor.		Stability		Infrastr.		Total		Total*		
	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP	rank	PSP
Austria	1.06	9	1.32	1	1.04	11	0.94	11	1.04	5	1.08	5	1.13	4	1.22	5	1.14	4	1.1	4	1.12	5	
Belgium	0.99	15	0.88	18	0.88	12	0.94	12	0.88	22	0.96	12	0.98	14	0.94	13	1.06	10	0.96	14	0.97	11	
Czech Republic	1.17	3	1.2	3	1.07	3	1.31	3	1.08	2	0.82	21	1.07	5	0.96	12	1.06	17	1.07	8	1.10	8	
Denmark	1.14	4	1.01	10	0.97	17	2.12	1	1.02	10	1.06	8	1.04	8	1.18	6	1.06	9	1.18	2	1.22	2	
Estonia	1.21	2	0.93	16	1.07	6	0.81	18	0.99	15	1	10	1.01	11	1.77	1	0.95	14	1.08	6	1.11	7	
Finland	1.05	12	1.06	7	1.16	2	1.46	2	1	13	1.23	1	0.95	15	1.03	10	1.18	2	1.12	4	1.13	4	
France	0.81	22	0.95	15	0.98	14	0.94	13	0.94	19	0.88	18	0.92	17	1.07	8	1.11	6	0.95	15	0.97	12	
Germany	1.06	11	0.98	13	0.96	18	1.09	5	1.07	3	0.99	11	1.05	7	1.16	7	1.11	5	1.05	9	1.06	9	
Greece	0.86	17	1.01	11	0.87	4	0.87	22	0.97	18	0.78	22	0.7	23	0.4	23	0.84	21	0.79	23	0.77	23	
Hungary	0.93	16	1.19	4	0.87	22	0.87	15	0.93	20	0.85	20	0.94	16	0.7	21	0.92	19	0.91	19	0.92	17	
Ireland	0.83	19	1.03	8	1.02	8	1.02	8	0.99	14	1.08	6	0.92	19	0.7	19	0.93	16	0.95	17	0.92	16	
Italy	0.84	18	0.78	22	1.03	7	0.69	19	0.98	17	0.73	23	0.86	20	0.83	16	0.84	20	0.84	22	0.84	20	
Latvia	1.07	8	0.76	23	0.91	20	0.99	10	0.85	23	0.94	15	0.92	18	1.3	4	1.15	3	1.08	7	1.11	6	
Netherlands	1.07	7	1.16	5	0.95	19	1.26	4	1.03	8	0.92	16	1.14	3	1.3	4	1.15	3	1.08	7	1.11	6	
Norway	1.22	1	0.98	14	1.16	1	1.26	4	1.03	7	0.85	23	0.92	18	0.41	22	0.92	18	0.97	12	0.83	22	
Poland	1.1	6	0.99	12	0.9	21	0.81	17	0.92	21	1.19	3	1.42	1	1.7	2	0.98	13	1.26	1	1.25	1	
Portugal	0.81	21	0.84	21	1	10	0.67	20	1	12	1.05	9	1.06	6	1.04	9	0.73	23	0.97	11	0.95	14	
Slovakia	1.01	14	0.9	17	0.81	17	0.81	17	0.92	16	0.92	17	0.99	13	0.82	17	1.11	7	0.9	20	0.87	19	
Slovenia	1.06	10	0.86	20	0.98	16	1	9	1.01	11	1.11	4	1	12	0.75	18	0.93	15	0.97	13	0.94	15	
Spain	0.72	23	0.86	19	1.07	4	0.63	21	1.06	4	0.94	14	0.78	22	0.7	20	1.09	8	0.87	21	0.84	21	
Sweden	1.05	13	1.02	9	1.12	3	1.04	6	1.03	6	1.07	7	1.01	10	1.02	11	1.05	11	1.05	10	1.04	10	
Switzerland	1.13	5	1.21	2	1.01	9	1.04	7	1.16	1	0.96	13	1.25	2	1.46	3	1.22	1	1.16	3	1.19	3	
United Kingdom	0.83	20	1.09	6	0.98	15	0.84	16	1.02	9	0.87	19	1.02	9	0.93	14	0.98	12	0.95	16	0.95	13	
HI, small gymm:	0.99		1.08		0.96		0.98		1.04		0.93		1.07		1.13		1.08		1.03		1.04		
HI, large gymm:	1.02		1.04		1.04		1.24		0.99		1.05		1.01		1.08		1.1		1.06		1.07		
MI, small gymm:	1.05		0.94		0.97		0.9		0.98		0.97		0.97		0.96		0.93		0.98		0.89		
MI, large gymm:	0.9		0.93		0.97		0.77		0.98		0.9		0.87		0.7		0.93		0.88		0.87		
special cases:	1.06		1.07		1.06		1.11		1.06		1.2		1.2		1.29		1.04		1.12		1.12		

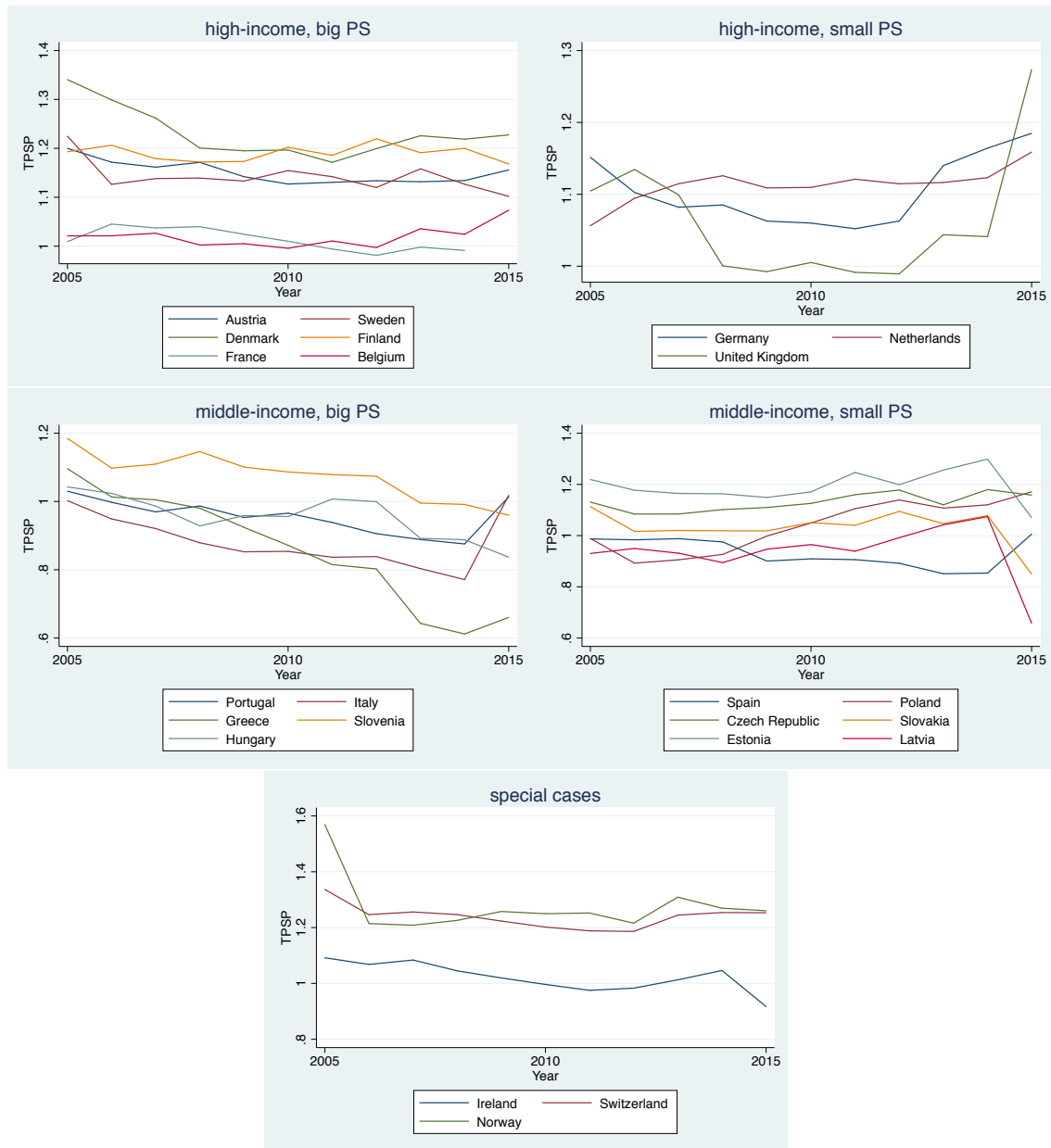
*without Environment and Security

Additionally, Table 2 shows the difference between countries with small and large public sectors. The overall performance indicator suggests that there is almost no difference in high income countries regarding overall public sector performance, irrespective of the size of the public sector. We can only see that redistribution seems to perform better in high income countries in case of a large public sector. On the other hand, for middle income countries it seems that those countries with a large public sector show even worse performances than those with a small public sector.

Here, we take a closer look on the development of the total public sector performance, with special interest on the impact of the financial crisis of 2008. We examine the time period between 2005 and 2015 and analyse how the public sector performance was influenced by the economic crises and whether there has been a significant change in the relative performance of the analyzed countries.

We show that the overall public sector performance of high income countries has been relatively stable after the crisis, especially for those countries with large public sectors. In those countries with high income and small public sectors, such as Netherlands and Germany, we can see a slight upward trend in their overall performance. In the group of middle-income countries with large public sectors, such as Portugal, Italy and others, we can see a significant decrease in the overall performance, while on the other hand, the middle income countries with small public sectors, such as Estonia, Poland show an upward tendency in relative performance.

Figure 4: Development of Public sector performance (PSP) within the sub-samples



4.2. Public sector efficiency (PSE)

To take the expenditure side into account as well, the obtained PSP indicators of different public sector areas are weighted by expenditures that are used to achieve these levels. The overall efficiency is then computed based on Equation 3, where all the areas are given the same weight. The results are highlighted in Figure 3. In this subsection we follow the methodology of Afonso et al. (2005) and the definition of efficiency presented in Equation 3, to compare our results to previous studies.

Taking the expenditure side into account has significantly changed the ranking position of some countries in the efficiency index as compared to the public sector performance index. The most efficient country is Switzerland, followed by Norway and Ireland. The case of Ireland is interesting in the sense that its performance is quite average, but as public expenditures in Ireland are relatively low, its efficiency level thus is high. Most of the South European countries are ranked at the bottom. Concerning the education sub-indices, the new EU member countries not just perform better than the average of the countries, but they are also more efficient. These countries are also efficient in the areas of economy and stability. The major part of Southern European countries display a relatively high efficiency in the areas of health and infrastructure. Most of the Scandinavian countries have a high efficiency in the areas of distribution, environment and security. Notable is the efficiency of Switzerland, which in almost every investigated area lies above the average efficiency level. Greece, on the other hand, except for the areas of health and education, always lies below the 20th place out of 23 countries.

Table 3: Public Sector Efficiency Index and Ranking 2015

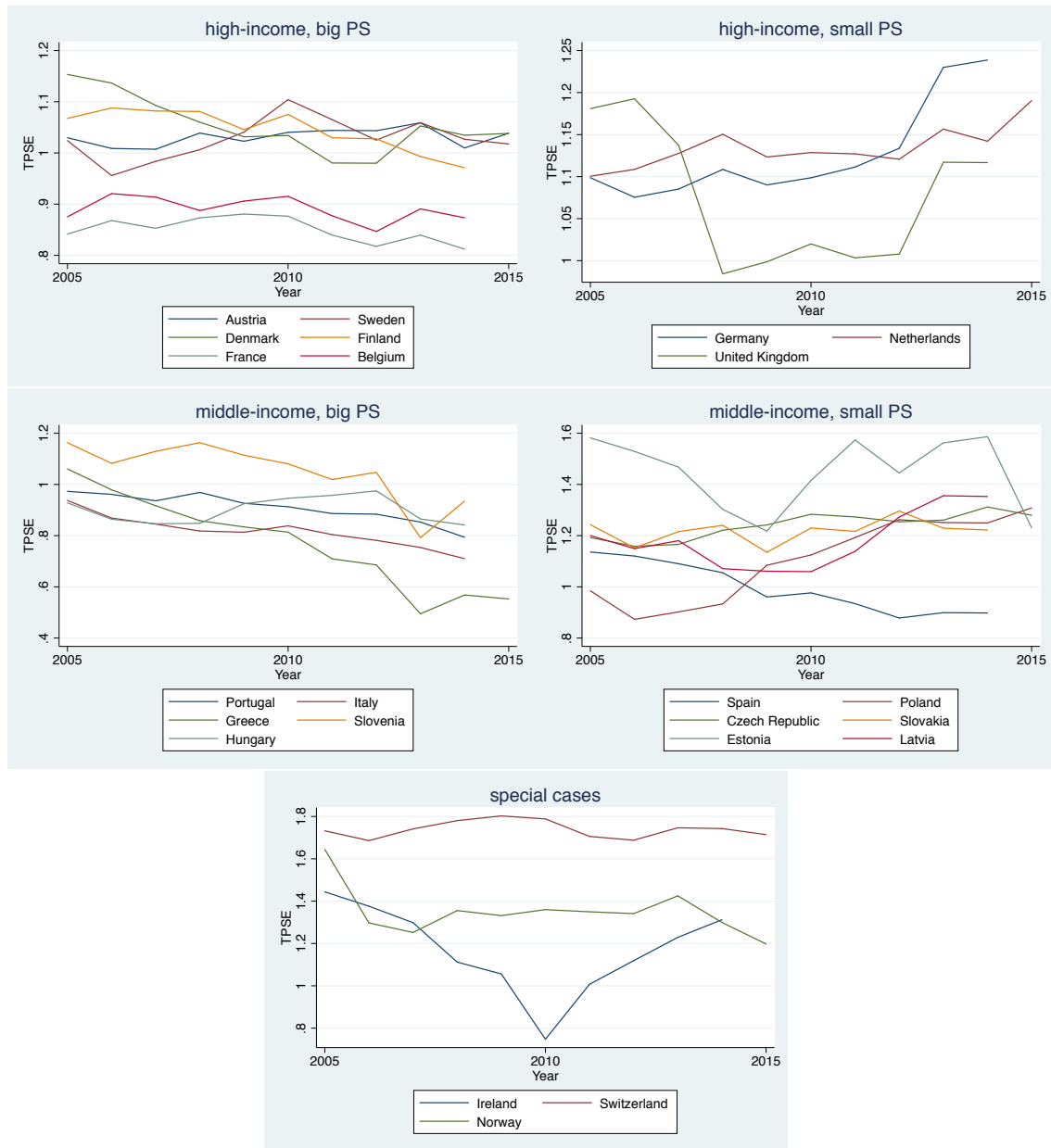
	Education		Administration		Health		Distribution		Environment		Security		Eco. Per.		Stability		Infrastr.		Total		Total*		
	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE	rank	PSE
Austria	1.12	5	1.03	9	0.70	19	0.78	17	1.48	3	1.26	5	1.01	12	1.09	7	1.19	6	1.07	11	0.99	11	
Belgium	0.83	21	0.65	20	0.69	20	0.85	15	0.60	19	0.83	13	0.81	17	0.78	16	1.66	3	0.85	17	0.90	15	
Czech Republic	1.25	3	1.70	2	0.78	13	1.86	1	0.63	18	0.72	17	1.17	3	1.05	8	0.83	12	1.11	5	1.24	2	
Denmark	0.85	18	0.84	15	0.63	23	1.61	2	1.47	4	1.74	2	0.87	16	0.99	10	0.74	14	1.08	9	0.93	13	
Estonia	1.04	10	1.35	4	1.08	4	1.12	6	0.92	10	0.89	10	1.15	6	2.02	1	0.46	20	1.11	4	1.17	4	
Finland	0.87	17	0.79	16	0.78	14	1.03	9	2.50	1	1.49	3	0.75	20	0.82	15	0.82	13	1.09	8	0.84	17	
France	0.77	22	0.89	13	0.67	21	0.69	18	0.60	20	0.86	12	0.74	22	0.85	14	0.7	16	0.75	22	0.76	21	
Germany	1.30	1	0.96	11	1.74	17	1.05	8	1.16	7	1.03	8	1.1	9	1.21	5	1.16	7	1.08	10	1.07	9	
Greece	1.05	8	0.63	21	1.21	4	0.53	22	0.42	23	0.60	22	0.58	23	0.33	23	0.41	23	0.64	23	0.68	23	
Hungary	0.95	13	0.73	18	0.98	7	1.01	10	0.50	21	0.71	18	0.87	15	0.64	21	0.72	15	0.79	21	0.84	16	
Ireland	1.05	9	1.06	8	0.76	16	1.42	3	1.16	6	1.25	6	1.13	8	0.86	13	1.94	2	1.18	3	1.17	3	
Italy	1.09	7	0.54	23	0.8	12	0.58	21	0.66	16	0.62	21	0.77	19	0.74	17	1.32	4	0.79	20	0.84	18	
Latvia	0.95	14	0.95	12	1.34	3			0.80	13	-		1.13	7	0.51	22	0.41	22	1.02	15	0.76	22	
Netherlands	1.03	11	1.43	3	0.66	22	1.07	7	0.46	22	0.82	14	1.16	5	1.32	4	1.2	5	1.02	13	1.13	6	
Norway	1.17	4	1.29	5	0.77	15	1.17	5	0.76	15	2.37	1	1.33	2	1.6	3	0.51	18	1.22	2	1.12	7	
Poland	1.11	6	1.24	7	1.08	7	0.92	13	0.97	9	0.87	11	1.17	4	1.16	3	0.66	17	1.02	14	1.05	10	
Portugal	0.68	23	0.59	22	0.9	10	0.65	19	1.43	5	0.75	15	0.75	21	0.73	18	3.47	1	1.1	6	1.11	8	
Slovakia	1.30	2	0.98	10	2.43	2	0.83	16	0.90	11	0.66	20	1.09	10	1	9	0.44	21	1.07	12	1.15	5	
Slovenia	0.94	15	0.70	19	0.83	11	1.00	11	0.65	17	1.09	7	0.92	14	0.69	20	0.49	19	0.81	19	0.80	20	
Spain	0.93	16	0.76	17	0.98	8	0.64	20	0.81	12	0.75	16	0.8	18	0.72	19	0.98	9	0.82	18	0.83	19	
Sweden	0.84	20	0.89	14	0.9	9	0.89	14	2.28	2	1.33	4	0.92	13	0.93	12	0.94	10	1.1	7	0.90	14	
Switzerland	1.01	12	1.75	1	2.55	1	1.38	4	1.06	8	0.91	9	1.7	1	1.99	2	1.09	8	1.49	1	1.64	1	
United Kingdom	0.85	19	1.26	6	0.72	18	0.92	12	0.78	14	0.70	19	1.07	11	0.97	11	0.88	11	0.91	16	0.95	12	
HI, small gymm:	1.06		1.22		0.71		1.01		0.8		0.85		1.11		1.17		1.01		1.00		1.05		
HI, large gymm:	0.88		0.85		0.73		0.98		1.49		1.25		0.85		0.91		1.01		0.99		0.89		
MI, small gymm:	1.1		1.16		1.28		1.07		0.84		0.78		1.09		1.08		1.01		1.02		1.09		
MI, large gymm:	0.94		0.64		0.94		0.75		0.73		0.75		0.78		0.63		1.28		0.83		0.85		
special cases:	1.08		1.37		1.36		1.32		1		1.51		1.39		1.48		1.18		1.30		1.31		

*without Environment and Security

Taking a closer look on the sub-groups of our sample again, we can see specific patterns regarding efficiency, especially with regard to total public sector efficiency (without environment and security indices). When we compare high income countries, we can see that small governments tend to be more efficient (with an average efficiency score of 1.05) than larger governments (with an average efficiency score of 0.89). The same holds true if we take into account the group of middle-income countries. While those with large public sectors show an average efficiency score of 0.85, those with small public sectors have an average efficiency score of 1.09.

Regarding the development of public sector efficiency, we can see that especially those countries with a small public sector tend to increase their (relative) efficiency, while those with large public sectors seem to worsen. For high-income countries, there is a negative trend in overall efficiency to be observed, especially in Belgium, France and Finland. While all high-income countries with small public sectors (Germany, Netherlands and UK show an upward trend during the crisis and the aftermath.

Figure 5: Development of Public sector efficiency (PSE) within the sub-samples



The same holds true when we take a close look on middle-income countries. All of those countries with a large public sector such as Portugal, Greece, Italy, Slovenia and Hungary show a decrease in public sector efficiency in the years of the crisis and its aftermath. On the other hand, middle-income countries (such as Estonia, Poland, Slovakia, Czech Republic and Latvia) with a small public sector show an upward trend in efficiency⁴.

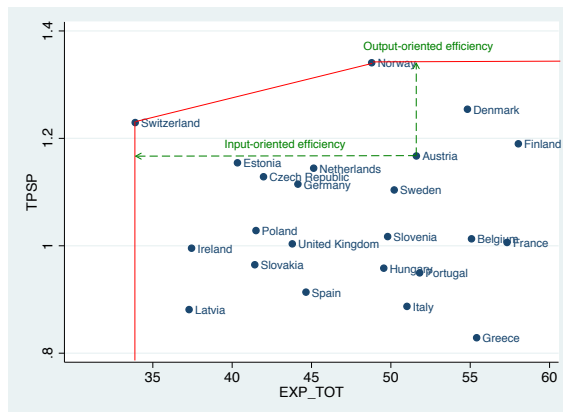
⁴Spain seems to be an exception but for Spain the decision of counting it as a country with large or small public sector, is anyhow complicated.

4.3. Public sector efficiency by FDH and Order-m Methods

Unlike Afonso et al. (2005) and Afonso et al. (2010), we additionally calculate efficiency by another partial frontier approach, namely the order-m method. Both frameworks determine the production possibility frontiers, but the order-m method allows some decision making units to lie outside the efficiency frontier (super-efficient countries). Hence, unlike in FDH method, the efficiency score in the order-m method can be greater than one. The order-m approach is especially interesting for our analysis, since it seems that we have three "outliers" in our sample, namely Switzerland, Norway and Ireland. For certain reasons, such as the fact that in Switzerland many areas are organized privately, it makes sense to correct for those outliers. The order-m method allows us to classify those countries as "super-efficient".

Additionally, both the FDH and the Order-m method allow us to calculate the input- and output-oriented efficiency. Input-oriented efficiency represents the efficiency of a decision making unit by a given level of output, while on the other hand the output-oriented efficiency expresses the efficiency of a decision making unit under a given level of inputs. Hence, countries with low input-oriented efficiency could reduce their expenditures without lowering their performance. On the other hand, countries with low output-oriented efficiency might increase their performance without increasing their expenditures. Figure 6 shows the differences of input-oriented and output-oriented efficiency graphically. Please note, that input-oriented FDH scores are restricted to be less or equal one (and output-oriented to be larger or equal to one), while this restriction does not apply to the order-m scores.

Figure 6: Input-oriented and output-oriented efficiency



Using frontier analysis (input-oriented efficiency approach), we can see that the ranks of the countries involved vary strongly as compared to the results of the simple public sector efficiency

index. For example Austria was ranked 11 in the PSE, while die FDH ranking is 18 and the order-m ranking is 19 out of 23. Regarding the input-oriented efficiency analysis with FDH as well as with order-m method, we can again see the same patterns which we have observed in the previous sub-sections. Table 4 shows that countries, no matter whether middle-income or high-income with a large public sector tend to have a significantly lower efficiency score than countries with a small public sector when we use input-oriented efficiency.

Table 4: FDH and Order-m efficiency and rankings 2015 (Input-oriented)

	FDH			Order-m		
	Eff. Score	Std. Err.	Eff. Rank	Eff. Score	Std. Err.	Eff. Rank
Austria	0.66	(0.17)	18	0.75	(0.15)	19
Belgium	0.62	(0.09)	20	0.71	(0.05)	21
Czech Republic	0.81	(0.16)	9	0.91	(0.10)	9
Denmark	0.89	(0.06)	5	0.89	(0.05)	10
Estonia	0.84	(0.20)	6	0.95	(0.15)	5
Finland	0.58	(0.16)	23	0.65	(0.15)	23
France	0.59	(0.08)	22	0.70	(0.05)	22
Germany	0.77	(0.15)	11	0.87	(0.08)	12
Greece	0.61	(0.05)	21	0.71	(0.03)	20
Hungary	0.68	(0.08)	14	0.79	(0.04)	14
Ireland	0.91	(0.11)	4	1.06	(0.07)	1
Italy	0.66	(0.07)	17	0.78	(0.04)	17
Latvia	0.91	(0.08)	3	1.04	(0.05)	3
Netherlands	0.75	(0.16)	13	0.83	(0.11)	13
Norway	1.00		1	1.00		4
Poland	0.82	(0.12)	8	0.94	(0.07)	6
Portugal	0.65	(0.07)	19	0.76	(0.04)	18
Slovakia	0.82	(0.09)	7	0.94	(0.05)	7
Slovenia	0.68	(0.09)	15	0.79	(0.06)	15
Spain	0.76	(0.08)	12	0.88	(0.05)	11
Sweden	0.67	(0.12)	16	0.78	(0.07)	16
Switzerland	1.00	(0.26)	1	1.05	(0.24)	2
United Kingdom	0.77	(0.10)	10	0.91	(0.06)	8
HI, small gvm:	0.76			0.87		
HI, large gvm:	0.67			0.75		
MI, small gvm:	0.83			0.94		
MI, large gvm:	0.66			0.77		
special cases:	0.97			1.04		

Taking a closer look at Table 5, one can see some significant differences among the countries in the input- and output- oriented efficiency scores. Countries like Austria (19), Finland(23) and France(22) show a relative poor input-oriented efficiency, but a much better efficiency in output-oriented efficiency (AUT:6; France:14; Finland:4). These countries show larger potential becoming more efficient in the expenditure part, i.e. they could make a large cut in expenditures, without reducing their performance in the public sector. On the other hand, Slovakia, Latvia and Ireland show a relative poor output-oriented efficiency, but a much better efficiency in input-oriented efficiency. These countries have a larger potential becoming more efficient in the performance part, i.e. to achieve much better performance with the same expenditures.

Again, we can see that according to output-oriented efficiency scores countries with smaller

governments tend to be more efficient than those with smaller public sectors.

Table 5: FDH and Order-m efficiency and rankings 2015 (Output-oriented)

	FDH			Order-m		
	Eff. Score	Std. Err.	Eff. Rank	Eff. Score	Std. Err.	Eff. Rank
Austria	1.15	(0.08)	9	1.04	(0.05)	6
Belgium	1.32	(0.09)	16	1.20	(0.05)	13
Czech Republic	1.09	(0.09)	6	1.05	(0.05)	8
Denmark	1.07	(0.07)	4	0.97	(0.04)	2
Estonia	1.06	(0.11)	3	1.05	(0.08)	7
Finland	1.13	(0.07)	8	1.01	(0.04)	4
France	1.33	(0.09)	17	1.20	(0.05)	14
Germany	1.10	(0.08)	7	1.05	(0.04)	9
Greece	1.62	(0.10)	23	1.46	(0.06)	23
Hungary	1.40	(0.11)	20	1.28	(0.07)	20
Ireland	1.23	(0.15)	13	1.21	(0.13)	16
Italy	1.51	(0.11)	22	1.37	(0.07)	21
Latvia	1.40	(0.20)	19	1.38	(0.18)	22
Netherlands	1.07	(0.06)	5	1.02	(0.03)	5
Norway	1.00	(0.08)	1	0.91	(0.05)	1
Poland	1.20	(0.11)	10	1.14	(0.07)	11
Portugal	1.41	(0.10)	21	1.27	(0.06)	18
Slovakia	1.27	(0.13)	14	1.24	(0.09)	17
Slovenia	1.32	(0.10)	15	1.20	(0.06)	15
Spain	1.35	(0.09)	18	1.28	(0.05)	19
Sweden	1.21	(0.09)	11	1.10	(0.05)	10
Switzerland	1.00		1	1.00		3
United Kingdom	1.23	(0.10)	12	1.17	(0.06)	12
HI, small gvm:	1.13			1.08		
HI, large gvm:	1.20			1.09		
MI, small gvm:	1.23			1.19		
MI, large gvm:	1.45			1.32		
special cases:	1.08			1.04		

5. Determinants of efficiency: decentralization and fiscal rules

5.1. Previous literature

This section analyzes the correlation of several factors with input-oriented order-m efficiency. We chose to focus on input-oriented order-m efficiency, as it is more likely to be more directly related to fiscal institutions, which are the focus of this section. Moreover, as explained previously, the order-m approach allows for super-efficiency, that makes the regression results less likely to depend on outlier observations, such as for the case of Switzerland. We obtain efficiency scores for all countries in the period between 2000 and 2015, ending up with more than 300 observations. We combine our dataset with data that covers information on fiscal rules in those countries, data that measures the level of decentralization of a country, as well as additional control variables.

The so-far most comprehensive study covering determinants of public sector performance and efficiency for the case of health and education expenditures is Hauner and Kyobe (2010). Using their results and previous literature we can identify the control variables likely affecting efficiency scores.

As for socio-economic determinants, expenditure might improve performance (La Porta et al., 1999) but it is likely to reduce efficiency (Afonso et al., 2005; Gupta and Verhoeven, 2001). First look at the performance score provided in Table 2 suggests that in our case the nexus between performance and expenditure might be non-linear. As argued by Hauner and Kyobe (2010), the theoretical impact of income per capita is a priori unclear: it could on the one hand, reduce efficiency by raising the relative cost of public services, but higher income per capita has also been found to correlate with better outcomes in education (Afonso and Aubyn, 2006). Finally, we expect globalization to positively affect efficiency: on the one hand through increasing pressure on the governments for improving public services in an increasingly competitive environment, and on the other hand through positive spill-overs of "good" policies between the countries.

There is also evidence that monetary variables might affect directly or indirectly fiscal performance. For instance, Beetsma and Bovenberg (1997) and Lewis and Conaty (2003) show significant interaction effects between inflation targeting and fiscal policies, which in turn could affect efficiency scores, through the impact on the expenditures. Hauner and Kyobe (2010) argue that inflation would reduce efficiency by making policy planning more difficult, but their empirical evidence is mixed, including positive effects in the education sector. Loose monetary policy, e.g., low or negative interest rates could also affect efficiency, by making the budget constraints of the government "softer", i.e., allowing issuance of relatively cheap public debt. While this hypothesis, according to our knowledge, has never been tested, it seems reasonable to include interest rates as determinants of efficiency in this study.

As for institutional determinants, there are several hypotheses, for why these matter for public sector efficiency. Civil society has been argued (see, e.g., Putnam et al., 1993) to affect diverse aspect of economic governance, which in turn could affect efficiency. Transparency of public-sector decision making as well as media freedom should increase accountability of the government and, thus remove incentives for inefficient expenditure. High corruption could also affect efficiency through its effect on allocation of resources, however Hauner and Kyobe (2010) do not find empirical confirmation of this claim - moreover, since corruption is one of the outcome variables in our calculations, we cannot include it as a determinant. Adam et al. (2014) also find an impact of British legal origin on efficiency for the case of OECD countries.

Political variables are also likely to affect efficiency, through its impact on the overall expenditure levels and allocation of resources. For instance, Persson and Tabellini (2004) find that presidential systems tend to have lower expenditures, due to more accountability (also see, Shugart

and Carey, 1992), however Blume et al. (2009) show that this result is not robust. Also, proportional elections, being likely in resulting in coalitional governments, are likely to increase the size of the government, and thus affect efficiency (Persson and Tabellini, 2004). Finally, political fragmentation and left-wing cabinets could contribute to expanding government expenses and affect efficiency scores. The latter relationship has been tested at the local level e.g., by Geys et al. (2010), who find positive correlation between the share of left-wing politicians and inefficiency.

Demographic characteristics of the population are also likely to affect efficiency. In particular the age structure of the population has a direct impact on education, health and social welfare expenditures, which constitute a large bunk of the overall government expenses. As for the impact of population density, several studies of efficiency at the local level have found impact of population density on efficiency: for instance, Geys (2006) and Sung (2007) report negative effect, while Herrera and Pang (2005) report a positive relationship. A case for a non-linear relationship could also be made: economies of scale might change into dis-economies above a certain density threshold. It is not straightforward how the relationship could look like on the cross-country level, yet Hauner and Kyobe (2010) find a positive relationship. Other often included variables are: ethnolinguistic fractionalization, which is likely to improve the costs of public sector provision (La Porta et al., 1999) or necessitate additional redistributive policies, which affect efficiency (Alesina et al., 1999).

Table A.11 in the Appendix summarizes the definitions and sources of all explanatory variables. Unfortunately, due to data limitations all explanatory variables are available for a sample of only about 250 observations.

5.2. Main hypotheses

When it comes to the effects of fiscal decentralization, we need to be precise about the actual measure used. While revenue decentralization can be helpful for improving efficiency, expenditure decentralization creating fiscal imbalances might be harmful. Revenue decentralization is expected to improve public sector efficiency through increased accountability and yardstick competition between the subnational government resulting from competition for a mobile tax base. Decentralization allows citizens to compare public services and taxes across jurisdictions and, thus increases electoral control of resource use (Besley and Smart, 2007). Moreover, it is expected to reduce corruption (Weingast, 2009), which could result in increasing allocative efficiency. On the other hand, a case can be made for a negative relationship of revenue decentralization with efficiency, mostly relying on the effect of economies of scale. In the presence of economies of scale,

higher decentralization could result in higher average cost of production of public goods and services (Stein, 1999). Prud'Homme (1995) additionally warns, that political decentralization could negatively affect provision of public services at the local level, as regional authorities attract lower quality politicians, compared to national bureaucracies. Nevertheless, most empirical literature points to overwhelmingly positive effect of decentralization on various measures of governance, including public sector efficiency.

Hypothesis 1. *Revenue decentralization is associated with higher public sector efficiency.*

On the other hand, badly designed federalism could result in low efficiency. This is in particular the case, whenever revenue and expenditure authority is not assigned to the same levels of government. Typically, this involves revenues being more centralized than expenditures. This results in high vertical fiscal imbalances, which in turn, create incentives to overspend at the regional or local levels. Transfer dependency of local authorities has been shown to increase borrowing (see, e.g., Köppl-Turyna and Pitlik, 2017). Evidence of the effect on expenditure in the cross-country context (Jin and Zou, 2002; Cassette and Paty, 2010; Ashworth et al., 2013; Prohl and Schneider, 2009) and intra-country studies with clear identification strategies (Dahlberg et al., 2008; Gordon, 2004) point to vertical imbalances increasing public expenditure. However, Gordon (2004) reports the latter effect being present only in the short run. Fiva (2006) and Rodden (2003) directly analyze vertical fiscal imbalances and conclude that it is associated with higher general spending. While most of the literature points to a positive relationship between fiscal imbalances and the size of public expenditure (input), it is less clear what should the effect of imbalances on the performance (output) be. If intergovernmental transfers are non-earmarked, this leaves at least partial flexibility of the subnational governments to allocate the funds to their best use. If the funds are allocated as earmarked grants, local and regional units are left with little flexibility, which could potentially undermine performance scores, at the same time being associated with higher expenditure. In the base case, vertical fiscal imbalances would leave the overall efficiency unaffected - in the worst case, efficiency is expected to be lowered as a result of high fiscal imbalances between the tiers of the government.

Hypothesis 2. *Vertical fiscal imbalances are associated with lower public sector efficiency.*

Regarding the interaction effect between fiscal decentralization and fiscal rules, two arguments emerge from the literature, which points to negative relationship between these two variables. Firstly, fiscal decentralization can lead to efficiency gains if it increases allocative efficiency because of competition among local service providers. However, this can only happen if subnational

governments have authority how to spend the resources. Therefore, with strict fiscal rules in place, full potential of fiscal decentralization cannot be realized. Secondly, revenue decentralization combined with strict fiscal rules which aim at restricting borrowing or requiring yearly balanced budgets, may reinforce the ratchet effect. The ratchet effect occurs when in an economic downturn, politicians react to a smaller tax base with increasing tax rates, which are however not reduced when the outlook improves (Fredriksen, 2013). If the subnational governments are strictly required to balance the budget annually, deficit carry-over is prohibited or borrowing is not allowed, ratchet effect would be stronger. Since this effect should be particularly visible during an economic downturn or recession, we additionally look at the interaction between decentralization, fiscal rules and the financial crisis starting in 2008.

Hypothesis 3. *Strict fiscal rules combined with revenue decentralization reduce efficiency. The effect is stronger in an economic downturn.*

5.3. Empirical strategy

Fiscal rules typically impose a constraint on fiscal policy through numerical limits on budgetary aggregates. According to the IMF, fiscal rules typically aim at correcting distorted incentives. Particularly in good times they contain pressures to overspend, so ensure fiscal responsibility and debt sustainability. The Fiscal Rule Index of the European Commission measures the strength and the quality of fiscal rules in the European member countries. The index covers all types of numerical fiscal rules setting numerical targets for budgetary aggregates at all levels of government. It is expressed in terms of a summary indicator of fiscal outcomes such as government budget balance, debt, expenditure or revenue developments. For the calculation of the fiscal rule index first a Fiscal Rule Strength Index is calculated, which takes five criterions into account: legal base, binding character, bodies monitoring compliance and the correction mechanisms and resilience to shocks (the methodology was inspired by Deroose, Moulin and Wiertz, 2005).

The Fiscal Rule Index is then calculated by summing up all fiscal rule strength indices in force in the respective member state. The different rules are weighted by the share of government sub sectors in the total public expenditures, in case of multiple rules applied in the same government sub-sector, decreasing weights are set (the second, third and fourth rule obtain weights of $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ respectively).

We use than a fixed effects model with clustered standard errors:

$$eff_{i,t} = \beta_0 + \beta_1 * FRSI_{i,t} + \beta_2 * dec_{i,t} + \beta_4 * FRSI_{i,t} * dec_{i,t} + \theta\mathbf{X} + \alpha_i + \varepsilon_{i,t} \quad (4)$$

where $eff_{i,t}$ is the efficiency of country i at time t , $FRSI_{i,t}$ the fiscal rule index, $dec_{i,t}$ is the decentralization measure and \mathbf{X} denotes the vector of control variables. Unlike Adam et al. (2014) we do not need to worry about right-censoring of the dependent variable, as order-m efficiency scores are not bounded from above.

While definition of the revenue decentralization is a standard one: revenues, as percentage of the overall state revenue, which are collected at the local and regional levels (for federal countries, these two are summed up), excluding intergovernmental grants, the definition of imbalance, that we use, requires some attention. We approximate the imbalance with $dezentexp/dezentrev$. This means, that we look at (the inverse of) how much of the local and regional expenditure is covered by local and regional revenue, in each case weighted by the expenditure decentralization of each tier for federal countries. This measure is not perfect, as it does not recognize whether subnational unites have authority over tax rates, e.g., for the case of Germany it underestimates the imbalances by considering fiscal equalization payments as own revenues. However, data limitations do not allow us to answer this in more detail. It should also not be understood as decentralization measure - it is rather a measure of fiscal equivalence, that is congruence between expenditure and revenue authority - it can therefore be fairly low also in centralization countries, as long as both revenues and expenditures are similarly centralized. Summary statistics can be found in Table 6 and show that, despite some issues, the measure captures imbalances reasonably well. The lower imbalance is found in Switzerland, with a value of only slightly above one, meaning that almost all regional expenditure is covered with regional revenue, while for countries such as Austria, United Kingdom, Netherlands and Estonia, it is above three, meaning that less than a third of local and regional expenditure is covered by local and regional income. On average it is slightly above 2, meaning less than 50% of expenditure covered.

An obvious concern regarding the empirical approach is endogeneity of fiscal decentralization. We, therefore, use two instrumental variables to overcome this problem. The first method, similarly to Baskaran and Feld (2013), involves using the Regional Authority Index (Hooghe et al., 2010) as an instrument for fiscal decentralization. It is a qualitative index of regional autonomy ($rai = Z1$) based solely on institutional and political factors, and is a good instrument for expenditure and revenue decentralization. The second approach follows Enikolopov and Zhuravskaya (2007) and Ligthart and Oudheusden (2017) and instruments the explanatory variables, with a weighted average of the corresponding variables in similar countries. The index of similarity is calculated on a base of an inverse of Euclidian distance between the countries' capital cities weighted by all

Table 6: Summary statistics of decentralization measures and imbalance

Country	Revenue	Expenditure	Imbalance
Austria	0.098	0.307	3.770
Belgium	0.175	0.378	2.305
Czech Republic	0.177	0.259	1.594
Denmark	0.293	0.608	2.075
Estonia	0.045	0.259	5.763
Finland	0.270	0.389	1.404
France	0.151	0.196	1.394
Germany	0.351	0.385	1.187
Greece	0.027	0.067	2.956
Hungary	0.121	0.224	2.078
Ireland	0.076	0.214	2.772
Italy	0.189	0.300	1.702
Latvia	0.188	0.273	1.561
Netherlands	0.104	0.331	3.315
Norway	0.147	0.326	1.731
Poland	0.175	0.308	1.953
Portugal	0.103	0.138	1.522
Slovakia	0.057	0.146	2.939
Slovenia	0.119	0.188	1.728
Spain	0.256	0.457	2.123
Sweden	0.345	0.459	1.322
Switzerland	0.481	0.566	1.169
United Kingdom	0.093	0.276	3.319
Total	0.171	0.303	2.266

distances, and is defined as follows:

$$Z2_{it} = \sum_{j=1}^N w_{ij} \times x_{tj}, \quad w_{ij} = \begin{cases} \left(\frac{\sum_{j=1}^N dist_{ij}}{dist_{ij}} \right)^2 & \text{if } i \neq j \\ 0 & \text{if } i = j \end{cases}, \quad (5)$$

where $dist_{ij} = \sqrt{(lat_i - lat_j)^2 + (lon_i - lon_j)^2}$ and lat and lon denote geographical latitude and longitude of the capital, respectively. Moreover, the distance is squared, so that more weight is placed on more similar observations. Obviously, the weights do not change over time in this case, but the actual weighted sum does. As argued by Ligthart and Oudheusden (2017), geographical proximity explains similar patterns of decentralization as neighbouring countries adopt each others' policies.

5.4. Results

Tables 7 and 8 present the results of the main specifications, in which we look at the effects of decentralization, imbalances, fiscal rules and their interactions. According to Table 7, revenue decentralization has a strong positive effect on public sector efficiency. As for the size of the coefficient, OLS specification points to 1.2, which means that 10 percentage points change in decentralization, corresponds to an increase of 12 percentage points of input-oriented efficiency - the difference between Greece and the Netherlands. The IV specifications point to an even higher coefficient of about 1.5-1.6, meaning for a 10 percentage points decentralization change, a jump from the efficiency of Greece, to the one of Germany.

On the other hand, in these specifications, fiscal rules do not seem to affect public sector efficiency - later on, we show that the effect might indeed be there, when we consider non-linear decentralization effect. The interaction effect between decentralization and FRSI is negative, although not significant, and suggests that ratchet effect might be present. As for fiscal imbalance, perhaps suprisingly, no significant effect can be found. While fiscal imbalances have been found in previous literature to affect several fiscal indicators, it is unexpected that no relationship with efficiency can be established. This question certainly requires further studies.

Turning briefly to other control variables, consistent effects are found for four of them: as already introduced in previous sections, most countries improved on their efficiency in the aftermath of the economic crisis. Moreover, there is a clear, significant negative relationship between the size of the state and the overall public sector efficiency. Even when controlling for expenditure, the share of left socialist parties in parliament is still negatively associated with efficiency, confirming some previous results for the local governments. Finally, increasing globalization is associated

Table 7: Efficiency: Results for revenue decentralization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV Z1	IV Z2	IV Z1 & Z2	IV Z1	IV Z2	IV Z1 & Z2
dezentrev	1.22*** (3.16)	1.35*** (3.38)	1.61*** (3.78)	1.50** (2.07)	1.34** (2.42)	1.76*** (3.23)	2.48 (0.88)	1.35** (2.01)
FRSI	-0.01 (-0.92)	0.01 (1.03)	0.01 (0.43)	-0.01 (-1.35)	0.01 (0.61)	0.07 (1.40)	0.13 (0.48)	0.03 (0.46)
dezentrev*FRSI		-0.08 (-1.50)				-0.33 (-1.44)	-0.80 (-0.50)	-0.13 (-0.36)
exptot	-0.02*** (-14.29)	-0.02*** (-14.20)	-0.02*** (-13.52)	-0.02*** (-13.55)	-0.02*** (-14.40)	-0.01*** (-13.46)	-0.02*** (-6.80)	-0.02*** (-14.50)
crisis	0.07** (2.23)	0.07** (2.28)	0.07*** (4.83)	0.08** (2.45)	0.07*** (4.88)	0.07*** (5.30)	0.07** (2.37)	0.07*** (5.29)
eco2gdppps	-0.00 (-0.39)	-0.00 (-0.20)	0.00 (0.03)	-0.00 (-0.22)	0.00 (0.02)	0.00 (0.31)	0.00 (0.42)	0.00 (0.11)
drig	0.01** (2.47)	0.01** (2.33)	0.00* (1.91)	0.01*** (2.90)	0.00** (2.00)	0.00* (1.74)	0.00 (0.23)	0.00* (1.96)
Inflation	-0.00 (-0.80)	-0.00 (-0.69)	-0.00 (-0.48)	-0.00 (-0.73)	-0.00 (-0.57)	-0.00 (-0.71)	-0.00 (-0.01)	-0.00 (-0.64)
LTinterest	0.00 (0.32)	0.00 (0.07)	0.00 (0.31)	0.00 (0.35)	0.00 (0.40)	0.00 (0.63)	0.00 (-0.46)	0.00 (0.52)
InfTarget	0.00 (0.01)	0.01 (0.33)	-0.01 (-0.43)	-0.00 (-0.13)	-0.01 (-0.33)	-0.01 (-0.48)	0.06 (0.48)	-0.01 (-0.33)
cpdsfrleg	0.01 (0.22)	0.01 (0.13)	-0.01 (-0.19)	0.01 (0.14)	-0.01 (-0.13)	-0.02 (-0.23)	-0.05 (-0.33)	-0.01 (-0.14)
cpdssls	-0.00*** (-5.09)	-0.00*** (-5.17)	-0.00*** (-6.92)	-0.00*** (-6.69)	-0.00*** (-5.69)	-0.00*** (-6.24)	-0.00*** (-2.54)	-0.00*** (-5.14)
fofpssc	0.00 (1.04)	0.00 (0.99)	0.00 (0.47)	0.00 (1.14)	0.00 (0.44)	0.00 (0.71)	0.00 (0.52)	0.00 (0.47)
pop14	-0.01* (-1.88)	-0.01 (-1.63)	-0.01 (-0.72)	-0.01* (-1.85)	-0.01 (-0.66)	-0.01 (-0.55)	-0.00 (-0.06)	-0.01 (-0.57)
pop65	-0.02 (-1.25)	-0.02 (-1.27)	-0.02 (-1.20)	-0.02 (-1.41)	-0.01 (-1.11)	-0.01 (-1.07)	-0.02 (-0.96)	-0.01 (-1.05)
popden	-0.00 (-1.49)	-0.00 (-1.67)	-0.00* (-1.76)	-0.00* (-1.83)	-0.00 (-1.47)	-0.00* (-1.69)	-0.00 (-0.90)	-0.00 (-1.49)
popurb	0.01 (1.60)	0.01* (1.73)	0.01 (1.58)	0.01 (1.59)	0.01 (1.18)	0.01 (1.25)	0.01 (0.83)	0.01 (1.01)
N	249	249	189	249	189	189	249	189
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F			38.169	32.898	29.335	10.157	0.481	7.363

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at country level in brackets.

with increased efficiency, consistently with a hypothesis of spillovers between countries, when it comes to adoption of good policies. This result is new to the literature and requires a more detailed analysis. Other variables in the regressions do not show consistent correlations.

Research by Adam et al. (2014) suggests, that the overall effect of decentralization might be non-linear, they also provide a theoretical model for why this could be the case. While their model is designed to consider revenue decentralization, we can also hypothesize that the effect of fiscal imbalances could be non-linear. Table 9 presents the results in this case. The overall conclusions about the role of decentralization do not change - while the curve is non-linear, the "decreasing" part is not significantly different from zero, also visualized in Figure 7. This means, that the non-linearity does not involve a maximum point, but rather that the returns to decentralization are initially constant and above a certain level start to increase at an increasing rate.

Moreover, we find statistically significant evidence consistent with the ratchet effect: while fiscal rules in general have little impact on the public sector efficiency, if combined with high

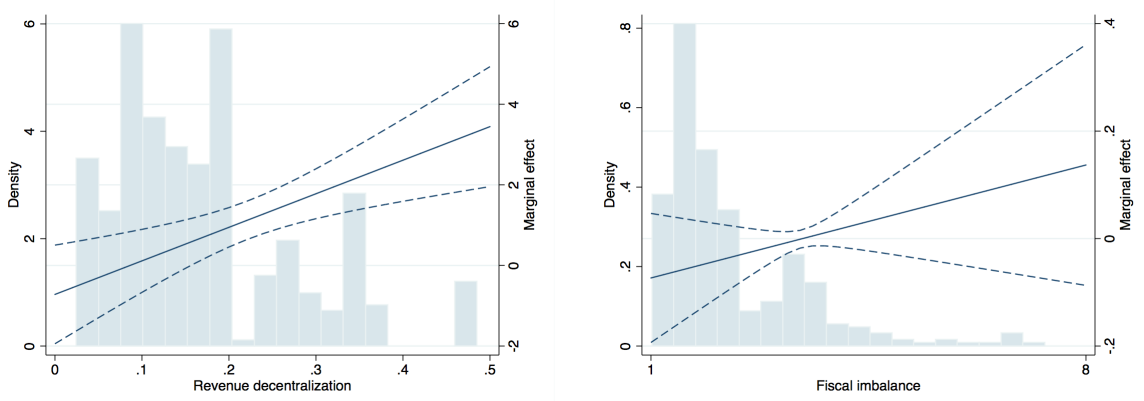
Table 8: Efficiency: Results for fiscal imbalance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV Z1	IV Z2	IV Z1 & Z2	IV Z1	IV Z2	IV Z1 & Z2
imb	-0.02 (-0.93)	-0.02 (-0.92)	2.23 (0.08)	0.06 (1.15)	0.11* (1.85)	-7.29 (-0.02)	0.08 (1.37)	0.07 (0.83)
FRSI	0.00 (0.26)	0.02 (0.69)	0.47 (0.08)	0.01 (0.96)	0.04** (2.12)	-0.30 (-0.01)	-0.13 (-1.53)	0.14 (0.66)
imb*FRSI		-0.01 (-0.72)				-0.59 (-0.02)	0.08* (1.69)	-0.06 (-0.48)
exptot	-0.02*** (-9.32)	-0.01*** (-9.53)	0.09 (0.06)	-0.01*** (-6.01)	-0.01*** (-3.13)	-0.35 (-0.02)	-0.01*** (-5.44)	-0.01*** (-2.73)
crisis	0.06* (2.04)	0.06* (2.01)	-0.42 (-0.06)	0.06* (1.88)	0.04** (2.17)	1.68 (0.02)	0.08** (2.17)	0.05** (2.03)
eco2gdppps	-0.00 (-1.07)	-0.00 (-1.04)	0.00 (0.08)	0.00 (0.40)	0.00 (1.05)	-0.00 (-0.02)	-0.00 (-0.17)	0.00 (1.18)
drig	0.01 (1.62)	0.01 (1.67)	-0.08 (-0.07)	0.00 (1.13)	0.00 (0.24)	0.25 (0.02)	0.00 (0.98)	0.00 (0.20)
Inflation	-0.00 (-1.10)	-0.00 (-1.02)	0.01 (0.07)	-0.00 (-0.54)	-0.00 (-0.13)	-0.03 (-0.02)	-0.00 (-1.11)	0.00 (0.22)
LTinterest	-0.00 (-0.08)	0.00 (0.16)	0.15 (0.08)	0.00 (1.25)	0.01 (0.94)	-0.47 (-0.02)	-0.00 (-0.14)	0.01 (0.73)
InfTarget	0.00 (0.19)	-0.01 (-0.32)	1.41 (0.08)	0.03 (1.15)	0.08 (1.06)	-4.53 (-0.02)	0.09* (1.73)	0.06 (0.75)
cpdsfrleg	0.03 (0.52)	0.03 (0.40)	0.05 (0.06)	0.05 (0.61)	0.01 (0.10)	-0.27 (-0.02)	0.09 (1.21)	-0.00 (-0.03)
cpdslls	-0.00** (-2.68)	-0.00*** (-3.00)	0.01 (0.05)	-0.00** (-1.99)	-0.00 (-1.22)	-0.03 (-0.02)	-0.00* (-1.92)	-0.00 (-1.52)
fortpsc	0.00 (0.69)	0.00 (0.72)	-0.04 (-0.07)	0.00 (0.58)	-0.00 (-0.46)	0.13 (0.02)	0.00 (0.39)	-0.00 (-0.42)
pop14	-0.02 (-1.26)	-0.02 (-1.28)	0.83 (0.08)	0.01 (0.27)	0.03 (0.75)	-2.60 (-0.02)	0.01 (0.23)	0.03 (0.97)
pop65	-0.01 (-0.94)	-0.01 (-0.97)	0.41 (0.07)	-0.01 (-0.60)	0.01 (0.53)	-1.40 (-0.02)	-0.01 (-0.45)	0.00 (0.09)
popden	-0.00 (-0.65)	-0.00 (-0.57)	0.06 (0.07)	-0.00 (-0.59)	0.00 (0.54)	-0.21 (-0.02)	-0.00 (-0.77)	0.00 (0.34)
popurb	0.00 (0.27)	0.00 (0.23)	-0.25 (-0.08)	-0.00 (-0.17)	-0.01 (-0.85)	0.80 (0.02)	0.00 (0.11)	-0.01 (-0.68)
N	249	249	189	249	189	189	249	189
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F			15.478	17.623	14.410	0.105	1.456	0.689

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at country level in brackets.

revenue decentralization, the correlation turns negative. Moreover, as reported in Column (3), the effect is visible after the crisis: while starting in 2008, countries' efficiency has generally increased, it was less so the case for countries which combine revenue decentralization with strict fiscal rules. Finally, the overall conclusions about fiscal imbalances do not change, with both coefficients on *imb* statistically indifferent from zero.

Figure 7: Marginal effects of *dezentrev* and *imb*



6. Conclusions

In this paper we examine the public sector efficiency of 23 European countries. Apart from the total performance, we analyze different public sector areas, such as administration, education, health, distribution, environmental protection, public security, infrastructure, economic performance and stability.

Switzerland and Norway not just show a top performance, but also a high public sector efficiency. On the other hand, the South European countries display poor public sector performances and they also belong to the inefficient ones. New European members show a rather moderate performance, but, in country comparison, they belong to the efficient ones. Vice versa, Scandinavian countries show a good performance, but because of the rather expensive system their efficiency is moderate. The other old EU member countries generally show an average performance with an average efficiency level.

Additionally, we examine public sector efficiency. We find that in order to increase public sector efficiency, some countries have much larger potential in input reduction than in an increase in performance. Austria, Finland and France show a relative poor input-oriented efficiency, but a much better output-oriented efficiency. These countries show higher potential becoming more efficient in the expenditure part, i.e. they could significantly reduce expenditures, without hurting

Table 9: Efficiency: Non-linear specifications

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
dezentrev	-0.72 (-1.15)	-0.85 (-1.33)	-0.78 (-1.32)			
dezentrev*dezentrev	4.16*** (3.22)	4.89*** (3.79)	4.60*** (4.15)			
dezentrev*FRSI		-0.13** (-2.18)	-0.04 (-0.65)			
crisis*dezentrev*FRSI			-0.09*** (-3.39)			
imb				-0.10 (-1.20)	-0.10 (-1.32)	-0.08 (-1.19)
imb*imb				0.02 (1.20)	0.01 (1.36)	0.01 (1.27)
imb*FRSI					-0.01 (-0.42)	-0.00 (-0.01)
crisis*imb*FRSI						-0.01** (-2.36)
FRSI	-0.01 (-1.18)	0.01 (1.52)	0.01 (1.11)	0.00 (0.26)	0.01 (0.42)	0.01 (0.50)
crisis	0.07** (2.42)	0.07** (2.54)	0.09*** (3.01)	0.06* (2.01)	0.06* (2.00)	0.06** (2.14)
exptot	-0.02*** (-15.01)	-0.02*** (-15.08)	-0.02*** (-17.12)	-0.01*** (-10.35)	-0.01*** (-10.12)	-0.01*** (-10.29)
eco2gdppps	-0.00 (-0.76)	-0.00 (-0.55)	-0.00 (-0.60)	-0.00 (-0.87)	-0.00 (-0.86)	-0.00 (-1.15)
drig	0.01** (2.28)	0.00* (2.09)	0.00* (1.78)	0.01 (1.70)	0.01 (1.68)	0.00 (1.33)
Inflation	-0.00 (-0.86)	-0.00 (-0.71)	-0.00 (-1.19)	-0.00 (-0.97)	-0.00 (-0.95)	-0.00 (-0.99)
LTinterest	0.00 (0.48)	0.00 (0.08)	-0.00 (-0.18)	-0.00 (-0.10)	0.00 (0.03)	-0.00 (-0.46)
InfTarget	0.00 (0.15)	0.01 (0.66)	0.01 (0.80)	0.01 (0.29)	0.00 (0.04)	0.00 (0.04)
cpdsfrleg	0.03 (0.41)	0.02 (0.32)	0.02 (0.32)	0.05 (0.70)	0.04 (0.63)	0.04 (0.56)
cpdslls	-0.00*** (-5.46)	-0.00*** (-5.66)	-0.00*** (-5.70)	-0.00** (-2.67)	-0.00*** (-2.90)	-0.00*** (-2.92)
fofpsc	0.00 (1.01)	0.00 (0.95)	0.00 (0.95)	0.00 (0.58)	0.00 (0.61)	0.00 (0.71)
pop14	-0.01 (-1.70)	-0.01 (-1.14)	-0.01 (-1.43)	-0.02 (-1.35)	-0.02 (-1.33)	-0.03 (-1.46)
pop65	-0.01 (-1.39)	-0.02 (-1.48)	-0.02 (-1.68)	-0.02 (-1.07)	-0.02 (-1.08)	-0.02 (-1.08)
popden	-0.00 (-1.13)	-0.00 (-1.36)	-0.00* (-1.75)	-0.00 (-0.87)	-0.00 (-0.79)	-0.00 (-0.56)
popurb	0.00 (0.84)	0.00 (0.99)	0.00 (1.04)	0.00 (0.14)	0.00 (0.13)	0.00 (0.19)
const.	1.56*** (4.58)	1.61*** (4.73)	1.87*** (5.28)	2.11*** (4.51)	2.09*** (4.68)	2.24*** (4.70)
N	249	249	249	249	249	249
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at country level in brackets.

their performance level of public sector. On the other hand, Slovakia, Latvia and Ireland show a relative poor output-oriented efficiency, but a much better efficiency in input-oriented efficiency. These countries have a larger potential becoming more efficient in the performance part, i.e. to achieve much better performance with the same expenditures.

We use several efficiency techniques and investigate input- and output-oriented efficiency. We find that countries with small public sectors tend to be more efficient. This result is robust against all efficiency methods used (PSE, FDH, order-m) and no matter whether we use input-oriented efficiency scores or output-oriented efficiency scores.

Because of the relative long time span of our data, our study contributes to the literature by analyzing the effect of the financial crisis on the efficiency of the public sector. We show that public sector efficiency increased after the crises especially in countries with smaller public sectors, while it stayed constant or got even worse in countries with large government sectors. Those results are robust, no matter which efficiency method we use (PSE, FDH or order-m).

Formal regression analysis of determinants of public sector efficiency, including instrumental-variables approach, additionally points to a strong positive effect of revenue decentralization on public sector efficiency. Our results suggest that for a 10 percentage points decentralization change, a jump from the input-oriented efficiency of Greece to the one of Germany is expected. On the other hand, fiscal rules do not positively affect efficiency in general, and they in fact might be detrimental if combined with high decentralization, consistently with the ratchet effect. Finally, other variables are shown to correlate with efficiency: the size of the state, share of left-wing parties in the parliament, as well as measures of globalization.

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Appendix A. Additional tables and figures

Figure A.8: Development of Public sector efficiency (ORDERM) within the sub-samples

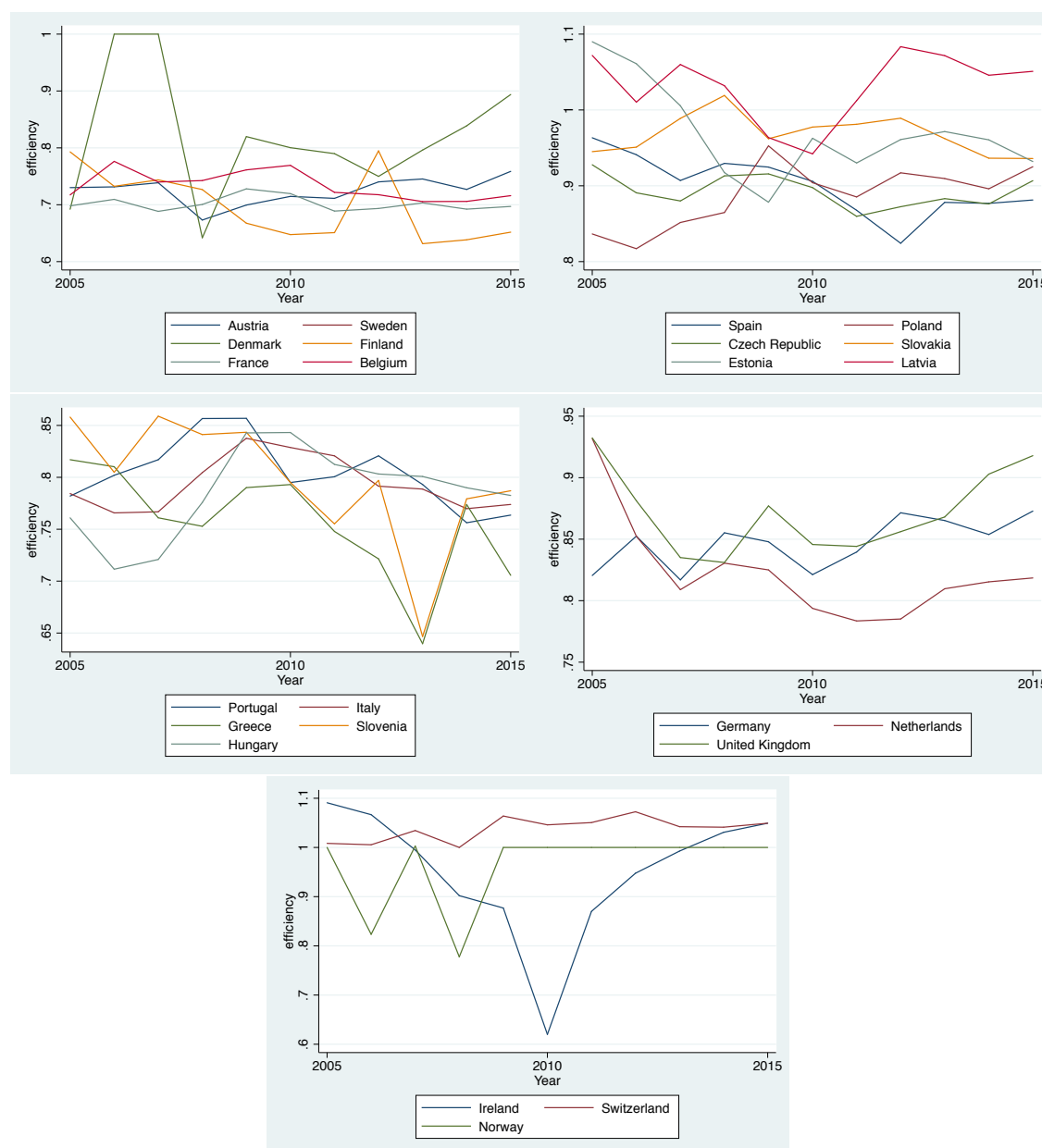


Table A.10: Public sector expenditure variables

expenditures	variable	measure	data source
Administration	General public services expenditures	% of GDP	OECD National Accounts Statistics
Education	Education expenditures	% of GDP	OECD National Accounts Statistics
Health	Health expenditures	% of GDP	OECD National Accounts Statistics
Environmental Protection	Environment protection	% of GDP	OECD National Accounts Statistics
Public Security	Public order and safety expenditures	% of GDP	OECD National Accounts Statistics
Social Security	Social protection expenditures	% of GDP	OECD National Accounts Statistics
Defence	Defence expenditures	% of GDP	OECD National Accounts Statistics
Infrastructure	Total inland transport infrastructure investment	% of GDP	OECD, International Transport Forum (ITF)
Total	Total expenditure	% of GDP	OECD National Accounts Statistics

Table A.11: Definitions and sources of explanatory variables

Name	Definition	Source
<i>exptot</i>	Total general government expenditure as % of GDP	OECD
<i>crisis</i>	Dummy = 1 for years 2008 onwards	
<i>cpdsls</i>	Share of seats in parliament: left-socialist	CPDS
<i>cpdsfrleg</i>	Legislative fractionalization of the party system (Rae index)	CPDS
<i>eco2gdppps</i>	GDP at current market prices, PPS per inhabitant	Eurostat
<i>fotpsc</i>	Freedom of the Press; Score, 0=most free, 100=least free	Freedom house
<i>pop14</i>	Population, ages 0-14 (% of total)	WDI
<i>pop65</i>	Population ages 65 and above (% of total)	WDI
<i>popden</i>	Population density (people per sq. km of land area)	WDI
<i>popurb</i>	Urban population (% of total)	WDI
<i>dezentrev</i>	Share of revenues of states and municipalities as % of total government revenue	OECD
<i>dezentexp</i>	Share of expenditure of states and municipalities as % of total government expenditure	OECD
<i>imb</i>	Fiscal imbalance: $dezentexp/dezentrev$	own calculations, OECD
<i>FRSI</i>	Fiscal Rules Stringency Index, higher values = more stringent fiscal rules	EU Commission
<i>legor</i>	Legal Origin (1 - English, 2 - French, 3 - Socialist, 4 - German, 5 - Scandinavian)	La Porta et al. (1999)
<i>drig</i>	Index of globalization	Dreher (2006)
<i>rai</i>	Regional Authority Index	Hooghe et al. (2010)
<i>inf</i>	Yearly inflation of consumer prices	OECD
<i>infstar</i>	Dummy=1 if a country's central bank uses inflation targeting	IMF
<i>LTinterest</i>	Long-term interest rate	OECD