Received: 22 January 2023 | Accepted: 22 April 2024

DOI: 10.1111/sjpe.12386

ORIGINAL ARTICLE

Scottish Journal of Political Economy WILEY

Privatisation and government spending efficiency: An empirical analysis in Europe

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Funding information
Ekonomiaren Garapen eta Lehiakortasun Saila, Eusko Jaurlaritza, Grant/Award Number: IT1523-22

Abstract

Academic literature has made an effort to demonstrate the positive effects of privatisation reforms on government performance and economic growth. However, there is no sufficient evidence to support the benefits of privatisation in terms of government spending efficiency. This study analyses the correlation between privatisation and government spending efficiency. Our empirical results do not support a positive effect of privatisation on government spending efficiency. These findings are relevant because they suggest that, although privatisation has been usually seen as a tool to balance public finances, it does not mean that government spending efficiency will be higher after privatising State-owned enterprises.

KEYWORDS
DEA, efficiency, order-m, privatisation, state-owned enterprises

JEL CLASSIFICATION
H50, H60

1 | INTRODUCTION

Privatisation is a major trend all over the world and it involves different methods and techniques. This study uses the "material" approach (Obinger et al., 2016) to define privatisation as the sale of shares of state-owned

enterprises (SOEs) to private investors. This results in property and decision-making capability transference from the public to the private sector.

Privatisation reforms were initiated by the Thatcher's government in the United Kingdom (UK) in 1979, motivated by the belief in greater efficiency of the private sector (Parker & Saal, 2003). From that moment, privatisation attracted the attention of academics, trying to explain the subsequent waves during the 80s and 90s across Europe (Clifton et al., 2006) and worldwide. Among the different reasons to explain privatisation reforms (Gonzalo et al., 2003; Obinger et al., 2016), the improvements in government public finances (such as reduction of deficits and indebtedness) are the most alluded in the literature. In general, scholars have noted that privatisations contribute to balancing public finances and reducing public indebtedness (e.g., Bortolotti et al., 2001, 2003; Cuadrado-Ballesteros & Peña-Miguel, 2019; Schmitt, 2013, 2014; Sheshinski & López-Calva, 2003). However, this perspective is misleading because it considers only how many resources the government spends, but not how efficiently is spending these resources, namely government spending efficiency.

The concept of public spending efficiency refers to the ability of the government to maximize the policy outcomes given a level of spending, or the ability to minimize its spending given a level of economic activity (Chan & Karim, 2012). Previous studies have noted privatisation for alleviating unfavourable financial situations of governments, by reducing public spending and increasing revenues through the sale of SOEs (Cuadrado-Ballesteros & Peña-Miguel, 2019; Schmitt, 2013, 2014), but it is essential that policy outcomes do not be damaged.

To our knowledge, this is the first attempt at testing a simultaneous two-causal relationship between privatisation and government spending efficiency by using a dynamic panel estimator (Arellano & Bond, 1991) to take into account endogeneity between efficiency and privatisations. For that, it uses a sample of 22 European countries during the period 1995–2013. We may conclude that, although privatisation has been usually seen as a tool to balance public finances (Bortolotti et al., 2003; Jeronimo et al., 2000; Sheshinski & López-Calva, 2003), our empirical results do not support a positive effect of privatisation on government spending efficiency.

These findings have practical implications nowadays. The Troika pushed through privatisation programmes in the European Union (EU) members that suffered financial problems during the crisis of 2008, as in the case of Greece and Ireland (Clifton et al., 2018), expecting to balance public finances (Bortolotti et al., 2003; Jeronimo et al., 2000; Sheshinski & López-Calva, 2003). However, the simple conversion of the public into private enterprises is not enough to ensure that governments spend efficiently. Market mechanisms (like competition) are also necessary (Vickers & Yarrow, 1991) because spending efficiency may improve only if transactional costs are lower than production costs by SOEs.

The paper is organized as follows. Section 2 provides a literature review on privatisation reforms and proposes the hypothesis. Section 3 addresses the research design and methodology. Section 4 presents and discusses the results, and Section 5 summarizes the main conclusions.

2 | THE LINK BETWEEN PRIVATISATION AND EFFICIENCY

2.1 | Brief literature review

Privatisation has been attracting scholarly attention from several decades. Obinger et al. (2016) group the major determinants of privatisation into: (i) economic performance reasons, referring to economic growth, public budget deficits and debt, unemployment, efficiency and inflation; (ii) actor preferences, denoting the influence of political partisanship and labour unions; (iii) institutional factors, referring to the fragmentation of governments, veto players, legal origin, capital market development, constitutional provisions, and the initial size of the SOE sector; and (iv) international influences, including economic integration, Europeanization, and policy diffusion.

Among all these reasons, efficiency argumentations have been one of the most salient to explain why governments would want to sell the ownership of a SOE. On the one hand, studies that take a microeconomic perspective usually

refer to efficiency as profitability or productivity, and they analyse samples of firms that were privatized in specific countries and/or industries (e.g., Boubakri et al., 2005; Cabeza-García et al., 2016; Cullinane et al., 2005; D'Souza et al., 2005, 2007; Estache et al., 2002; Megginson et al., 1994; Tiemann & Schreyögg, 2012; Villalonga, 2000). On the other hand, studies that take a macroeconomic perspective refer to efficiency as economic growth or development, financial health, or unemployment (see meta-analysis of Agasisti et al., 2018; Obinger et al., 2016).

This study contributes to previous literature by considering a wider concept of efficiency to represent government performance (not firms' performance). Concretely, it refers to government spending efficiency, as the ability of the government to maximize the policy outcomes given a level of spending, or the ability to minimize its spending given a level of economic activity (Chan & Karim, 2012). This concept could be considered an indicator of the effectiveness of government policy implementation in different areas, such as administration, education, health, income distribution, and economic stability (Chan & Karim, 2012).

The scarce literature on central government efficiency has led previous literature to be focused on developing indicators that represent this concept (Adam et al., 2011; Afonso et al., 2005, 2010). Others are focused on explaining the relevant factors to improve efficiency (Chan & Karim, 2012; Hauner & Kyobe, 2010; Montes et al., 2019; Rayp & Van De Sijpe, 2007). Among them, privatisation has been not previously considered; just decentralization, which is another New Public Management (NPM) reform (Adam et al., 2014; Ubago Martínez et al., 2018). Then, this is the first attempt at testing the relationship between privatisation and government spending efficiency, contributing to previous literature on both strands of research.

2.2 | Research hypothesis

In the late 1980s, the public sector in the EU adopted NPM reforms with the aim of modernising public administrations that were characterised by large bureaucracies. NPM theory involves the introduction of organisational and management structures of the private sector (Haynes, 2003), aiming to increase efficiency and productivity through a market-oriented outlook to achieve a better use of resources (Diefenbach, 2009).

The critical view towards inefficient, hierarchical, and inflexible bureaucracies led the UK to introduce some NPM reforms. Measures for avoiding bureaucratic monopoly are, among others, the introduction of competition in public services delivery, privatisation, and outsourcing to reduce spending (Niskanen, 1971). Indeed, efficiency gain was the main driving force of privatisation for the governments in the UK during the 1980s and 1990s. The state provision was traditionally associated with monopolies, so the expectation was that privatisation would lead to higher operating efficiency (Farazmand, 1999; Parker, 1999).

According to Public Choice theory, in an unfavourable financial situation, governments should orient public services towards the application of market techniques (Stark, 2002), expecting a positive effect of privatisation reforms on fiscal balance (e.g., Bortolotti et al., 2001, 2003; Cuadrado-Ballesteros & Peña-Miguel, 2019; Schmitt, 2013, 2014; Sheshinski & López-Calva, 2003). Private enterprises have been traditionally considered more efficient than SOE because they tend to operate closer to the border of possibilities of production, reducing the waste of resources. So, if governments sell (inefficient) SOEs, subsidies and transfers will be cut, which results in a reduction in expenditures, while revenues from the sale may be used directly to finance the public deficit (Cuadrado-Ballesteros & Peña-Miguel, 2019).

Nevertheless, this view does not consider the consequences of a cut in spending in the policy outcomes. The financial situation could be improved with privatisation reforms through spending cuts, but it is essential that the effectiveness of government policy implementation is not reduced. Indeed, some scholars do not totally support the superiority of private ownership over nationalisation in terms of performance and efficiency (Cavaliere & Scabrosetti, 2006; Parker, 1992; Parker & Saal, 2003; Saal & Parker, 2001).

This study proposes the following hypothesis, with the aim of contributing to the debate of how privatisation affects government spending efficiency, which refers to the ability of the government to maximize the policy

outcomes given a level of spending, or the ability to minimize its spending given a level of economic activity (Chan & Karim, 2012).

H0. There is a positive link between the privatisation of SOEs and government efficiency.

3 | METHODOLOGY

3.1 | Sample and model of analysis

To test the link between privatisation reforms and government efficiency, we selected a sample of 22 European countries: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. The period of analysis is 1995–2013.

The European context is highly appropriate due to the importance of privatisation reforms. Most of the countries in the Organisation for Economic Co-operation and Development (OECD) privatisation top 10 are European: France, Italy, Germany, the Netherlands, the United Kingdom, Finland, and Sweden are among the top ten if privatisation is measured by the number of transactions, whereas Slovakia, the Czech Republic, Finland, Hungary, Greece, Portugal, France, and Poland are among the leading nations when privatisation is measured relative to the Gross Domestic Product (GDP) (OECD, 2009).

Over this sample, we estimate the following models, considering the possible simultaneous two-causal relationship between privatisation and efficiency: expecting a positive effect of privatisation reforms on spending efficiency, governments with efficiency problems may decide on privatizing in an attempt to improve efficiency levels; that is, government spending efficiency may be simultaneously a *cause* and a *consequence* of privatisation reforms.

$$P_{it} = \alpha + \beta E_{it} + \gamma C_{it} + \eta_i + \varepsilon_{it} \quad (1)$$

$$E_{it} = \alpha + \beta P_{it} + \gamma C_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

In both models, i and t refer to each country and year, respectively; α, β, and γ are the parameters to be estimated; η_i refers to unobservable heterogeneity (i.e., the characteristics of each country, which are different from others, but are invariant over time), and ε_{it} is the classical disturbance term. E is the vector that includes the variables that represent government efficiency; P vector includes the variables that represent privatisations; and C is the vector of the control variables, which are different in each model, depending on the dependent variable. All variables are described in the following section.

3.1.1 | Efficiency variables

Government spending efficiency (E) refers to the maximum potential output obtained from the given input, or the minimum potential input required to produce the given output (Lovell, 1993). Thus, a set of inputs and outputs should be first selected. Concretely, this study follows the methodology of Adam et al. (2011), Chan and Karim (2012), Chan et al. (2017), and Montes et al. (2019). They group inputs and outputs into two categories, called opportunity and Musgravian indicators (Afonso et al., 2005, 2010):

(i) Opportunity indicators reflect the interaction between fiscal policies and the market process and the influence on individual opportunities this has. A well-functioning public administration and a healthy and well-educated

population, who enjoy high-quality public infrastructure, could be considered essential for well-functioning markets and secure property rights, with plenty opportunities to all (Afonso et al., 2005). Then, four dimensions should be represented by different inputs and outputs:

- *Administrative dimension*: the government expenditure on public services (% of GDP) is the selected input; while outputs are corruption perception index, as well as the government effectiveness and regulatory quality indexes.
- *Education dimension*: the government expenditure on education (% of GDP) is the input in this case, while outputs are the secondary school enrolment gross rate.
- *Health dimension*: input is the government expenditure on health (% of GDP); outputs are the life expectancy, infant mortality rate, and immunization measles.
- *Infrastructure dimension*: input is the government expenditure on economic affairs (% of GDP), and outputs are the electricity power and the internet and telephone users.

(ii) Musgravian indicators represent the outcomes of the interaction with and reactions to the market process by government. They refer to:

- *Income distribution*: input is the government expenditure on social security and welfare (% of GDP); outputs are the GINI index and the income share by the highest 20%.
- *Economic stability*: is represented by the total government expenditure per capita, as input variable, while the inflation rate is the main output.
- *Allocative efficiency*: the total government expenditure per capita is also considered the input variable in this category; outputs are unemployment rate, the GDP growth rate, and the GDP per capita.

Despite the selection of inputs and outputs is to some extent arbitrary, the indicators tend to be highly correlated, and they yield very similar results (Afonso et al., 2005, 2010; Hauner & Kyobe, 2010). Tables A1 and A2 in Appendix A describe in more detail input and output variables of this study, along with some descriptive statistics.

Once input and output variables are selected, efficiency representation requires the use of frontier functions that refer to the best possible combination of input–output. The previous literature reveals a wide range of statistical techniques, and the *non-parametric approaches* are the most used. They determine the best frontier as a linear envelopment of the data, which is created with the most efficient decision-making units; for that, it is necessary to find the maximum ratio of the linear combination of outputs to the linear combination of inputs, also selecting the optimal weights of inputs and outputs.

On the other hand, the *parametric approach* determines the best frontier by using a specific functional form for the technology that is estimated with econometric techniques—the deviation from such estimated best frontier is interpreted as inefficiency (deterministic approach), and additionally stochastic influences may be considered, such as socioeconomic and institutional conditions, or even measurement errors (stochastic approach). The main advantage of non-parametric analysis is that it does not require a specific functional form, as do the *parametric techniques*, although non-parametric analyses also have some limitations that will be indicated in the conclusion section.

This study deals with three efficiency indicators, which are estimated by taking a non-parametric approach (see Appendix B for a more detailed formalization of the methodological process): (i) *DEA* refers to efficiency obtained by data envelopment analysis (Charnes et al., 1978); (ii) *DEAb* has been obtained by using bootstrap methods based on subsampling (Simar & Wilson, 1998) to correct DEA bias generated by its drawbacks (no noise is allowed, difficulty to make statistical inference, and influence of outliers); and (iii) *Orderm* refers to the partial frontier proposed by Cazals et al. (2002) to avoid outlier bias and the curse of dimensionality.

3.1.2 | Privatisation variables

Privatisation reforms (*P*) are represented by two variables: *Deals* refers to the number of privatisation transactions (both partial and total) conducted in a country by year; and *Proceeds* represents the total revenue (in current US$) from privatisation deals as a proportion of GDP (in current US$) (Bortolotti et al., 2001, 2003; Zohlnhöfer et al., 2008). The first variable (*Deals*) represents privatisation policy progress, whereas the second one (*Proceeds*) measures the economic impact of such reforms (Bortolotti et al., 2003). It is important to include the two indicators because, on the one hand, considering just the number of transactions underestimates the economic effect of privatisation, but on the other hand, considering only the revenue overestimates the impact of privatisation when only a few large SOEs are involved (Bortolotti et al., 2001).

Data on privatisation proceeds were obtained from the Privatisation Barometer, a project launched by *Fondazione Eni Enrico Mattei* (FEEM), a non-profit and non-partisan institution for the study of governance. This is the official provider of privatisation data to the OECD and the World Bank.

3.1.3 | Control variables

As privatisation is affected by the operational context, i.e., socioeconomic, financial, institutional, and political characteristics of each country, the two models include some control variables. In the first model, in which the dependent variable represents privatisations, the results are controlled by some political factors. First, the literature on the political economy of privatisation has noted that right-wing governments tend to have a greater predisposition towards privatisation than leftist ones (e.g., Bortolotti et al., 2003; Bortolotti & Pinotti, 2008; Bortolotti & Siniscalco, 2004; Obinger et al., 2014; Schmitt, 2013; Schneider & Häge, 2008); so, model (1) includes the variable *Right*, that is a dummy variable that takes the value 1 for conservative and right-wing governments, and 0 otherwise. Besides, Peña-Miguel and Cuadrado-Ballesteros (2020) noted that privatisation reforms tend to be used less by politicians who have been in power for a long period of time, and by fragmentised governments. Accordingly, model (1) includes the variables *Herfindahl* and *Years office*; the former is the sum of the squared seat shares of all parties in the government, ranging from 0 to 1, from the minimum to the maximum political concentration; and the second variable indicates the number of years that the chief executive has been in office.

Furthermore, the European integration has been one of the main drivers of privatisation in the EU (Clifton et al., 2003, 2006). The foundation of the EU or the adoption of a common coin (euro) could be a determinant of free market, liberalization, and privatisation policies. Accordingly, it is relevant to control the results by the variable called *Euro*, which is a dummy variable that takes the value 1 in the year when a specific country adopted the euro and 0 otherwise.

In addition, privatisation reforms may depend on entry regulations and the market structure (Belloc et al., 2014). Accordingly, variables *Public ownership* and *Entry barriers* are used to control the results in the model (1). The former refers to the share of economic sectors where the state controls at least one firm; the latter refers to the share of sectors in which there are explicit legal limitations on the number of competitors. Both are obtained from the OECD Indicators of Product Market Regulation (Koske et al., 2015).

Finally, model (1) also includes *Balance*, *Growth*, and *FDI*. The former is the total central government revenue minus total central government expenditure because governments with large deficits may decide on privatizing expecting a positive effect of privatisation reforms on fiscal balance (Cuadrado-Ballesteros & Peña-Miguel, 2019). *Growth* is the economic growth rate, in order to represent the business cycle, as high growth rates are typically associated with a booming economy and high fiscal revenue, having fewer incentives to privatize (Bortolotti et al., 2003). And *FDI* refers to the foreign direct investment, calculated as the net inflows in the reporting economy from foreign investors divided by GDP; it is a proxy of the globalization of the economy, which may favour

the investment of foreign investors and facilitate the sale of SOEs (Belloc et al., 2014; Cuadrado-Ballesteros & Peña-Miguel, 2019; Debab, 2011).

The second model, in which the dependent variable is the government efficiency, includes several socio-economic and political factors, whose effect on government spending efficiency has been previously evidenced in the literature. First, it is important to control the percentage of dependent population (*Dependency*), that is, the sum of the share of the population over 65 and lower 15 years old. It could be expected that the younger population increases the spending in education, and the older population could affect the spending in the health sector (Adam et al., 2011; Hauner & Kyobe, 2010; Ubago Martínez et al., 2018). Furthermore, population density (*Density*) may affect government spending efficiency (Adam et al., 2011, 2014; Hauner & Kyobe, 2010; Ubago Martínez et al., 2018), since it could be expected to reduce the cost of service provision through economies of scale.

Second, some political factors have been evidenced as determinant factors of government spending efficiency, such as the political ideology and the support in polls (Adam et al., 2011). Political ideology is represented by a dummy variable (*Right*) that takes the value 1 for conservative and right-wing governments, and 0 otherwise; and electoral support is represented by the total vote share of all government parties (*Turnout*).

Following Hauner and Kyobe (2010) and Montes et al. (2019), model (2) also includes the level of trade openness of the economy (*Openness*), represented by the sum of it could be expected that economic openness increases the competitive pressure on the domestic economy and making available new skills and technologies that may positively affect efficiency. Besides, Montes et al. (2019) found that inflation is harmful to the process of resource allocation and makes governments less efficient. These scholars also noted that countries with higher public debt tend to have less efficiency in government spending, so model (2) also includes the variable *Debt* that is the government consolidated gross debt (% of GDP). Finally, the economic level is represented by the GDP per capita at constant 2011 international $ (*GDPpc*), which is essential to compare countries with different levels of development and correct any potential bias due to omitted variables (Ubago Martínez et al., 2018).

Data on elections and political ideology were obtained from the Database of Political Institutions 2015 (Cruz et al., 2016). The rest of the control variables were obtained from the Eurostat and World Bank databases.

3.2 | Technique of analysis

Here, endogeneity is obviously a relevant problem because models (1) and (2) represent a simultaneous relationship between government efficiency and privatisation reforms, resulting in causality problems. In addition, they include proxy variables to represent unobservable or difficult to quantify concepts, such as efficiency, which leads to measurement error. Endogeneity may also appear because some relevant determinants of efficiency and privatisations (e.g., unemployment, corruption, political stability, accountability indicators, legal origin, electoral systems, and transparency) have been omitted due to multicollinearity[1] problems with other variables in the models.

Accordingly, parameters in models (1) and (2) have been estimated by using the generalized method of moments (GMM), concretely, the two-step *system* estimator of Arellano and Bover (1995). This estimator allows correcting endogeneity problems, along with other statistical issues, like heteroscedasticity and serial correlation (Arellano & Bond, 1991). Despite there are other estimators that may correct the last two issues, the GMM estimator overcomes endogeneity by using lagged values of the right-hand-side variables included in the model as instruments. These instruments are uncorrelated with the errors, as Arellano and Bond (1991)

[1]Bivariate correlations are shown in Appendix C (Tables C1 and C2), suggesting there are no multicollinearity problems; just relevant correlations appear between the two DEA indicators, but they are considered individually in both models.

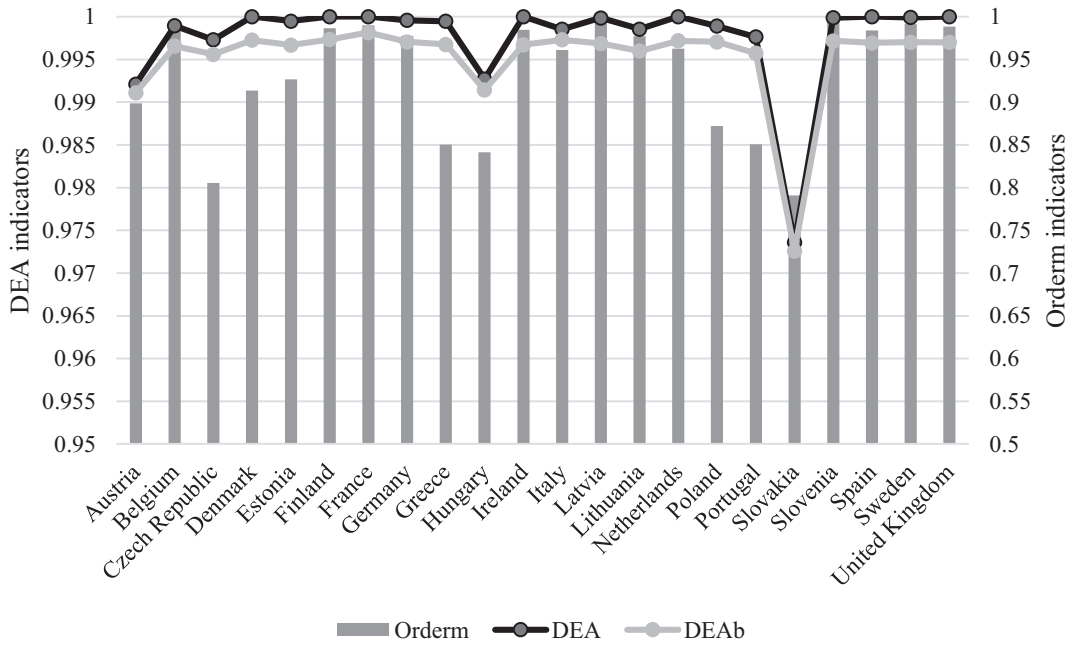

FIGURE 1 Efficiency by country.

demonstrated, and they contain information about the current value of the variable, since there is frequently a delay between deciding and acting on it (Pindado & Requejo, 2015). In contrast, it is difficult to prove that external instruments that are traditionally selected for, as conventional instrumental variables estimators, are uncorrelated with the error term yet also contain enough information about the variables they represent (Pindado & Requejo, 2015). Instrument validity is checked by two tests: (i) the Arellano-Bond test for AR(2) in first differences is the test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as $N(0, 1)$ under the null hypothesis of no serial correlation between the error terms and (ii) the Hansen test of over-identification restrictions is the test for the validity of the over-identifying restrictions for the GMM estimator, asymptotically distributed as χ^2, under the null hypothesis that the over-identifying restrictions are valid.

4 | RESULTS

4.1 | Descriptive analysis

Table 1 shows the descriptive statistics of all variables that have been previously described. The level of efficiency is quite large, especially *DEA* and *DEAb* indicators. In Figure 1, we can see that the least efficient countries, on average, are the Czech Republic, Hungary, and Slovakia.

The mean value of *Deals* suggests that there were around four or five privatisation transactions in the sample countries during the period of analysis, on average. The mean value of *Proceeds* indicates that the value of transactions is 0.45% of GDP, on average. Nevertheless, there are large differences among the sample countries: the maximum value of *Deals* is 55, obtained by Poland in 2010, while the maximum value of *Proceeds* is 5.16%, obtained by Portugal in 1997, when the government sold, among others, 30% of *EDP Electricidade de Portugal* for

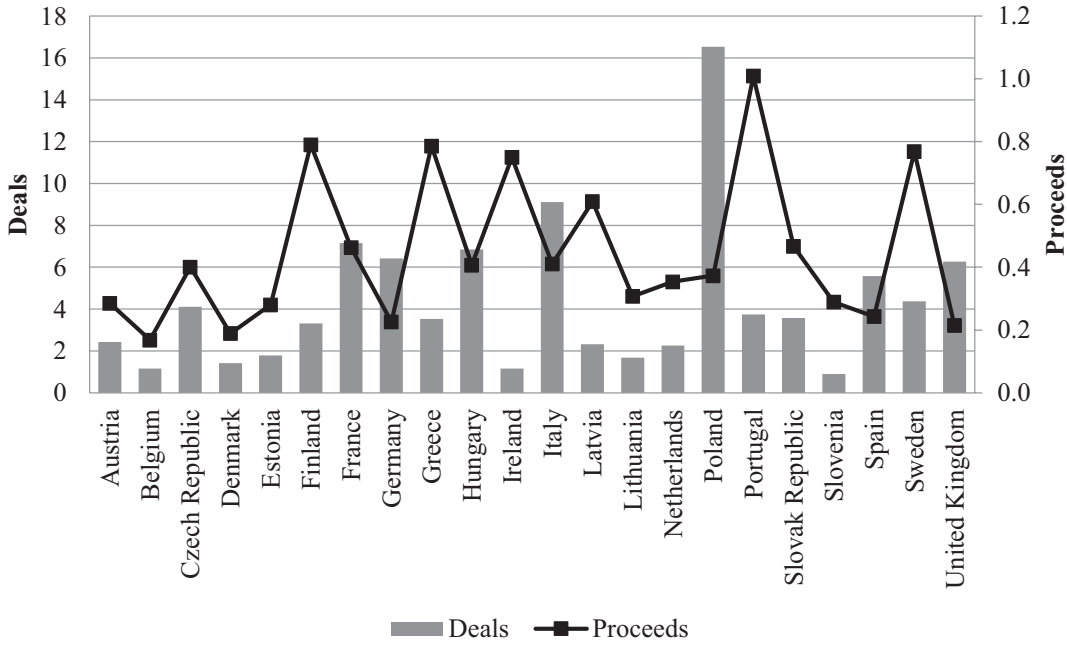

FIGURE 2 Privatizations by country.

US$2033.4 million. Thus, although Poland is the country with the largest number of privatisation transactions, Portugal excels with revenues obtained from privatisation reforms.

These differences are shown in Figure 2, in which the mean value of *Deals* and *Proceeds* is represented by country.

Table 1 also shows the descriptive statistics of control variables of models (1) and (2), which represent the operational environment, corresponding to each country's characteristics. The most relevant results could be summarized as follows: the mean value of *Right* suggests that 36.12% of observations have a right-wing government, and the Herfindahl index is 0.63, indicating quite fragmented governments, on average.

The government consolidated gross debt is 55.92% of GDP, and the mean value of *Balance* suggests a deficit situation in most of the countries. These values are extremely dangerous in Ireland in 2010, where the deficit is about 29% of GDP (minimum value in the sample) and Greece in 2013, where the debt is 177.4% of GDP (maximum value in the sample). The net inflows are 5.41% of GDP, reaching 87.44% in the Netherlands; and the sum of exports and imports is about 93.8% of GDP, on average, reaching 191.4% in Ireland. There are also large differences in terms of economic development: on average, the growth rate of GDP is 4.9%, although Latvia got 65.62% in 2013; the GDP per capita is around 25.176,53 (international $), reaching 64,182 in Denmark in 2008 and falling to 2168 in Lithuania in 1995.

4.2 | Empirical analysis

Table 2 shows the empirical results of the model (1) by using the *system* estimator. Concretely, panel A shows the effect of efficiency indicators (*DEA* in Equation 1, *DEAb* in Equation 2, and *Orderm* in Equation 3

$$P_{it} = \alpha + \beta E_{it} + \gamma C_{it} + \eta_i + \varepsilon_{it} \,(1)$$
$$E_{it} = \alpha + \beta P_{it} + \gamma C_{it} + \eta_i + \varepsilon_{it} \,(2) \qquad (3)$$

on *Deals*, and panel B represents the effect of efficiency indicators on *Proceeds*. None of the efficiency indicators are statistically relevant in explaining privatisation variables, neither *Deals* nor *Proceeds*. This suggests that privatisation

TABLE 1 Descriptive statistics.

Variable	Mean	SD	Min	Max
DEA	0.9976	0.0070	0.9526	1
DEAb	0.9952	0.0066	0.9517	0.9992
Orderm	0.9334	0.0840	0.6272	1
Deals	4.3469	5.4131	0	55
Proceeds	0.0045	0.0073	0	0.0516
Right	0.3612	0.4809	0	1
Herfindahl	0.6298	0.2623	0.1788	1
Years office	3.6759	2.6296	1	16
Euro	0.4258	0.4951	0	1
Public ownership	2.9120	0.7978	1.12	4.98
Entry barriers	1.1328	0.6253	0.2	3.52
Balance	−0.1934	3.6934	−29.1939	9.5699
Growth	0.0490	0.1428	−0.9854	0.6562
FDI	5.4182	8.3754	−15.99	87.44
Density	131.1428	107.2623	16.77	499.09
Dependency	32.7001	1.7263	27.84	36.33
Turnout	46.4769	13.0493	0	69.4
Openness	93.79689	37.45927	37.1	191.4
Debt	55.9196	31.3665	3.7	177.4
GDPpc	25,176.53	15,315.28	2168.80	64,182.00
Inflation	3.6578	4.4813	−4.4799	39.6568

reforms in Europe have not been carried out specifically by the governments that showed lower levels of spending efficiency.

Furthermore, model (2) checks the effect of privatisation reforms on government spending efficiency. The empirical results are shown in Table 3. Panels A and B show the effects of *Deals* and *Proceeds* variables, respectively, on the three efficiency indicators (*DEA* in Equation 1, *DEAb* in Equation 2, and *Orderm* in Equation 3). Coefficients of the variable *Deals* are positive on the three equations, although it is statistically relevant only in the first equation; further, *Proceeds* is not statistically significant in any equation. These findings do not support the hypothesis of this study, which suggested that privatisation reforms positively affect government spending efficiency.

Returning to Table 2 and focusing on control variables (i.e., contextual factors that explain privatisation reforms), we can see that the variable *Right* has positive coefficients that are statistically relevant in all equations, suggesting that privatisations tend to be more adopted by right-wing governments (Belke et al., 2007; Belloc et al., 2014; Bortolotti et al., 2001, 2003; Bortolotti & Pinotti, 2003; Obinger et al., 2014, 2016; Schmitt, 2013). Coefficients of *Herfindahl* are negative and significant in Panel A, indicating that privatisation reforms could be impeded by fragmentised governments. In addition, *Years office* has negative and relevant coefficients in some equations, indicating that privatisations tend to be used less by politicians who have been in power for a long period of time (Peña-Miguel & Cuadrado-Ballesteros, 2020).

We also found that the financial situation may explain the most relevant privatisation reforms in monetary terms, since *Balance* impacts negatively on *Proceeds*, i.e., privatisations are used by governments to reduce deficits (Bortolotti et al., 2001). *Growth* exerts a negative impact, being statistically relevant in explaining *Proceeds*; this suggests that governments with lower levels of economic growth tend to privatise more SOEs, maybe as a way to improve economic development (Peña-Miguel & Cuadrado-Ballesteros, 2020).

TABLE 2 Empirical results of model (1).

	Equation 1		Equation 2		Equation 3	
	Dep. Var. = *Deals*		Dep. Var. = *Deals*		Dep. Var. = *Deals*	
	Coef.	SE	Coef.	SE	Coef.	SE
Panel A. Effects of efficiency indicators on *Deals*						
L1.Deals	0.3431	0.2177	−0.1190	0.2746	0.1931	0.2069
DEA	1.7782	2.0482				
DEAb			1.1248†	0.5574		
Orderm					2.5882	8.8101
Right	0.0646*	0.0296	0.0973*	0.0412	0.0447†	0.0229
Herfindahl	−33.4147*	14.1872	2.8424	7.7595	−30.4301†	14.7013
Years office	−0.7583*	0.3066	0.2355	0.2010	−0.8367†	0.4481
Euro	−11.3207†	6.3806	−0.1639	4.7765	−5.7565	7.5485
Public ownership	1.6935	4.7836	9.2417	6.4134	5.4904	3.2702
Entry barriers	−8.8814*	4.1861	−8.3690*	3.7775	−4.0067	3.1939
Balance	−0.1486	0.1432	−0.0237	0.1701	0.2086	0.3050
Growth	−1.1185	2.7160	−1.3852	2.8355	0.4330	4.5537
FDI	−0.1150	0.1738	−0.1664	0.1597	0.0873	0.1124
_cons	−1.4913	2.0276	−1.1392†	0.5727	7.4638	14.9326
Arellano-Bond test for AR(2)	$Pr>z=0.269$		$Pr>z=0.310$		$Pr>z=0.647$	
Hansen test	$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$	
	Equation 1		Equation 2		Equation 3	
	Dep. Var. = *Proceeds*		Dep. Var. = *Proceeds*		Dep. Var. = *Proceeds*	
	Coef.	SE	Coef.	SE	Coef.	SE
Panel B. Effects of efficiency indicators on *Proceeds*						
L1.Proceeds	−0.4105	0.2803	−0.3189	0.3276	−0.2966	0.2655
DEA	−5.4139	4.2570				
DEAb			−4.1280	3.5825		
Orderm					0.7309	1.1117
Right	0.0154*	0.0067	0.0149*	0.0069	0.0164*	0.0066
Herfindahl	−1.0471	1.9458	−0.9503	2.4837	−3.0476	2.7753
Years office	−0.2292†	0.1244	−0.2337	0.1582	−0.1587	0.1483
Euro	1.9102*	0.8978	1.9398†	1.1008	1.5477	0.9762
Public ownership	0.7258†	0.4014	0.7886	0.8691	0.8767†	0.4585
Entry barriers	−0.9905†	0.5180	−1.0179†	0.5859	0.7493	0.5223
Balance	−0.0960	0.0584	−0.1198*	0.0460	−0.1436**	0.0453
Growth	−1.9985**	0.6928	−1.8538*	0.7474	−1.4631*	0.5551
FDI	0.0546†	0.0298	0.0605†	0.0315	0.0332	0.0347
_cons	5.2248	4.2380	3.8976	3.7708	−1.6521	1.3141

(Continues)

TABLE 2 (Continued)

	Equation 1		Equation 2		Equation 3	
	Dep. Var. = *Proceeds*		Dep. Var. = *Proceeds*		Dep. Var. = *Proceeds*	
	Coef.	SE	Coef.	SE	Coef.	SE
Arellano-Bond test for AR(2)	$Pr>z=0.371$		$Pr>z=0.654$		$Pr>z=0.806$	
Hansen test	$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$	

Note: L1. Refers to the first order lag; all regressions include year fixed effects; †, *, **, *** significant at 10%, 5%, 1%, and 0.1% level, respectively.

Returning to Table 3 and focusing on control variables (i.e., the operational context in each country that explain the level of efficiency), we can see that the variable *Dependency* affects government spending negatively. This variable represents the segment of the population connected with the provision of education, health, and welfare services, so, pressure on government spending is increased as the share of the dependent population is larger, resulting in a reduction of efficiency (Adam et al., 2014; Ubago Martínez et al., 2018). Population density impacts positively on government spending efficiency, suggesting the use of economies of scale that allows governments to provide services more efficiently (Adam et al., 2014). The rest of the control variables are not statistically relevant in most equations.

4.3 | Robustness checking

Previous results have been obtained by using the two-step *system* estimator of Arellano and Bover (1995), with the aim of solving heteroscedasticity, serial correlation, and endogeneity problems. However, the dependent variable in model (2) is the government efficiency, which is represented by indicators that are limited between two values (0–1). In such a situation, Simar and Wilson (2007) suggested using the truncated estimator, which provides better and more consistent statistical inference than other estimators.[2] Accordingly, we have estimated model (2) again by using the truncated estimator, such as Adam et al. (2014) did in their study on government spending efficiency.

The results of all equations are shown in Table 4; they are like those obtained previously by using the system GMM estimator, indicating that privatisation reforms do not ensure spending efficiency gains. Regarding control variables, the results are also similar for *Dependency* and *Density*, but other variables become significant here: *Debt* impacts negatively on efficiency indicators, such as Montes et al. (2019) noted; the variable *Turnout* shows positive coefficients, suggesting the positive effect of democratic participation on public sector efficiency (Adam et al., 2014); and *Openness* is relevant in some equation, showing positive coefficients, which means that more open economies achieve higher government efficiency (Ubago Martínez et al., 2018).

4.4 | Discussion of results

On the basis of NPM theory, privatisation of SOEs has been traditionally supported by throwing an SOE into market competition. Megginson et al. (1994), Shleifer (1998), and D'Souza and Megginson (1999) noted that privatisation positively impacted the financial and operating performance. However, our empirical results do

[2]Some scholars (Adam et al., 2011, 2014; Afonso et al., 2010; Ubago Martínez et al., 2018) have also used the Tobit estimator, but it has been criticized by Simar and Wilson (2007), who point out correlation problems between contextual variables (control variables) and the inputs and outputs used to obtain the efficiency indicators.

TABLE 3 Empirical results of model (2).

	Equation 1		Equation 2		Equation 3	
	Dep. Var. = *DEA*		Dep. Var. = *DEAb*		Dep. Var. = *Orderm*	
	Coef.	SE	Coef.	SE	Coef.	SE
Panel A. Effects of *Deals* on efficiency indicators						
L1.DEA	0.4866**	0.1397				
L1.DEAb			0.1451	0.2643		
L1.Orderm					0.2629	0.2066
Deals	0.1335**	0.0396	0.1516	0.0879	0.9824	0.9137
Dependency	−0.2572	0.2555	−1.3902†	0.7006	−0.0193*	0.0084
Density	−0.2201	0.5719	7.9656†	4.0225	0.1010†	0.0518
GDPpc	0.0427*	0.0188	0.0186	0.0237	0.15	0.309
Debt	0.0327	0.0367	0.0487	0.0408	−0.9185	0.6745
Right	2.0637*	0.9663	0.7107	0.8961	2.7335	14.14
Turnout	−0.0601	0.0409	0.028	0.0497	1.8856	1.7789
Inflation	−0.0347	0.0682	−0.3476*	0.13	−4.6246†	2.6142
Openness	0.0555*	0.0227	0.1252	0.0545	0.0591	0.0698
_cons	0.5174	0.1423	0.8467	0.2615	0.7545*	0.2919
Arellano-Bond test for AR(2)	$Pr>z=0.833$		$Pr>z=0.479$		$Pr>z=0.665$	
Hansen test	$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$	
Panel B. Effects of *Proceeds* on efficiency indicators						
L1.DEA	0.6296***	0.0959				
L1.DEAb			0.6872***	0.1069		
L1.Orderm					0.1305	0.2270
Proceeds	−0.2874	0.279	0.1944	0.2687	−0.8616	7.7147
Dependency	−1.0725†	0.6178	0.2289	0.2518	−0.0351*	0.0151
Density	0.2173	0.2055	0.9221*	0.4421	−0.0723	0.0427
GDPpc	−0.203	0.127	0.0451*	0.0179	0.299	0.328
Debt	0.1363	0.0832	0.0583	0.0578	−2.1735†	1.171
Right	−0.1158	0.4487	1.0786	0.7645	7.8565	15.89
Turnout	0.0241	0.0492	−0.046	0.041	1.9742	1.9612
Inflation	−0.1529†	0.086	−0.0593	0.1244	−4.4187	4.7226
Openness	0.0389†	0.0219	0.0146	0.0199	0.4638	0.481
_cons	0.3811	0.0969	0.3099	0.1090	2.1609**	0.7182
Arellano-Bond test for AR(2)	$Pr>z=0.893$		$Pr>z=0.850$		$Pr>z=0.276$	
Hansen test	$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$		$Pr>\chi^2=0.999$	

Note: L1. Refers to the first order lag; all regressions include year fixed effects; †, *, **, *** significant at 10%, 5%, 1%, and 0.1% level, respectively.

not allow supporting the proposed hypothesis, which suggests that privatisation of SOEs positively affects government efficiency. Previously, other scholars have not totally supported the superiority of private ownership over nationalisation in terms of performance (Cavaliere & Scabrosetti, 2006; Parker, 1992; Parker & Saal, 2003; Saal & Parker, 2001). Now, our study shows that privatization does not guarantee improvements in

TABLE 4 Robustness checking for model (2) by using truncated estimator.

	Equation 1		Equation 2		Equation 3	
	Dep. Var. = *DEA*		Dep. Var. = *DEAb*		Dep. Var. = *Orderm*	
	Coef.	SE	Coef.	SE	Coef.	SE
Panel A. Effects of *Deals* on efficiency indicators						
L1.DEA	0.5549***	0.1382				
L1.DEAb			1.1582***	0.1279		
L1.Orderm					0.8084***	0.0805
Deals	0.1223*	0.0534	0.0339	0.0252	0.2273	0.1531
Dependency	−0.0868	0.1590	0.0057	0.0693	−1.3346***	0.4190
Density	0.3844	0.6144	−0.0532	0.1312	1.0041	0.6596
GDPpc	0.0001†	0.0000	0.0000	0.0000	0.0000	0.0001
Debt	−0.1608	0.0774	0.0345	0.0275	−0.4401*	0.1950
Right	−0.0966	0.3454	−0.0730	0.1938	−0.7151	1.2376
Turnout	0.0663**	0.0249	0.0249*	0.0110	−0.0909	0.0596
Inflation	−0.0663	0.0733	0.0264	0.0363	−0.1660	0.1994
Openness	0.0057	0.0100	0.0040	0.0034	0.0339†	0.0190
_cons	0.4695**	0.1514	−0.1414	0.1214	0.6676***	0.1715
/sigma	0.8587***	0.1182	0.7429***	0.0838	6.3382***	0.4325
Panel B. Effects of *Proceeds* on efficiency indicators						
L1.DEA	0.6865***	0.1552				
L1.DEAb			1.2111***	0.1351		
L1.Orderm					0.8159***	0.0803
Proceeds	0.1891	0.1700	−0.0230	0.0786	0.5075	0.5468
Dependency	−0.2042	0.1817	0.0015	0.0707	−1.2816**	0.4119
Density	0.5614	0.6730	−0.0242	0.1332	1.1705†	0.6680
GDPpc	0.0001	0.0000	0.0000	0.0000	−0.0001	0.0001
Debt	−0.1696†	0.0874	0.0361	0.0280	−0.4384*	0.1945
Right	−0.3631	0.3700	−0.1371	0.1950	−1.0533	1.2114
Turnout	0.0747*	0.0289	0.0238*	0.0112	0.0862	0.0595
Inflation	−0.0290	0.0784	0.0354	0.0373	−0.1166	0.1949
Openness	−0.0089	0.0102	0.0020	0.0032	0.0446*	0.0177
_cons	0.3887*	0.1686	−0.1899	0.1283	0.6527***	0.1709
/sigma	0.9287***	0.1341	0.7539***	0.0863	6.3242***	0.4307

Note: L1. Refers to the first order lag; all regressions include year fixed effects; †, *, **, *** significant at 10%, 5%, 1%, and 0.1% level, respectively.

the efficiency of public spending either. In addition, some scholars noted that privatisation is more probable in governments with fiscal problems (Belke et al., 2007; Bortolotti et al., 2001; Schmitt, 2013, 2014; Zohlnhöfer et al., 2008). However, our results do not suggest that privatisation is more probable in governments with poor public spending efficiency.

Our empirical findings do not support the superiority of private over public ownership that NPM theory advocates, at least in terms of government spending efficiency. Probable, the simple conversion of the public into

private enterprises is not enough to increase the level of spending efficiency. First, market mechanisms, like competition, are also necessary (Vickers & Yarrow, 1991); but, competition generates additional costs, as transaction cost theory proposes. Thus, the level of efficiency will increase only if such transactional costs are lower than production under public administration. Second, the transformation of public entities in private enterprises requires changes in their purpose, incentives, responsibility, structure, and organisational culture (Osborne & Plastric, 1998). Following the neo-Taylorism theory, the professionalisation of managers, along with control mechanisms (Osborne & Gaebler, 1992), are essential in pursuing efficiency gains.

5 | CONCLUSIONS

Traditionally, proponents of privatisation have advocated efficiency gains (Megginson & Netter, 2001) based on the NPM theory. Indeed, privatisation was one of the first NPM reforms initiated by the United Kingdom in the 1980s, looking for greater efficiency of the private sector (Parker & Saal, 2003). A vast part of the literature has shown that privatisation programmes may be useful for reducing deficits and balancing public finances (Bortolotti et al., 2001, 2003; Cuadrado-Ballesteros & Peña-Miguel, 2019; Schmitt, 2013, 2014; Sheshinski & López-Calva, 2003). This paper contributes to that debate by checking the relationship of privatisation reforms in Europe and the government spending efficiency. Our empirical results do not support the hypothesis that privatisation of SOEs improves the government spending efficiency.

Furthermore, this study also contributes to the literature on the efficiency of public administrations, which has been mainly focused on local governments until now (Narbón-Perpiñá & De Witte, 2018a, 2018b). The analysis of efficiency at the central government level is scarcer; most of the previous studies are focused on developing consistent and reliable indicators (e.g., Adam et al., 2011; Afonso et al., 2005, 2010) and analyse the determinants of government spending efficiency (Adam et al., 2014; Chan & Karim, 2012; Hauner & Kyobe, 2010; Montes et al., 2019; Rayp & Van De Sijpe, 2007; Ubago Martínez et al., 2018; among others). This study adds evidence by considering the role of privatisation reforms in government spending efficiency.

Our findings are relevant for practitioners and public decision-makers. Since the early 2000s, privatisations have fallen sharply (Bortolotti & Siniscalco, 2004), but governments have resorted to these reforms in recent years, especially after the 2008 financial crisis, hoping they contribute to balancing public finances and reducing public indebtedness. Accordingly, privatisation reforms have returned to being a subject of debate again in the last decade. This study adds evidence to that debate, by showing that privatisation of SOEs (ceteris paribus) do not ensure spending efficiency gains in European governments. Based on these findings, we would suggest alternatives to privatisation, including reforms in public management and coordination methods (Talbot & Johnson, 2007).

Despite these contributions, this study is not free of limitations: first, the three efficiency indicators are obtained by non-parametric techniques, which also have some limitations; for instance, it is not possible to estimate parameters for the models, due to their deterministic nature, while parametric techniques allow such estimation (but that may cause both specification and estimation problems in the definition of a specific functional form).

Second, it could be interesting to check the robustness of empirical findings for different legal contexts (common vs. civil law countries); here it is not possible, because this study is focused on the European context, where the civil law origin is predominant. For future studies, therefore, it could be interesting to consider some contextual conditions, such as Brexit in Europe, and the multi-collateral effects of migration policy, which may externally affect the government efficiency. Further, through comparative studies, it would be useful to know the structures of different public administrations, and thus to learn the strengths and weaknesses of each one, with the aim of improving government performance.

Third, the analysis which has been undertaken relates solely to the changing level of efficiency in government spending over time, essentially comparing these changing efficiency levels before and after privatisations. This then provides the scope and extent to which inferences and conclusions can be drawn, that is, the success or otherwise of privatisation policies can only be assessed in terms of an explicit policy objective of improving the efficiency of government spending and, therefore, nothing can be said about the success or otherwise of privatisation given different objectives. To assess the (wider) "success" of privatisation policies in Europe, there needs to be a sector-based study focussing on pre- and post-privatisation performance of each sector and this is way beyond the scope of this study.

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How to cite this article: Cuadrado-Ballesteros, B. & Peña-Miguel, N. (2024) Privatisation and government spending efficiency: An empirical analysis in Europe. *Scottish Journal of Political Economy*, 00, 1–24. Available from: https://doi.org/10.1111/sjpe.12386

APPENDIX A

INPUT AND OUTPUT VARIABLES

TABLE A1 Inputs description.

			Mean	SD	Min.	Max.
Opportunity indicators						
Administrative dimension	Public services spending	Government expenditure on public services (% of GDP) (*Source*: Eurostat)	7.09	2.58	3	17.6
Education dimension	Education spending	Government expenditure on education (% of GDP) (*Source*: Eurostat)	5.35	0.94	3.2	7.3
Health dimension	Health spending	Government expenditure on health (% of GDP) (*Source*: Eurostat)	6.12	1.19	2	8.9
Infrastructure dimension	Infrastructure spending	Government expenditure on economic affairs (% of GDP) (*Source*: Eurostat)	5.11	1.99	1.3	25
Musgravian indicators						
Distribution	Welfare spending	Government expenditure on social security and welfare (% of GDP) (*Source*: Eurostat)	16.64	3.96	7.9	25.3
Stability General economic performance	Total spending	Total general government expenditure (% of GDP) (*Source*: Eurostat)	46.21	6.56	30.9	65.1

TABLE A2 Outputs description.

			Mean	SD	Min.	Max.
Opportunity indicators						
Administrative dimension	Corruption	Corruption Perception index assesses how corrupt a country's public sector is perceived to be by experts and business executives (*Source*: Transparency International)	6.50	1.88	2.7	10
	Regulatory quality	Regulatory quality index captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development (*Source*: Worldwide Governance Indicators)	1.25	0.38	0.44	2.08
	Government effectiveness	Government effectiveness index captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (*Source*: Worldwide Governance Indicators)	1.26	0.58	0.06	2.36
Education dimension	Secondary school enrolment (% gross)	Total enrollment in secondary education, regardless of age, expressed as a percentage of the population of official secondary education age (*Source*: World Bank)	106.96	15.74	82.16	161.02
Health dimension	Life expectancy	Life expectancy at birth (years) (*Source*: World Bank)	77.12	3.33	66.39	83.08
	Infant mortality rate	Infant mortality rate (per 1000 live births) (*Source*: World Bank)	5.12	2.23	2.2	15.7
	Immunization against measles	Immunization, measles (% of children ages 12–23 months) (*Source*: World Bank)	92.23	7.63	50	99
Infrastructure dimension	Electricity power	Electricity generation (gigawatt hours) from fossil fuels, nuclear power plants, hydro power plants (excluding pumped storage), geothermal systems, solar panels, biofuels, wind, etc. (*Source*: World Bank)	7.86	4.44	1.82	46.58
	Internet users	Individuals using the Internet (% of population) (*Source*: World Bank)	43.18	29.30	0	94.78
	Telephone users	Fixed telephone subscriptions (per 100 people) (*Source*: World Bank)	42.69	13.14	13.83	72.13
Musgravian indicators						
Distribution	GINI index	GINI index (*Source*: Eurostat)	31.33	4.15	23	39
	Income share by the highest 10%	Share of national equivalised income held by highest 10% (*Source*: Eurostat)	39.47	3.03	33.6	46.3
Stability	Inflation rate	Inflation, consumer prices (annual %) (*Source*: World Bank)	3.65	4.48	-4.48	39.65
General economic performance	Unemployment rate	Unemployment total (% of total labor force) (*Source*: World Bank)	9.32	4.31	2.12	27.47
	GDP per capita	GDP per capita (constant 2010 US$) (*Source*: World Bank)	35,069.08	11,820.68	9510.85	59,566.36
	GDP growth rate	GDP growth (annual %) (*Source*: World Bank)	2.57	3.54	−14.84	13.05

APPENDIX B

FORMULATION OF EFFICIENCY VARIABLES

B.1 | Data envelopment analysis (DEA)

This variable (DEA) refers to the technical efficiency obtained by FEAR 1.15 software. The DEA model (Charnes et al., 1978) is based on linear programming techniques to define an empirical frontier which creates an envelope by the most efficient decision-making units. As with other measures of efficiency, it tries to get the maximum level of output with the minimum input. In the specific case of the public sector, outputs (public services) are totally or partially set externally by law (local government regulatory law); thus, it is more appropriate to evaluate efficiency in terms of the minimization of inputs (budgetary variables), while assuming variable returns to scale (VRS). The minimum is found by selecting, by year, the optimal weights associated with inputs and outputs, by solving the following program:

$$\begin{aligned} &\text{Min}_{\theta,\lambda}\,\theta \\ \text{s.t.}\quad & y_{ri} \le \sum_{i=1}^{n} \lambda_i y_{ri}, \quad r = 1, \ldots, p \\ & \theta x_{ji} \ge \sum_{i=1}^{n} \lambda_i x_{ji}, \quad j = 1, \ldots, q \\ & \lambda_i \ge 0, \quad i = 1, \ldots, n \\ & \sum_{i=1}^{n} \lambda_i = 1 \end{aligned}$$

where i represents each local government ($i=1, ..., n$), y_r refers to each input ($r=1, ..., p$), and x_j refers to each output ($j=1, ..., q$). The restriction $\sum_{i=1}^{n} \lambda_i = 1$ implies the assumption of VRS, which ensures that each local government is compared only with others of similar sizes. For each local government, we obtain the value of θ, that is the efficiency score (*DEA*): if $\theta=1$, then it is defined as efficient; if $\theta<1$, then it has an inefficient performance.

However, DEA technique has some background problems due to its deterministic nature (De Witte & Marques, 2010): firstly, it is highly sensitive to extreme values and outliers, since it creates a frontier that envelops all data; and secondly, DEA assumes the absence of statistical noise, so it is sensitive to measurement errors. Accordingly, other methodologies may overcome such backgrounds, such as bias-corrected DEA via bootstrapping techniques, and the order-m methodology.

B.2 | DEA with application of bootstrap technique (DEAbc)

The bootstrap is a way to analyse the sensitivity of efficiency to the sampling variations, simulating the efficiency for different subsamples (Simar & Wilson, 1998). Here, we use the Simar and Wilson (1998) algorithm that applies the smoothed bootstrapping procedure to generate θ_i^* ($i=1, ..., n$), with replacement from $\left(\hat{\theta}_1, \ldots, \hat{\theta}_n\right)$, producing $\left(\theta_{1b}^*, \theta_{2b}^*, \ldots, \theta_{nb}^*\right)$, where b is the bth iteration of the re-sampling process (Assaf & Matawie, 2010).

Then, the bootstrap inputs are obtained as $x_{ib}^* = \left(\frac{\hat{\theta}_i}{\theta_{it}^*}\right) x_i$; these bootstrap inputs are used to obtain the new estimates of efficiency, namely $\hat{\theta}_{ib}^*$. These steps are repeated B times, producing a set of $\hat{\theta}_{ib}^*$ where $b=1, ..., B$. Finally, the mean of the bootstrap estimator is used as bootstrap DEA estimates, namely $\text{DEA}bc = \frac{1}{B}\sum_{b=1}^{B} \hat{\theta}_{ib}^*$. Therefore, the difference between the original DEA estimates and these newly created scores is usually called bias $\left(\widehat{\text{bias}}_i = \frac{1}{B}\sum_{b=1}^{B} \hat{\theta}_{ib}^* - \hat{\theta}_{in}\right)$.

Moreover, we can obtain confidence intervals via $\left(\%\hat{\theta}_{in}^{\alpha}, \%\hat{\theta}_{in}^{1-\alpha}\right)$, where $\tilde{\theta}_{in}^{\alpha}$ is the 100α percentile of the distribution of θ_{in}^*; and, shifting the bounds of the interval by the factors $\left(2 * \widehat{\text{bias}}_i^*\right)$, will ensure that the bootstrap distribution centres on the bias-corrected estimate $\tilde{\theta}_{in} = \hat{\theta}_{in} - \widehat{\text{bias}}_i^*$ (Assaf & Matawie, 2010).

B.3 | Order-m methodology (Orderm)

The order-m frontier (Cazals et al., 2002), may overcome DEA backgrounds, since it does not require enveloping all data. We also take an input orientation since the outputs are required externally, as indicated previously. In this case, the order-m estimator uses as a benchmark the expected minimum level of inputs given a fixed number of *m* local governments producing at least an output level *y* (Narbón-Perpiñá et al., 2017). Thus, following a similar notation, efficiency (Orderm) is defined as:

$$\widehat{\theta}_m(x,y) = E\left[\left(\widehat{\theta}_m(x,y)|\, Y \geq y\right)\right]$$

This means that for a given level of input–output, the estimation defines the expected maximum of *m* random variables, drawn from the conditional distribution of the output matrix *Y* observing the condition $Y \geq y$. A value >1 indicates super-efficiency, suggesting that the local government that operates at the level (*x*, *y*) is more efficient than the average of the *m* peers randomly drawn from the rest of the population producing more output level than *y* (Narbón-Perpiñá et al., 2017).

APPENDIX C

BIVARIATE CORRELATIONS

TABLE C1 Bivariate correlations between variables of Model (1).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. *Deals*	1													
2. *Proceeds*	0.3173***	1												
3. *DEA*	0.0734	−0.002	1											
4. *DEAb*	0.0955†	−0.0013	0.9916***	1										
5. *Orderm*	0.0287	0.0214	0.2503***	0.2405***	1									
6. *Balance*	0.0162	−0.0318	0.0997*	0.0892†	−0.2015***	1								
7. *Right*	0.005	0.0034	−0.0201	−0.0162	−0.1391**	0.0754	1							
8. *Years office*	0.0125	−0.1135*	−0.0629	−0.0702	0.0696	−0.0175	−0.0196	1						
9. *Herfindahl*	0.2228***	0.0029	0.1292*	0.1482**	0.2609***	−0.1425**	0.2962***	0.0408	1					
10. *Euro*	−0.143**	−0.1346**	0.0618	0.0746	−0.1025*	−0.0059	−0.0479	0.0257	0.1004*	1				
11. *Public Ownership*	0.4198***	0.2899***	−0.1648**	−0.127*	−0.1052*	−0.0402	0.0505	−0.105†	−0.0023	−0.2801***	1			
12. *Entry Barriers*	0.1385**	0.1616**	−0.1415**	−0.1346*	−0.3415***	0.2511***	0.2602***	−0.066	0.1519**	−0.0473	0.2416***	1		
13. *Growth*	−0.1163*	−0.0319	0.0087	0.0005	−0.0362	0.0901†	−0.0182	0.0397	−0.03	−0.0858†	0.0614	−0.0348	1	
14. *FDI*	−0.1251*	0.0479	0.127*	0.1075*	−0.038	0.0841†	−0.0524	−0.0421	−0.1301*	0.128**	−0.2506***	−0.0002	0.0737	1

Note: †, *, **, *** significant at 10%, 5%, 1%, and 0.1% level, respectively.

TABLE C2 Bivariate correlations between variables of Model (2).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. *DEA*	1												
2. *DEAb*	0.9916***	1											
3. *Orderm*	0.2503***	0.2405***	1										
4. *Deals*	0.0734	0.0955†	0.0287	1									
5. *Proceeds*	−0.002	−0.0013	0.0214	0.3173***	1								
6. *Dependency*	0.2008***	0.1886***	−0.2085***	0.0018	−0.0173	1							
7. *Density*	−0.0259	−0.0049	0.1143*	0.1362**	−0.1379**	−0.1181*	1						
8. *GDPpc*	0.139**	0.1298**	−0.1955***	−0.2108***	−0.2811***	0.4154***	0.1665***	1					
9. *Debt*	0.0997*	0.0892†	−0.2015***	0.0162	−0.0318	0.2368***	−0.0638	0.1365**	1				
10. *Right*	−0.1596**	−0.1554**	−0.0801	−0.0252	−0.0027	−0.1754***	0.0451	−0.2626***	−0.0793	1			
11. *Turnout*	−0.1138*	−0.1244*	−0.2347***	−0.0216	−0.0051	−0.0393	0.0162	0.2599***	0.2251***	0.0037	1		
12. *Inflation*	−0.0451	−0.058	−0.0617	0.2405***	0.1718***	−0.0916†	−0.0836†	−0.438***	−0.0143	0.1073*	−0.1729***	1	
13. *Openness*	0.0297	0.0091	−0.0104	−0.3908***	−0.0492	−0.286***	−0.0452	−0.0049	−0.0726	−0.1522**	0.0428	0.05	1

Note: †, *, **, *** significant at 10%, 5%, 1%, and 0.1% level, respectively.