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

## 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.

## 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 determinants of public-sector efficiency, in particular, the role of fiscal decentralization and fiscal rules. For 23 European countries over the period from 1995 to 2015, we construct a measure of public-sector performance consisting 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, e.g., free disposal hull and order-m, and investigate input- and output-oriented efficiency in the public sector. We analyse, in depth, the impact of fiscal decentralization and fiscal rules on public-sector efficiency. We conclude that, while decentralization is fostering efficiency, fiscal rules have no effect. Moreover, fiscal rules, when combined with decentralization, may harm efficiency, which is consistent with the ratchet effect.

**JEL Classification:** C14, H50, H72

**Keywords:** Public sector, efficiency, order-m, input-oriented efficiency, decentralization, fiscal rules

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## I. INTRODUCTION

The transparency of government budgets has increased tremendously in recent decades. This development has led to increased interest not only among economists, but also among the public with regard to the use of resources by the state and whether the state can use these resources more efficiently.

Additionally, the member states of the EU have agreed on the Stability and Growth Pact, which should result in more fiscal discipline and limit expenditure increases among member states. Furthermore, both capital and labour have become more mobile within the EU, alongside more pressure being applied on European governments in terms of revenues. All in all, these developments have increased the importance of public-sector efficiency (see, e.g., [Tanzi and Schuknecht, 2000](#); [Heller, 2003](#); [Journard et al., 2004](#)).

This paper focuses on the development and determinants of public efficiency. The measure is calculated as a ratio of public-sector performance and expenditure for all years between 1995 and 2015, and for 23 European economies. Public-sector performance is defined as a composite of nine distinct indices for each area of public policy, such as administration, health education, economic performance, security and infrastructure. Compared to previous studies ([Afonso et al. \(2005\)](#) or [Afonso et al. \(2010\)](#)), we include more output variables, making our results more robust and less dependent on a single outcome variable.

The efficiency is calculated by several partial frontier approaches, e.g., free disposal hull (FDH) and order-m. The order-m method allows for the possibility that some countries lie outside the efficiency frontier, which classifies them as super-efficient countries. We find three countries that are super-efficient: Switzerland, Norway and Ireland. Classifying these countries as super-efficient reduces the effect of possible outliers. The paper also distinguishes between input- and output-oriented efficiency. Input-oriented efficiency represents the efficiency of a country according to a given level of output, while output-oriented efficiency expresses efficiency under a given level of inputs.

Having constructed the efficiency measures in the second part of the paper, we investigate the effect of two determinants on public-sector efficiency: fiscal decentralization and the existence of fiscal rules. Although the question of decentralization has been analysed by [Adam et al. \(2014\)](#), [Hauner \(2008\)](#) and [Hauner and Kyobe \(2010\)](#), to the best of our knowledge, this paper is the first to formally analyse whether fiscal rules affect general public-sector efficiency in a cross-country set-up, while explicitly taking into account endogeneity of decentralization. While [Adam et al. \(2014\)](#) look at the decentralization-efficiency nexus, they do not account for endogeneity of decentralization measures and concentrate instead on health and education sectors. Moreover, since they do not account for super-efficiency, censoring the dependent variables causes some problems in econometric estimations. [Hauner \(2008\)](#) looks at the decentralization measure, but for only one country, which restricts a number of varying institutional determinants. Finally, [Hauner and Kyobe \(2010\)](#) concentrate on education and health sectors only.

Revenue decentralization increases accountability between subnational governments, which in turn could improve public-sector efficiency. Hence, we investigate whether revenue decentralization is associated with higher public-sector efficiency and find a strong positive effect of revenue decentralization on input-oriented public-sector efficiency.

Fiscal rules typically impose budgetary constraints on fiscal policy. On the one hand, these constraints force governments to limit or reduce expenditure. This increases the efficiency of such spending. On the other hand, as the fiscal rules are usually pro-cyclical, they could deny sufficient flexibility to decision makers and thus harm efficiency. For fiscal imbalance, no significant correlation can be found. Nevertheless, when considering fiscal imbalance instead of revenue decentralization, fiscal rules are positively associated with efficiency. The interaction between imbalance and fiscal rules is also (borderline) significant and positive, suggesting that, in the presence of high fiscal imbalances, fiscal rules could indeed foster more efficient spending.

In addition to our main variables, our paper outlines other interesting results. First, most countries have demonstrated improved public-sector efficiency in the aftermath of the economic crisis. While government expenditure significantly decreased after the 2009 crisis, the performance of the public sector did not decrease to the same extent, resulting in higher public-sector efficiency. Second, a clear, significant negative relationship between the size of the state and overall public-sector efficiency has been found. Third, the share of left and socialist parties in parliament was found to be negatively associated with efficiency. This result is, to some extent, unexpected, as the composition of the government or the parliament does not necessarily affect the performance of the civil service or bureaucracy directly. Fourth, higher globalization is associated with increased efficiency, indicating a new finding to add to the literature, which requires a more detailed investigation in the future.

The paper is structured as follows. The next section provides a brief overview of the literature. Section III presents the main hypotheses. In Section IV, we present the employed method and data. Section V presents the results of the investigation. Finally, in Section VI, we draw our conclusions.

## II. LITERATURE REVIEW

Some cross-country studies on public services concentrate on public-sector (in)efficiencies. The 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 public-sector performance (PSP) composite indicators for 23 industrialized countries for 2000. They concluded that economies with a small public sector are the most efficient. Afonso et al. (2010) analysed public-sector efficiency in "new" EU member states, compared to that in some emerging Asian markets, and concluded that expenditure efficiency across new EU member states is rather diverse, especially when compared to the top-performing emerging markets in Asia. Angelopoulos et al. (2008) used a sample of 64 countries, both developed and developing, in five-year time periods from 1980 to 2000. They constructed a measure of public-sector efficiency in each country and each time period by calculating an output-to-input ratio. Additionally, they applied an estimate of technical efficiency for public spending in 52 countries for the time period 1995-2000, by applying a stochastic frontier analysis. Several later studies have considered efficiency at 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.

Another strand of literature related to this work considers socio-economic, institutional and political determinants of fiscal outcomes. According to the fiscal federalism literature, for instance,

carefully designed decentralization could boost efficiency in the public sector. While some authors, especially from the public finance tradition, warn against the negative effects of decentralization, such as underprovision of public goods, [Eichenberger \(1994\)](#) convincingly argues that these arguments are often a result of unrealistic assumptions and that, in fact, a more careful assessment of the literature points to overwhelmingly positive predictions regarding various aspects of public finance, which affects the productive efficiency of governments. The empirical literature seems to confirm the validity of such claims. It has been shown that diverse fiscal outcomes are affected by decentralization through diverse channels: reducing excessive spending (as in [Jin and Zou, 2002](#); [Cassette and Paty, 2010](#); [Ashworth et al., 2013](#); [Prohl and Schneider, 2009](#)), reducing excessive borrowing (as in [Goodspeed, 2002](#); [Sorens, 2016](#); [Köppl-Turyna and Pitlik, 2017](#)), affecting the subnational tax base due to the "flypaper effect" (in line with [Rodden, 2002](#)), or through the efficiency of public goods provision (along the lines of [Oates, 1972](#); [Tiebout, 1956](#)). Decentralization has also been found to affect responsiveness to expenditure needs (see, e.g., [Faguet, 1999](#); [Borge et al., 2014](#)) and composition of public spending [Alegre \(2010\)](#); [Borge et al. \(2014\)](#). Political impacts of decentralization are also expected to affect efficiency: through increased control of the electorate over incumbents (see, e.g., [Person and Tabellini, 2000](#)), and through a decrease in lobbying by interest groups, which distorts policy choices and increases waste.

Other factors, which are affected by decentralization, but not necessarily directly related to the technical or allocative efficiency of governments, have been analysed. [Espasa et al. \(2017\)](#) look at the question of whether decentralization is associated with higher subjective well-being and find a significant positive effect of subcentral public-service provision (in particular, health and educational services) on subjective well-being. In a similar spirit, [Diaz-Serrano and Rodríguez-Pose \(2012\)](#) find a positive link between decentralization and life satisfaction and peoples' perception of institutions. [Hessami \(2010\)](#) additionally finds that decentralization positively affects the effect of the size of the government on well-being. Finally, [Bähr \(2008\)](#) finds that subnational autonomy improves the effectiveness of using EU structural funds.

The above-cited results implicitly, and through diverse channels, point to a generally positive impact of decentralization on public-sector efficiency, though mostly focusing on allocative efficiency. The nexus between decentralization and *technical efficiency* has been analysed much less often.

At the cross-country level, [Adam et al. \(2014\)](#) looked at several determinants of public-sector efficiency for the health and education sectors, with a particular focus on fiscal decentralization, in turn finding an inverted-U relationship between the two. Similarly, [Enikolopov and Zhuravskaya \(2007\)](#) examined the decentralization-governance nexus and discovered a significant relationship; however, they did so not by actually estimating efficiency scores, but by simply looking at World Bank governance indices and World Development Indicators as proxies. More recently, [Goel et al. \(2017\)](#) demonstrated a relationship between decentralization and the *perception* of governance quality.

[Hauner and Kyobe \(2010\)](#) also analysed public-sector performance and efficiency in the health and education sectors for a large panel of countries using a broad set of controls. Control variables used for cross-country efficiency comparisons will be described in more detail in Section [IV](#).

At the local level, the question of decentralization and technical efficiency has been looked at by, e.g., [Barankay and Lockwood \(2007\)](#) and [Balaguer-Coll et al. \(2010\)](#). [Barankay and Lockwood](#)

(2007) find, in the case of Swiss cantons, a positive relationship between decentralization and technical efficiency in the provision of educational services. Balaguer-Coll et al. (2010) look at Spanish municipalities and several outputs provided de lege by Spanish local governments (public street lighting, cemeteries, waste collection and street cleaning services, domestic drinking water supplies, access to population centres, surfacing public roads, and regulation of food and drink) and conclude that granting more power to municipalities should result in more technical efficiency, and that those gains increase over time.

This study builds and improves on the above-cited literature in several ways. Firstly, compared to, e.g., Adam et al. (2014), it uses a much broader definition of public services (besides health and expenditure) and directly accounts for endogeneity of decentralization. Secondly, unlike intra-country studies, it allows us to look at a broader set of political, socio-economic and institutional determinants of efficiency, which vary over time and space. Thirdly, by allowing for technical super-efficiency, it allows us to overcome some econometric problems encountered in previous estimations (such as in Adam et al., 2014).

A large body of 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. For instance, many works have examined the political determinants of efficiency (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) and some other determinants. The most comprehensive study to date covering determinants of public-sector performance and efficiency in the case of health and education expenditure is that of Hauner and Kyobe (2010). Using their results and previous literature, we can also identify some further control variables that likely affect efficiency scores.

As for socio-economic determinants, expenditure could improve performance (La Porta et al., 1999), but it is likely to reduce efficiency (Afonso et al., 2005; Gupta and Verhoeven, 2001). 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, by increasing pressure on governments to improve public services in an increasingly competitive environment; and, on the other hand, through positive spillovers of "good" policies between countries.

There is also evidence that monetary variables might directly or indirectly affect fiscal performance. For instance, Beetsma and Bovenberg (1997) and Lewis and Conaty (2003) highlight significant interaction effects between inflation targeting and fiscal policies, which in turn could affect efficiency scores through the impact on expenditures. Hauner and Kyobe (2010) argue that inflation will reduce efficiency by making policy planning more difficult, but their empirical evidence is mixed and includes 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 governments "softer", i.e., allowing for the 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 as to why these matter in the

case of public-sector efficiency. It has been argued that civil society (see, e.g., [Putnam et al., 1993](#)) affects diverse aspects of economic governance, which in turn could affect efficiency. Transparent public-sector decision-making, as well as media freedom, should increase the accountability of the government and thus remove incentives for inefficient expenditure. High-level corruption could also affect efficiency through its effect on the allocation of resources. That said, [Hauner and Kyobe \(2010\)](#) found no 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 origins on efficiency in the case of OECD countries.

Political variables are also likely to affect efficiency through its impact on the overall expenditure levels and the allocation of resources. For instance, [Persson and Tabellini \(2004\)](#) find that presidential systems tend to have lower expenditures, due to more accountability (see also [Shugart and Carey, 1992](#)); however, [Blume et al. \(2009\)](#) show that this result is not robust. In contrast, proportional elections, being likely to result in coalition governments, are also 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 the expansion of government expenditure and affect efficiency scores. The latter relationship has been tested at the local level, e.g., by [Geys et al. \(2010\)](#), who find a 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 in turn constitute the significant bulk of overall government expenses. As for the impact of population density, several studies of efficiency at the local level have observed an impact of population density on efficiency: for instance, [Geys \(2006\)](#) and [Sung \(2007\)](#) report a negative effect, while [Herrera and Pang \(2005\)](#) report a positive relationship. The case for a non-linear relationship could also be made: economies of scale might change into diseconomies above a certain density threshold. It is not straightforward as to how the relationship would look at 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 affecting efficiency ([Alesina et al., 1999](#)).

### III. THEORY AND MAIN HYPOTHESES

The review of the literature related to efficiency leads us to the following hypotheses. Firstly, 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, which creates fiscal imbalances, that is, if not accompanied by revenue decentralization, might be harmful. Revenue decentralization is expected to improve public-sector efficiency through increased accountability and yardstick competition between subnational governments, which result from competition for a mobile tax base. Decentralization allows citizens to compare public services and taxes across jurisdictions and thus increases electoral control over 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 between revenue decentralization and efficiency, mostly relying on the effect of economies of scale. In the presence of economies of scale, higher decentralization could result in higher average costs of production of public goods and services (Stein, 1999). Prud'Homme (1995) additionally warns that political decentralization could negatively affect the 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 an overwhelmingly positive effect of decentralization in relation to various measures of governance.

**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 especially the case whenever authority over revenue and expenditure is not assigned to the same tier 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 level. 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) points to vertical imbalances, in turn increasing public expenditure. However, Gordon (2004) reports that the latter effect is only present in the short term. Fiva (2006) and Rodden (2003) directly analyse vertical fiscal imbalances and conclude that they are associated with higher general spending. While most of the literature indicates a positive relationship between fiscal imbalances and the size of public expenditure (input), it is less clear what the effect of imbalances on performance (output) should be. If intergovernmental transfers are non-earmarked, this allows subnational governments at least partial flexibility to allocate funds according 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, while, at the same time, being associated with higher expenditure. In the base case, vertical fiscal imbalances would leave overall efficiency unaffected, whereas, 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.*

Fiscal rules typically impose a constraint on fiscal policy through numerical limits on budgetary aggregates. According to the International Monetary Fund (IMF), fiscal rules are typically aimed at correcting distorted incentives. Particularly, in good times, they restrain pressures to overspend, thus ensuring fiscal responsibility and debt sustainability. The effect of fiscal rules on efficiency is not straightforward. On the one hand, fiscal rules might positively affect efficiency, in that, by imposing expenditure or balanced budget rules, they force governments to limit or reduce spending. On the other hand, the balanced budget rule (which is common in the EU) tends to be pro-cyclical and might limit the flexibility available to decision makers when it comes to the allocation of resources, thus harming efficiency. Moreover, the premise in any case is that national governments in fact follow the rules imposed on them, which, given weak sanctions, is often questioned (see, e.g., Eyraud and Wu, 2015). Nevertheless, following Schelker and Eichenberger (2010), the effect of fiscal rules on public-sector efficiency could be significantly increased by an



additional extension of the fiscal rules and an introduction of independent auditing institutions with an extended mandate to audit the budget draft ex ante. Such auditing could lead to less wasteful spending and a significant reduction in the general tax burden and public expenditures. Yet, empirical evidence of the latter is mixed. [Eliason and Lutz \(2018\)](#) find, for the US, that fiscal rules do not affect taxation and spending behaviour in any way, as they are being avoided by policymakers and thus do not contribute to taming overspending. Balanced budget rules could also represent an incentive for policymakers to increase taxes and undermine efficiency [\(Asatryan et al., 2018\)](#).

Regarding the interaction effect between fiscal decentralization and fiscal rules, two arguments emerge from the literature, which point to a negative relationship between these two variables. Firstly, fiscal decentralization can lead to efficiency gains if it increases allocative efficiency because of competition between local service providers. However, this can only happen if subnational governments have substantial flexibility when deciding on how to spend resources. Therefore, with strict fiscal rules in place, the full potential of fiscal decentralization cannot be realized. Secondly, revenue decentralization, combined with strict fiscal rules aimed at restricting borrowing or requiring yearly balanced budgets, may reinforce the ratchet effect. The ratchet effect occurs in an economic downturn when politicians react to a smaller tax base by increasing tax rates, which are subsequently not reduced when the outlook improves [\(Fredriksen, 2013\)](#). If either subnational governments are strictly required to balance the budget annually, deficit carry-over is prohibited or borrowing is not allowed, the ratchet effect should be stronger. Since this effect ought to 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.*

#### IV. METHODOLOGY AND DATA

##### 1. Calculation of efficiency

Our paper focuses on the technical efficiency of the public sector. From 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 to measure the efficiency of a particular part of the public sector. [Tanzi and Schuknecht \(1997\)](#) measure the efficiency of public expenditure, addressing the question as to 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, that is, an outcome of different public policies. The overall performance of the 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 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 reflects the quality of the interaction between fiscal policies and market processes, i.e., the effect of public policies on individual opportunity/realization. On the other hand, Musgravian tasks for government comprise allocation, distribution and stabilization.

As public-sector variables do not take the expenditure side into account, for the computation of public-sector efficiency, public-sector performance is weighted by the amount of relevant public expenditure 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  $i$  in 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 is a comparative method, which compares 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 non-parametric approaches. The first approach augments a classical regression model with a non-positive error term capturing inefficiency in production (stochastic frontier). The main restriction of this method is the assumption about the functional form and distribution of random errors. The second approach non-parametrically envelops a given sample of data by a piecewise linear hull, e.g., data envelopment analysis (DEA) or FDH. DEA assumes a convex technology and employs linear programming for enveloping the data, while FDH is based on the principle of weak dominance, which relaxes the convexity assumption. The main criticisms of deterministic approaches concern the lack of a well-defined data-generating process and the fact that the methods are vulnerable to outliers. To control for the last caveat, partial frontier approaches - order- $m$  and order- $\alpha$  - generalize FDH by allowing super-efficient observations to lie outside the estimated production possibility frontier<sup>2</sup> (see [Tauchmann, 2011](#)). In our study, we estimate efficiency using the order- $m$  approach.

## 2. Empirical strategy

To establish the determinants of efficiency, we use a fixed-effects model of the form:

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<sup>2</sup>The order- $m$  approach benchmarks the decision-making units according to the expected best performance in a sample of  $m$  peers, while order- $\alpha$  uses the  $(100-\alpha)$ th percentile of input consumption among available peers as a benchmark.

$$eff_{i,t} = \beta_0 + \beta_1 * decentralization_{i,t} + \beta_2 * FRSI_{i,t} + \beta_3 * FRSI_{i,t} * dec_{i,t} + \theta \mathbf{X} + \alpha_i + \varepsilon_{i,t} \quad (4)$$

where  $eff_{i,t}$  is the efficiency of country  $i$  at time  $t$ ,  $FRSI_{i,t}$  is the fiscal rule index,  $decentralization_{i,t}$  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 the right-censoring of the dependent variable, as order-m efficiency scores are not bounded from above.

**Decentralization** The definition of revenue decentralization is a standard one: revenue, as a percentage of overall state revenue, collected at the local and regional level (for federal countries, these two are summed up), excluding intergovernmental grants. Table [1](#) shows that, on average, about 17.1% of state revenue is collected at the subnational level. The highest level of revenue decentralization is found in Switzerland, at 48.1%, and the lowest, at 2.7%, is only found in Greece. In most countries, expenditure is more decentralized. On average, 30.3% of government expenditure comes from local and regional levels, with the highest levels observed in Denmark (60.8%) and the lowest again in Greece at 6.7%.

The definition of imbalance that we apply requires closer attention. We approximate the imbalance in  $expendituredecentralization/revenuedecentralization$ , that is, the ratio of expenditure decentralization to revenue decentralization. This means that we look at (the inverse of) how much 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 imperfect, as it does not recognize whether subnational units have authority over tax rates, e.g., in the case of Germany, it underestimates 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 a decentralization measure; rather, it is a measure of fiscal equivalence, namely, congruence between expenditure and revenue authority. The latter can therefore be fairly low in centralist countries too, as long as both revenue and expenditure are similarly centralized. Summary statistics can be found in Table [1](#), showing that, despite some issues, the measure captures imbalances reasonably well. The lowest imbalance is found in Switzerland, with a value that is only slightly above 1, meaning that almost all regional expenditure is covered by regional revenue, while, for countries such as Austria, the UK, the Netherlands and Estonia, it is above 3, meaning that less than one 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 the endogeneity of fiscal decentralization. We, therefore, use two instrumental variables to overcome this problem. The first method, similar to [Baskaran and Feld \(2013\)](#), involves using the Regional Authority Index ([Hooghe et al., 2010](#)) as an instrument for fiscal decentralization. This is a qualitative index of regional autonomy ( $rai = Z1$ ), based solely on institutional and political factors, which correlates strongly with expenditure decentralization. The second approach follows [Enikolopov and Zhuravskaya \(2007\)](#) and [Ligthart and Oudheusden \(2017\)](#) and equips the explanatory variables with a weighted average of the corresponding variables in similar countries. The index of similarity is calculated on the basis of an inverse of Euclidean distance between the countries' capital cities, weighted by all distances, and defined as follows:

Table 1: 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
UK	0.093	0.276	3.319
Total	0.171	0.303	2.266

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

where  $dist_{ij} = \sqrt{(lat_i - lat_j)^2 + (lon_i - lon_j)^2}$ , and  $lat$  and  $lon$  denote the geographical latitude and longitude of the capital, respectively. Moreover, the distance is squared, such that more weight is placed on much 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. The instrument relies on an exclusion restriction, whereby there is no direct mechanism or omitted variable captured in the error term, which affects efficiency in a country and is related to a weighted average of fiscal decentralization measures for all other countries in the sample. We cannot think of such a mechanism and thus claim that instrumental variables are likely to be related to decentralization, but not the error term. Interaction terms are equipped with an interaction between the exogenous variables and the instruments<sup>3</sup>.

**Fiscal rules** The Fiscal Rule Index of the European Commission measures the strength and quality of fiscal rules in EU 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 balancing government budgets, debt, expenditure or revenue rules. For the calculation of the fiscal rule index, a Fiscal Rule Strength Index is firstly calculated, which takes five criteria into account: legal base, binding character, bodies monitoring compliance, correction mechanisms, and resilience to shocks (the methodology was inspired by [Deroose et al. \(2006\)](#)).

The Fiscal Rule Index is then calculated by summing up all Fiscal Rule Strength Indices in force in the respective member state. Different rules are weighted by the share of government subsectors in relation to total public expenditures. In the case of multiple rules applied in the same government subsector, decreasing weights are set (the second, third and fourth rules obtain weights of  $\frac{1}{2}$ ,  $\frac{1}{3}$  and  $\frac{1}{4}$ , respectively).

### 3. 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. \(2017\)](#)) data set covering the time period between 1995 and 2015. Despite the unavailability of some variables for the whole time period, due to the large variety of variables used for the generation of the PSP indices in several areas, the impact of the missing data points is rather negligible.

The 20-year time span allows us to identify not only long-term or structural changes in public policy, but also short-term changes, as well as the development of performance and efficiency over time. As already mentioned, we use several indicators to derive public-sector performance in the examined areas of the economy. Table [A.4](#) shows the socio-economic variables used to determine

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<sup>3</sup>When  $X_1$  is exogenous,  $X_2$  is endogenous; when  $Z$  is a valid instrument for  $X_2$ ,  $X_1 \times Z$  is a valid instrument for  $X_1 \times X_2$  (compare, e.g., [Wooldridge \(2010\)](#))

the PSP indices for several policy areas on which government has a significant influence. These indices reflect the outcomes of public policies. While detailed information on the data used can be found in Table [A.4](#) in the Appendix, several examples include: public administration (measured by, e.g., the quality of public services), education (several indices related to the quality of the educational system), health, public security (e.g., precedence of crime), environmental protection, social security (e.g., poverty measures), economic performance, inequality and economic stability. Inclusion of many policy areas allows us to formulate more general conclusions about the performance of governments, compared to previous works on the topic.

To define public-sector efficiency, we need to relate the public-sector performance of a specific area with the corresponding expenditures. Table [A.12](#) in the Appendix summarizes the used expenditure variables for the examined areas.

On the other hand, we include the determinants of efficiency as described in Section [III](#). The definitions and sources of all explanatory variables are presented in Table [A.5](#) in the Appendix.

#### 4. Calculation of public-sector efficiency

Unlike [Afonso et al. \(2005\)](#) and [Afonso et al. \(2010\)](#), we calculate efficiency by a partial frontier approach, namely, the order-m method. Both frameworks determine the production possibility frontiers, but the order-m method allows for some decision-making units to lie outside the efficiency frontier (super-efficient countries). Hence, unlike the FDH method, the efficiency score in the order-m method can be greater than 1. The order-m approach is especially noteworthy 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 make corrections for these outliers. The order-m method allows us to classify those countries as "super-efficient".

Additionally, both the FDH and the order-m methods allow us to calculate input- and output-oriented efficiency. Input-oriented efficiency represents the efficiency of a decision-making unit by a given level of output, while output-oriented efficiency expresses the efficiency of a decision-making unit under a given level of inputs. Hence, the first approach aims at proportionally reducing the inputs at a fixed output level and is mainly used for efficiency estimations when a public service, at a given quality, has to be offered with minimum input level. Countries with low input-oriented efficiency could reduce their expenditure without lowering their performance. The second approach, namely, output-oriented efficiency, maximizes the level of output (quality) at a fixed input level. Countries with low output-oriented efficiency level might increase their performance without increasing their expenditure. Hence, this efficiency measure highlights the efficiency of the realized output in relation to the potential output. Potential output is determined as a production frontier of the best practice units and depends on the nature of the process and whether the potential output has already been observed in the data. [Kalirajan and Obwona \(1994\)](#) argue that best practice methods vary from input to input and not every decision-making unit can apply all inputs efficiently. These might be influenced by various organizational factors, which are in turn influenced by socio-economic or demographic characteristics. Hence the two scores of input- and output-oriented efficiency measures can significantly differ from each other. In one case, when governments operate with constant returns to scale and no other imperfections or asymmetries are present, input- and output-oriented efficiency scores should point to the same

results. The scores are presented in Tables [A.10](#) and [A.11](#) in the Appendix, respectively.

On taking a closer look at Table [A.11](#) in the Appendix, one can see some significant differences between countries in the input- and output- oriented efficiency scores. Countries such as Austria (19), Finland (23) and France (22) show relatively poor input-oriented efficiency, but much better efficiency in output-oriented efficiency (Austria: six; France: 14; Finland: four). These countries show a larger potential to become more efficient in the expenditure part, i.e., they could make a large cut in expenditure without reducing their performance in the public sector. On the other hand, Slovakia, Latvia and Ireland show relatively poor output-oriented efficiency, but much better efficiency in input-oriented efficiency. These countries have a larger potential to become more efficient in the performance part, i.e., to achieve much better performance with the same expenditure.

## V. RESULTS

### 1. *Main results*

Tables [2](#) and [A.6](#) present the results of the main specifications, in which we look at the effects of decentralization measures, fiscal rules and their interactions. According to Table [2](#), revenue decentralization has a strong positive effect on input-oriented public-sector efficiency. As for the size of the coefficient, OLS estimation yields a coefficient equal to 1.2, which means that a change of 10 percentage points in decentralization corresponds to an increase of 12 percentage points in input-oriented efficiency - the difference between Greece and the Netherlands. It should, however, be mentioned that 10 percentage points of revenue decentralization is a fairly high number, as the average for all analysed countries is at 17.1%, with Switzerland as high as 48.1%. Ten percentage points thus mean that Greece would need to raise the local revenue to the level of Slovenia or Hungary. The IV specifications point to an even higher coefficient of about 1.5-1.6, meaning that, for a decentralization change of 10 percentage points, a jump from the input-oriented efficiency of Greece to that of Germany is expected.

As for fiscal imbalance, perhaps surprisingly, no significant correlation can be found. While fiscal imbalances have been reported in the literature to affect several fiscal indicators, it is unexpected that no relationship with efficiency can be established. On the other hand, results in Columns 5 and 7 of Table [A.6](#) in the Appendix point to an interesting conclusion: when considering fiscal imbalance instead of revenue decentralization, fiscal rules are positively associated with efficiency. The interaction between imbalance and fiscal rules is also (borderline) significant and positive, suggesting that, in the presence of high fiscal imbalances, fiscal rules might indeed foster more efficient spending, which is in line with the theoretical considerations behind introduction of fiscal rules as a means of restoring correct incentives against regional overspending. All in all, however, a picture emerges that revenue decentralization is a much better mechanism for fostering efficiency as it readily introduces correct incentives, compared to fiscal rules which aim at correcting the wrong ones.

On the other hand, in these specifications, fiscal rules do not seem to affect public-sector efficiency. Later on, we will show that the effect might indeed be there when we consider a non-linear decentralization effect. The interaction effect between decentralization and FRSI is negative, although not significant, which suggests that the ratchet effect might be present.



Table 2: Input-oriented efficiency: results for revenue decentralization

	(1) OLS	(2) OLS	(3) IV Z1	(4) IV Z2	(5) IV Z1 & Z2	(6) IV Z1	(7) IV Z2	(8) IV Z1 & Z2
Revenue decentralization	1.22*** (3.16)	1.35*** (3.38)	1.61*** (3.78)	4.54* (1.86)	1.72*** (4.51)	1.76*** (3.23)	3.59 (1.01)	2.12*** (4.14)
FRSI	-0.01 (-0.92)	0.01 (1.03)	0.01 (0.43)	-0.03 (-1.06)	0.01 (0.38)	0.07 (1.40)	-0.30 (-0.37)	0.10 (1.52)
Revenue decentralization*FRSI		-0.08 (-1.50)				-0.33 (-1.44)	1.48 (0.35)	-0.48 (-1.59)
Total expenditure	-0.02*** (-14.29)	-0.02*** (-14.20)	-0.02*** (-13.52)	-0.02*** (-6.06)	-0.02*** (-12.81)	-0.01*** (-13.46)	-0.02*** (-4.12)	-0.01*** (-11.24)
Crisis	0.07** (2.23)	0.07** (2.28)	0.07*** (4.83)	0.10* (1.89)	0.06*** (4.72)	0.07*** (5.30)	0.13 (0.85)	0.07*** (5.11)
GDP (PPS)	-0.00 (-0.39)	-0.00 (-0.20)	0.00 (0.03)	0.00 (1.18)	0.00 (0.04)	0.00 (0.31)	-0.00 (-0.15)	0.00 (0.44)
Globalization	0.01** (2.47)	0.01** (2.33)	0.00* (1.91)	0.01** (1.97)	0.00* (1.83)	0.00* (1.74)	0.02 (0.60)	0.00 (1.44)
Inflation	-0.00 (-0.80)	-0.00 (-0.69)	-0.00 (-0.48)	-0.00 (-0.04)	-0.00 (-0.45)	-0.00 (-0.71)	-0.00 (-0.25)	-0.00 (-0.72)
LTinterest	0.00 (0.32)	0.00 (0.07)	0.00 (0.31)	0.00 (0.16)	0.00 (0.27)	0.00 (0.63)	0.01 (0.34)	0.00 (0.69)
Inflation target	0.00 (0.01)	0.01 (0.33)	-0.01 (-0.43)	-0.03 (-0.83)	-0.01 (-0.48)	-0.01 (-0.48)	-0.14 (-0.41)	-0.01 (-0.62)
Party fractionalization	0.01 (0.22)	0.01 (0.13)	-0.01 (-0.19)	-0.05 (-0.49)	-0.02 (-0.21)	-0.02 (-0.23)	0.04 (0.15)	-0.02 (-0.30)
Left wing	-0.00*** (-5.09)	-0.00*** (-5.17)	-0.00*** (-6.92)	-0.00*** (-2.49)	-0.00*** (-7.34)	-0.00*** (-6.24)	-0.00 (-0.81)	-0.00*** (-6.21)
Press freedom	0.00 (1.04)	0.00 (0.99)	0.00 (0.47)	0.00 (1.14)	0.00 (0.47)	0.00 (0.71)	0.00 (0.46)	0.00 (0.79)
Population below 15	-0.01* (-1.88)	-0.01 (-1.63)	-0.01 (-0.72)	-0.00 (-0.23)	-0.01 (-0.74)	-0.01 (-0.55)	-0.02 (-0.27)	-0.01 (-0.50)
Population above 64	-0.02 (-1.25)	-0.02 (-1.27)	-0.02 (-1.20)	-0.03** (-2.24)	-0.02 (-1.24)	-0.01 (-1.07)	-0.02 (-0.95)	-0.01 (-1.10)
Population density	-0.00 (-1.49)	-0.00 (-1.67)	-0.00* (-1.76)	-0.01* (-1.76)	-0.00* (-1.81)	-0.00* (-1.69)	-0.00 (-0.23)	-0.00* (-1.76)
Urban population	0.01 (1.60)	0.01* (1.73)	0.01 (1.58)	0.02** (1.99)	0.01* (1.73)	0.01 (1.25)	0.02 (0.90)	0.01 (1.50)
N	249	249	189	249	189	189	249	189
Country 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	2.220	19.209	10.157	0.481	7.363

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.

Turning briefly to other control variables, consistent correlations are found for four of them. Most countries improved in terms of efficiency in the aftermath of the economic crisis. This means that, while government expenditures have plummeted since the 2009 crisis, the performance of the public sector has not decreased to the same extent. Moreover, there is a clear, significant negative relationship between the size of the state and 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 local governments. This finding is, to some extent, unexpected, as the composition of the government or parliament does not necessarily directly affect the performance of the civil service or bureaucracy. While the channel of transmission is unclear, it could be hypothesized that left wing-oriented cabinets have, on average, higher expenditure; this is, however, not directly related to the performance of the bureaucracy, which undermines overall efficiency scores. Finally, increasing globalization is associated with increased efficiency, consistently with a hypothesis of spillovers between countries when it comes to the adoption of good policies. This result is new to the literature and requires a more detailed analysis in future research. Other variables in the regressions do not point to consistent or robust correlations.

## 2. Channels of transmission

The theoretical literature on the relationship between efficiency and revenue decentralization offers more than one explanation: on the one hand, higher efficiency can be achieved through the impact of decentralization on the expenditure side, i.e., through the pressure to lower expenditure while keeping the outcome levels high; on the other hand, higher efficiency can be achieved through better-targeted policies, as local- or regional-level governing bodies have more information about the preferences and needs of their communities. The question arises as to which of these two possible channels is present in our analysis. To answer this question, we look at whether public-sector performance also depends on decentralization. This measure only takes the outputs into account, and not the inputs (expenditure) used to achieve them. The results are presented in Table 3. For comparison, we use the same set of control variables.

While, in all specifications, revenue decentralization is positively associated with public-sector performance, it is not statistically significant, except for the OLS regression in Column (1), which is significant at the 10% level. Further, fiscal rules do not seem to have any significant effect on the performance of the public sector. As for other control variables, there is some positive correlation between the measure of globalization and performance, along with the hypothesis that globalization fosters spillovers of good policies between countries. A positive correlation is also visible in the inflation-targeting dummy. It seems, therefore, that the driver of the significant effect of revenue decentralization on public-sector efficiency is the ability to achieve good performance scores at lower costs, rather than improving performance per se.

## 3. Robustness

The research by Adam et al. (2014) suggests that the overall effect of decentralization might be non-linear, as well as providing a theoretical model as to 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 A.7 in the Appendix 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 0. This means that non-linearity does not involve a maximum point; rather, 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 public-sector efficiency, if combined with high 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, this has been less so for countries that have combined revenue decentralization with strict fiscal rules. Finally, the overall conclusions about fiscal imbalances do not change, with both coefficients in the case of *imb* being statistically indifferent from 0.

A further check involves leave-one-out regressions in order to test the sensitivity of the results towards the impact of single countries. Results of the leave-one-out regressions are presented in Table A.8 in the Appendix and show that the coefficient for decentralization is stable and significant.

Finally, we include the lagged efficiency score in the regressions to account for the fact that

Table 3: Performance: results for revenue decentralization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	IV	IV	IV	IV
			Z1	Z2	Z1 & Z2	Z1	Z2	Z1 & Z2
Revenue decentralization	1.36*	1.20	1.41	2.64	1.46	0.95	3.77	1.19
	(1.85)	(1.52)	(1.16)	(0.59)	(1.22)	(0.71)	(0.63)	(0.93)
FRSI	0.01	-0.00	0.03	0.00	0.03	-0.17	0.32	-0.11
	(0.83)	(-0.16)	(0.85)	(0.09)	(0.84)	(-0.92)	(0.50)	(-0.71)
Revenue decentralization*FRSI		0.10				1.02	-1.76	0.74
		(1.46)				(1.12)	(-0.50)	(0.94)
Total expenditure	0.00	0.00	0.01*	0.00	0.01*	0.01*	0.00	0.01*
	(0.23)	(0.23)	(1.76)	(0.01)	(1.77)	(1.65)	(0.15)	(1.71)
Crisis	-0.07	-0.07	-0.05	-0.06	-0.05	-0.05	-0.09	-0.05
	(-0.67)	(-0.66)	(-1.08)	(-0.58)	(-1.08)	(-1.13)	(-0.69)	(-1.13)
GDP (PPS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(1.17)	(1.10)	(0.68)	(1.20)	(0.68)	(0.35)	(0.84)	(0.45)
Globalization	0.01**	0.02**	0.01	0.02**	0.01	0.01	0.00	0.01
	(2.25)	(2.32)	(1.57)	(2.18)	(1.56)	(1.52)	(0.16)	(1.53)
Inflation	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	(0.96)	(0.95)	(0.09)	(1.02)	(0.09)	(0.30)	(0.83)	(0.25)
LTinterest	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01
	(-0.79)	(-0.63)	(-0.18)	(-0.84)	(-0.19)	(-0.66)	(-0.58)	(-0.54)
Inflation target	0.14**	0.13**	0.12**	0.13*	0.12**	0.12**	0.27	0.12**
	(2.36)	(2.17)	(2.20)	(1.93)	(2.19)	(2.10)	(0.99)	(2.12)
Party fractionalization	-0.14	-0.13	-0.08	-0.16	-0.08	-0.07	-0.26	-0.07
	(-0.60)	(-0.56)	(-0.28)	(-0.70)	(-0.28)	(-0.25)	(-0.81)	(-0.27)
Left wing	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00*	-0.00	-0.00*
	(-0.93)	(-0.88)	(-1.59)	(-1.08)	(-1.60)	(-1.89)	(-0.84)	(-1.94)
Press freedom	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00
	(-0.47)	(-0.50)	(0.20)	(-0.36)	(0.20)	(-0.13)	(-0.21)	(-0.04)
Population below 15	-0.05	-0.05	-0.09	-0.05	-0.09	-0.10	-0.03	-0.10
	(-1.19)	(-1.24)	(-1.21)	(-1.28)	(-1.22)	(-1.26)	(-0.40)	(-1.26)
Population above 64	0.01	0.01	0.02	0.01	0.02	0.02	-0.00	0.02
	(0.31)	(0.33)	(0.63)	(0.19)	(0.62)	(0.58)	(-0.01)	(0.59)
Population density	-0.00	-0.00	-0.01	-0.00	-0.01	-0.01	-0.01	-0.01
	(-1.06)	(-0.98)	(-1.40)	(-0.99)	(-1.41)	(-1.61)	(-0.78)	(-1.59)
Urban population	-0.01	-0.01	0.00	-0.00	0.00	0.01	0.00	0.01
	(-0.82)	(-0.90)	(0.14)	(-0.06)	(0.15)	(0.39)	(0.15)	(0.36)
N	249	249	189	249	189	189	249	189
Country 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	2.220	19.209	10.157	0.481	7.363

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.

efficiency scores might be persistent over time. Since some of the performance variables and many expenditure categories do not change rapidly over time, it is important to account for this. Results in Table [A.9](#) in the Appendix point to the same conclusions as the main results. Interestingly, it does not seem to be the case that efficiency scores are persistent: the estimated correlation between efficiency and lagged scores is close to 0.

## VI. CONCLUSIONS

In this work, we estimated input- and output-oriented efficiency, using the order-m approach, for 23 European countries over the period of 20 years and analysed its determinants. A formal regression analysis of the determinants of public-sector efficiency, including an instrumental variables approach, points to the strong positive effect of revenue decentralization on public-sector efficiency. Our results suggest that, for a decentralization change of 10 percentage points, a jump from the input-oriented efficiency of Greece to that of Germany is expected. It should, however, be mentioned, that 10 percentage points in the case of revenue decentralization is fairly high, as the average for all analysed countries is at 17.1%, with Switzerland as high as 48.1%. The implication of 10 percentage points is that Greece would need to raise local revenue to the level of Slovenia or Hungary. The IV specifications point to an even higher coefficient of about 1.5 to 1.6, implying that, for a decentralization change of 10 percentage points, a jump from the input-oriented efficiency of Greece to that of Germany is expected.

On the other hand, fiscal rules do not positively affect efficiency in general; in fact, they could be detrimental if combined with high decentralization, which is consistent with the ratchet effect. These results suggest that policies aimed at fostering public-sector efficiency in Europe should concentrate less on imposing fiscal restrictions and more on taking subsidiarity principles more seriously. According to our results, revenue decentralization is a much more effective policy tool than fiscal rules, as revenue decentralization readily introduced correct incentives against overspending by subnational governments, while fiscal rules only aim at correcting wrong ones, especially in the presence of high fiscal imbalances. Finally, other variables are shown to correlate with efficiency: size of the state, share of left-wing parties in parliament and measures of globalization.

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Appendix A. ADDITIONAL TABLES AND FIGURES

Table A.4: Variables for public-sector performance indicators

Indicator	Variable	Type	Data source
Administration	Public services (quality)	Index	QoG data set
	Independence of the judiciary	Index	QoG data set
	Absolute legal institutional quality	Index	QoG data set
	Level of the shadow economy	% of GDP	QoG data set
	Corruption Perceptions Index	Index	QoG data set
Education	Public-sector Corruption Index	Index	QoG data set
	Regulatory quality	Index	QoG data set
	Labour force with primary education	% of total labour force	QoG data set
	Quality of primary education	Index	QoG data set
	Quality of the educational system	Index	QoG data set
Health	Young people not in education or employment: aged 20-24	% of age group	QoG data set
	Pupil-teacher ratio in primary, secondary and tertiary education (headcount basis)	Average	QoG data set
	PISA score	Average across all fields	QoG data set
	Life expectancy, both sexes, aged 0-1 years	Years	QoG data set
	Healthy life years at birth: males	Years	QoG data set
Public security	Healthy life years at birth: females	Years	QoG data set
	Infant mortality	in %	QoG data set
	Crime, violence or vandalism in the area	Cases per population	QoG data set
	Organized crime	Index	QoG data set
	Reliability of police services	Index	QoG data set
Environmental protection	Air quality	Index	QoG data set
	Environmental health	Index	QoG data set
Social security	Environmental Performance Index	Index	QoG data set
	Pension Generosity Index	Index	QoG data set
	Poverty gap	in % of population	QoG data set
	Poverty rate 50%	in % of total labour force	QoG data set
	Armed forces personnel	% of total labour force	QoG data set
Economic indicator	quality of overall infrastructure	Index	QoG data set
	General government net lending	in % of GDP	QoG data set
	GDP per capita growth	in %	QoG data set
	General government debt	in % of GDP	QoG data set
	Real GDP growth	in %	QoG data set
Stability	Stability of economic growth	QoG data set	QoG data set
	Stability of inflation	QoG data set	QoG data set
	Political stability	QoG data set	QoG data set
Inequality	General government debt	QoG data set	QoG data set
	Income inequality: Gini coefficient	QoG data set	QoG data set

Table A.5: Definitions and sources of explanatory variables

Name	Definition	Source
<i>totalexpenditure</i>	Total general government expenditure as % of GDP	OECD
<i>crisis</i>	Dummy=1 for 2008 onwards	
<i>leftwing</i>	Share of seats in parliament: left socialist	CPDS
<i>partyfractionalization</i>	Legislative fractionalization of the party system (Rae Index)	CPDS
<i>GDP(PPS)</i>	GDP at current market prices, PPS per inhabitant	Eurostat
<i>pressfreedom</i>	Freedom of the press, score: 0=most free, 100=least free	Freedom House
<i>populationyounger15</i>	Population aged 0-14 (% of total)	WDI
<i>populationabove64</i>	Population aged 65 and above (% of total)	WDI
<i>populationdensity</i>	Population density (people per km <sup>2</sup> of land area)	WDI
<i>urbanpopulation</i>	Urban population (% of total)	WDI
<i>revenuecentralization</i>	Share of revenues of states and municipalities as % of total government revenue	OECD
<i>expenditurecentralization</i>	Share of expenditure of states and municipalities as % of total government expenditure	OECD
<i>imb</i>	Fiscal imbalance: <i>expenditurecentralization</i> divided by <i>revenuecentralization</i>	own calculations, OECD
<i>FRSI</i>	Fiscal Rules Stringency Index, higher values=more stringent fiscal rules	European Commission
<i>legalorigin</i>	Legal origin (1 - English, 2 - French, 3 - socialist, 4 - German, 5 - Scandinavian)	La Porta et al. (1999)
<i>globalization</i>	Index of Globalization	Dreher (2006)
<i>regionalauthority</i>	Regional Authority Index	Hooghe et al. (2010)
<i>Inflation</i>	Yearly inflation of consumer prices	OECD
<i>Inflationtarget</i>	Dummy=1 if a country's central bank uses inflation targeting	IMF
<i>LTinterest</i>	Long-term interest rate	OECD

Table A.6: Input-oriented efficiency: results for fiscal imbalance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	IV	IV	IV	IV
			Z1	Z2	Z1 & Z2	Z1	Z2	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)
Total expenditure	-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)
GDP (PPS)	-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)
Globalization	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)
Inflation target	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)
Party fractionalization	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)
Left wing	-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)
Press freedom	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)
Population below 15	-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)
Population above 64	-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)
Population density	-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)
Urban population	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
Country 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	5.196	14.410	0.105	2.247	0.689

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.

Table A.7: Input-oriented efficiency: non-linear specifications

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
Revenue decentralization	-0.72 (-1.15)	-0.85 (-1.33)	-0.78 (-1.32)			
Revenue decentralization*revenue decentralization	4.16*** (3.22)	4.89*** (3.79)	4.60*** (4.15)			
Revenue decentralization*FRSI		-0.13** (-2.18)	-0.04 (-0.65)			
Crisis*exp*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)
Total expenditure	-0.02*** (-15.01)	-0.02*** (-15.08)	-0.02*** (-17.12)	-0.01*** (-10.35)	-0.01*** (-10.12)	-0.01*** (-10.29)
GDP (PPS)	-0.00 (-0.76)	-0.00 (-0.55)	-0.00 (-0.60)	-0.00 (-0.87)	-0.00 (-0.86)	-0.00 (-1.15)
Globalization	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)
Inflation target	0.00 (0.15)	0.01 (0.66)	0.01 (0.80)	0.01 (0.29)	0.00 (0.04)	0.00 (0.04)
Party fractionalization	0.03 (0.41)	0.02 (0.32)	0.02 (0.32)	0.05 (0.70)	0.04 (0.63)	0.04 (0.56)
Left wing	-0.00*** (-5.46)	-0.00*** (-5.66)	-0.00*** (-5.70)	-0.00** (-2.67)	-0.00*** (-2.90)	-0.00*** (-2.92)
Press freedom	0.00 (1.01)	0.00 (0.95)	0.00 (0.95)	0.00 (0.58)	0.00 (0.61)	0.00 (0.71)
Population below 15	-0.01 (-1.70)	-0.01 (-1.14)	-0.01 (-1.43)	-0.02 (-1.35)	-0.02 (-1.33)	-0.03 (-1.46)
Population above 64	-0.01 (-1.39)	-0.02 (-1.48)	-0.02 (-1.68)	-0.02 (-1.07)	-0.02 (-1.08)	-0.02 (-1.08)
Population density	-0.00 (-1.13)	-0.00 (-1.36)	-0.00* (-1.75)	-0.00 (-0.87)	-0.00 (-0.79)	-0.00 (-0.56)
Urban population	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
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.



Table A.8: Leave-one-out regressions: regression coefficient of decentralization

Left Out	Z1	Z2	Z1&2
Austria	1.68*** (3.95)	3.52 (.709)	1.69*** (4.00)
Belgium	1.64*** (4.11)	4.61* (1.69)	1.74*** (4.91)
Czech Republic	1.58*** (3.36)	6.42 (1.20)	1.62*** (3.63)
Denmark	2.85 (0.68)	3.99*** (2.52)	3.67* (1.66)
Estonia	1.61*** (3.77)	4.54* (1.86)	1.72*** (4.51)
Finland	1.69*** (3.77)	4.24 (1.60)	1.77*** (4.27)
France	1.59*** (3.89)	4.05* (1.91)	1.66*** (4.39)
Germany	1.53*** (4.54)	3.95 (1.40)	1.59*** (5.17)
Greece	1.55*** (3.44)	4.23** (2.23)	1.65*** (4.03)
Hungary	1.99*** (6.52)	4.47* (1.93)	2.13*** (6.90)
Ireland	1.66*** (3.85)	17.94 (.423)	1.70*** (4.12)
Italy	1.80*** (6.16)	4.84* (1.75)	1.88*** (6.11)
Latvia	1.70*** (4.99)	4.80 (1.65)	1.79*** (5.85)
Netherlands	1.72*** (4.73)	4.87* (1.91)	1.85*** (6.10)
Norway	1.61*** (3.77)	4.54* (1.86)	1.72*** (4.51)
Poland	1.57*** (3.54)	4.49* (1.88)	1.67*** (4.27)
Portugal	1.64*** (3.68)	4.05** (2.28)	1.81*** (4.81)
Slovakia	1.56*** (3.76)	4.20** (2.00)	1.65*** (4.54)
Slovenia	1.67*** (3.73)	5.61* (1.67)	1.77*** (4.40)
Spain	1.52*** (3.18)	3.57*** (2.63)	1.72*** (4.22)
Sweden	1.58*** (3.41)	4.61* (1.76)	1.66*** (3.92)
Switzerland	1.61*** (3.77)	4.54* (1.86)	1.72*** (4.51)
UK	1.66*** (3.99)	4.56* (1.86)	1.75*** (4.75)

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.

Table A.9: Input-oriented efficiency: lagged dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	IV	IV	IV	IV
			Z1	Z2	Z1 & Z2	Z1	Z2	Z1 & Z2
L.efficiency	-0.02 (-0.18)	-0.02 (-0.14)	0.00 (0.04)	-0.20 (-1.19)	0.01 (0.05)	0.00 (0.04)	-0.30 (-0.59)	0.01 (0.09)
Revenue decentralization	1.19*** (3.61)	1.31*** (3.86)	1.38*** (4.72)	5.78 (1.58)	1.47*** (5.68)	1.43*** (3.87)	5.50 (1.14)	2.01*** (4.08)
FRSI	-0.00 (-0.65)	0.01 (0.80)	0.02 (1.42)	-0.03 (-0.90)	0.02 (1.35)	0.04 (0.58)	-0.20 (-0.34)	0.10 (1.21)
Revenue decentralization*FRSI		-0.07 (-1.42)				-0.08 (-0.28)	0.96 (0.31)	-0.43 (-1.11)
Total expenditure	-0.02*** (-16.75)	-0.02*** (-17.00)	-0.02*** (-13.99)	-0.02*** (-4.04)	-0.02*** (-13.68)	-0.02*** (-13.93)	-0.02** (-2.00)	-0.02*** (-10.91)
Crisis	0.07* (2.02)	0.07* (2.08)	0.07*** (5.20)	0.13* (1.84)	0.07*** (5.21)	0.07*** (5.13)	0.14 (1.11)	0.07*** (5.06)
GDP (PPS)	-0.00 (-0.26)	-0.00 (-0.11)	0.00 (0.38)	0.00 (1.23)	0.00 (0.38)	0.00 (0.42)	0.00 (0.16)	0.00 (0.63)
Globalization	0.01** (2.52)	0.01** (2.39)	0.01** (2.13)	0.01* (1.78)	0.00** (2.05)	0.01** (2.04)	0.02 (0.67)	0.00 (1.47)
Inflation	0.00 (0.20)	0.00 (0.31)	0.00 (0.37)	0.00 (0.41)	0.00 (0.39)	0.00 (0.30)	0.00 (0.02)	0.00 (0.15)
LTinterest	0.00 (0.06)	-0.00 (-0.15)	0.00 (0.11)	0.00 (0.11)	0.00 (0.08)	0.00 (0.20)	0.01 (0.28)	0.00 (0.50)
Inflation target	0.00 (0.03)	0.01 (0.52)	0.01 (0.47)	-0.03 (-0.62)	0.01 (0.44)	0.01 (0.43)	-0.17 (-0.36)	0.00 (0.12)
Party fractionalization	0.04 (0.44)	0.03 (0.33)	0.03 (0.22)	-0.02 (-0.16)	0.02 (0.22)	0.02 (0.19)	0.12 (0.24)	0.01 (0.07)
Left wing	-0.00*** (-5.47)	-0.00*** (-5.41)	-0.00*** (-5.95)	-0.00 (-1.50)	-0.00*** (-5.71)	-0.00*** (-5.84)	-0.00 (-1.33)	-0.00*** (-4.27)
Press freedom	0.00 (0.16)	0.00 (0.04)	-0.00 (-0.26)	0.00 (0.21)	-0.00 (-0.26)	-0.00 (-0.16)	0.00 (0.35)	0.00 (0.08)
Population below 15	-0.01 (-0.76)	-0.01 (-0.72)	0.00 (0.25)	-0.01 (-0.29)	0.00 (0.23)	0.00 (0.23)	-0.01 (-0.24)	0.00 (0.06)
Population above 64	-0.02 (-1.46)	-0.02 (-1.51)	-0.02 (-1.40)	-0.05** (-2.07)	-0.02 (-1.45)	-0.02 (-1.27)	-0.04 (-1.24)	-0.02 (-1.22)
Population density	-0.00* (-1.79)	-0.00* (-1.96)	-0.00** (-2.04)	-0.01 (-1.62)	-0.00** (-2.08)	-0.00* (-1.84)	-0.00 (-0.51)	-0.00 (-1.63)
Urban population	0.01** (2.57)	0.01** (2.64)	0.01** (2.55)	0.03* (1.92)	0.01*** (2.73)	0.01** (2.40)	0.02 (1.43)	0.01*** (2.66)
N	234	234	174	234	174	174	234	174
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald-Wald F			52.354	1.609	52.354	11.395	0.478	6.861

Results of OLS and IV regressions with country and time fixed effects; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors clustered at the country level; T-statistics in brackets; N corresponds to the number of observations in each estimation; for the IV regressions, the Cragg-Donald-Wald weak instrument F-statistic is reported.

Table A.10: FDH and order-m efficiency and rankings for 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
UK	0.77	(0.10)	10	0.91	(0.06)	8

Table A.11: FDH and Order-m efficiency and rankings for 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
UK	1.23	(0.10)	12	1.17	(0.06)	12

Table A.12: Public-sector expenditure variables

Expenditure	Variable	Measure	Data source
Administration	General public services expenditure	% of GDP	OECD National Accounts Statistics
Education	Education expenditure	% of GDP	OECD National Accounts Statistics
Health	Health expenditure	% of GDP	OECD National Accounts Statistics
Environmental protection	Environment protection expenditure	% of GDP	OECD National Accounts Statistics
Public security	Public order and safety expenditure	% of GDP	OECD National Accounts Statistics
Social security	Social protection expenditure	% of GDP	OECD National Accounts Statistics
Defence	Defence expenditure	% 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