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Local governments' efficiency: A systematic literature review—part I

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Abstract

The efficient management of the available resources in local governments has been a topic of high interest in the field of public sector. We provide an extensive and comprehensive review of the existing literature on local governments' efficiency from a global point of view, covering all articles from 1990 to August 2016. This paper is the first of two. It covers the basic aspects related to local governments' efficiency measurement not taking into account the effect of environmental conditions. First, we show a detailed overview of the studies investigating public sector efficiency across various countries, comparing the data and samples employed, and the main results obtained. Second, we describe which techniques have been used for measuring efficiency in the context of local governments. Third, we summarize the inputs and outputs used. Finally, we discuss some operative directions and considerations for further research in the field.

Keywords: efficiency; local government; survey

1. Introduction

Over the last 30 years, there have been many empirical studies that have focused on the evaluation of efficiency in local governments from multiple points of view and contexts. Following De Borger and Kerstens (1996a), it is possible to identify two strands of empirical research. On the one hand, some studies concentrate on the evaluation of a particular local service, such as refuse collection and street cleaning (Worthington and Dollery, 2000b, 2001; Bosch et al., 2000; Benito-López et al., 2011, 2015), water services (García-Sánchez, 2006a), street lighting (Lorenzo and Sánchez, 2007), fire services (García-Sánchez, 2006b), library services (Stevens, 2005), and road maintenance (Kalb, 2012). On the other hand, other studies evaluate local performance from a "global point of view" considering that local governments supply a wide variety of services and facilities.

We provide a systematic review of the existing literature on local government efficiency from a global point of view, covering all articles from 1990 up to the year 2016. This paper is the first of two. In this paper, we focus on the basic aspects of local governments' efficiency measurement, while in the companion paper (Narbón-Perpiñá and De Witte, 2017) we take into account the incorporation of environmental variables in the efficiency estimation. More specifically, this paper contributes to the literature in three major aspects. First, we present a detailed review of the studies investigating local government efficiency across various countries, comparing the data and samples employed as well as the main results obtained. Second, we describe which techniques have been used for measuring efficiency in the context of local governments. Finally, we suggest classifications for the input and output variables. In local government efficiency measurement, the selection of variables is a complex task, due to the difficulty to collect data and measure local services (Balaguer-Coll et al., 2013). Indeed, different studies use diverse measures, even those that analyze efficiency using data from the same country. We identify all variables used in previous literature according to the classifications proposed.

Our review starts from five previous works that referred to local government literature. First, Worthington and Dollery (2000a) provided a survey of the empirical analysis on efficiency in local government until 1999. Second, Afonso and Fernandes (2008) reviewed some relevant studies that evaluated both nonparametric and global local governments' efficiency. Third, Kalb et al. (2012) collected 23 studies that analyzed local government efficiency and made a comparison across various countries. Fourth, Da Cruz and Marques (2014) suggested a general classification for the determinants of local government performance. Finally, De Oliveira Junqueira (n.d.) reviewed some empirical studies on local government efficiency and identified the main inputs and output variables included in the analysis. However, to the best of our knowledge, the literature review presented in these papers is the most complete source of references on local government efficiency analysis. We show a complete overview of the existing literature, the variables' selection, the methodologies employed, and some considerations for further work.

The remainder of the paper is organized as follows. Section 2 provides the bibliographic selection process to construct the systematic literature review. Section 3 presents an extensive review of the existing literature on local governments' efficiency at country level. Section 4 reports which techniques have been used for measuring efficiency, while Section 5 describes the input and output variables most commonly used. Finally, Section 6 discusses the main conclusions and suggests operative directions for future researchers in the field.

2. A systematic review on local government efficiency

In this review, we have used the search engines Web of Science (WoS),[1] Scopus,[2] and Google Scholar. The search was limited to the Social Sciences Citation Index (SSCI) in WoS and to the Social Sciences and Humanities area in Scopus to reduce the likelihood of retrieving articles that were not related

[1]WoS is a scientific citation indexing database and search service maintained by Thomson Reuters. It allows for in-depth exploration of specialized subfields within an academic or scientific discipline.

[2]Scopus is a bibliographic database maintained by Elsevier. It contains abstracts and citations for academic journal articles, books, and conference proceedings.

to the topic, such as energy or health efficiency. Also, we have restricted the literature search to English language. We included empirical papers until August 2016.

As the main focus is local governments' efficiency, the initial search was done using combinations of the keywords "efficiency," "performance measurement," "local government," and "municipality." Using these keywords, the databases provided us more than 250 books, papers, and unpublished working papers. To limit the total number of results, we excluded the presentations given at conferences as well as dissertations. Next, the results retrieved were filtered qualitatively to ensure they addressed the research question. As a criterion for inclusion, we included studies that present empirical data, measuring efficiency at local government level (LAU-2),[3] with a selection of inputs and outputs, and excluding studies addressed to international comparisons and studies addressed to measure a particular service, such as refuse collection, water services, road maintenance, education, and so on. Finally, we obtained 84 studies.

3. Country-level analysis

As mentioned in the Introduction, there have been many empirical studies that have focused on the evaluation of the overall efficiency in local governments covering several countries. Table A1 summarizes the empirical contributions focused on local government efficiency from a global point of view, listed by countries and chronological order of publication. As we can observe, some of these studies also attempted to analyze the relationship between local government efficiency and other important topics, such as the municipal size, effect of amalgamation of the municipalities, impact of fiscal decentralization, effects of political competition, and influence of the spatial closeness between municipalities, among others. The differences in the average efficiency scores found between the studies are remarkable due to differences in the samples, methodologies, and variables included. However, we summarize efficiency scores by countries with the aim to define general trends.

Looking first at Japan, Nakazawa (2013, 2014) evaluated 479 municipalities in 2005 considering the effects that amalgamation had over cost efficiency. Moreover, Nijkamp and Suzuki (2009) evaluated 34 cities in Hokkaido prefecture in 2005, and Haneda et al. (2012) used 92 municipalities in Ibaraki prefecture for the years 1979–2004 to analyze the change in efficiency in the postmerger period. In general, Japanese municipalities show high efficiency levels, scoring from 0.75 to 0.90 depending on the method and data. Two studies have evaluated local governments in Korea. Seol et al. (2008) analyzed 106 local governments in 2003, while Sung (2007) assessed 222 local governments from 1999 to 2001. Both studies examined the impact of information technology on Korean local government performance. Their results vary from 0.57 to 0.97 depending on the specification model and the sample.

In addition, five more studies focused on other Asian countries. Yusfany (2015) analyzed 491 Indonesian municipalities in 2010, Liu et al. (2011) measured 22 local governments in Taiwan in 2007, Kutlar and Bakirci (2012) evaluated 27 Turkish municipalities from 2006 to 2008, and Ibrahim

[3]Local administrative units (LAUs) are basic components of the Nomenclature of Territorial Units for Statistics (NUTS) for referencing the subdivisions of countries regulated by the European Union. Specifically, LAU-2 is a low-level administrative division of a country, ranked below a province, region, or state. So, we exclude studies focused on intermediate level of local governments, such as those of Nold Hughes and Edwards (2000), Hauner (2008), Nieswand and Seifert (2011), and Otsuka et al. (2014), among others.

and Karim (2004) and Ibrahim and Salleh (2006) analyzed 46 local governments in Malaysia in 2000. Efficiency results for Indonesian municipalities are quite low (0.50), while in Taiwan results range from 0.38 to 0.82, in Turkey from 0.53 to 0.86, and in Malaysia from 0.59 to 0.76.

Three studies have evaluated local governments on the Australian context. Specifically, Worthington (2000) measured cost efficiency for municipalities in New South Wales for 1993. Also, Fogarty and Mugera (2013) evaluated efficiency for Western Australia municipalities in 2009 and 2010. Finally, Marques et al. (2015) used a sample of 29 Tasmanian local councils between 1999 and 2008 with the aim to estimate the optimal size on local government. The mean efficiency scores in Australian municipalities range from 0.40 to 0.86; however, heterogeneous results were expected since none of the Australian studies used the same dataset and method. Moreover, there are three studies that analyzed local governments in Brazil. Sampaio de Sousa et al. (2005) evaluated 3,756 local governments in 1991, while Sampaio de Sousa and Ramos (1999) and Sampaio de Sousa and Stošić (2005) used 4,796 municipalities in 1991 and 2001, respectively. Despite data in these last two studies have 10 years' difference, their efficiency scores are quite similar, ranging from 0.52 to 0.92 depending on the method used. In addition, Pacheco et al. (2014) analyzed the efficiency of 309 Chilean municipalities from 2008 to 2010, reporting an average efficiency score of around 0.70.

Further, some studies assessed cost efficiency in local governments in the United States. Hayes and Chang (1990) evaluated 191 U.S. municipalities in 1982, studying whether or not the council-management form is more efficient than the mayor-council form of government in formulating and implementing public policies. Moreover, Grossman et al. (1999) examined 49 U.S. central cities for the years 1967, 1973, 1977, and 1982. They measured technical inefficiency in the local public sector based on a comparison of local property values. Finally, Moore et al. (2005) analyzed largest cities in the United States from 1993 to 1996. Interestingly, despite the different methods and data used, results for the efficiency levels in U.S. local governments are quite consistent, varying between 0.81 and 0.84. Three studies assessed provision of basic services in local municipalities in South Africa from 2005 to 2010 (Dollery and van der Westhuizen, 2009; Mahabir, 2014; Monkam, 2014). In general, they show low efficiency levels, scoring from 0.17 to 0.64.

There exist several studies about performance in Belgian local governments.[4] De Borger et al. (1994) and De Borger and Kerstens (1996a, 1996b) measured cost efficiency for 589 municipalities in 1985, while Eeckaut et al. (1993) analyzed 235 Walloon municipalities in 1986. Moreover, Geys and Moesen (2009a, 2009b) and Geys (2006) evaluated 304 Flemish municipalities in 2000, analyzing in the last study the existence of spatial interdependence in local government policies. Similarly, Coffé and Geys (2005) evaluated 305 Flemish municipalities, studying the effect of social capital on local government performance, while Ashworth et al. (2014) assessed 308 Flemish municipalities, measuring whether political competition affects local government efficiency. In general, despite many studies have used similar samples for the same years, efficiency results for Belgian municipalities differ from 0.49 to 0.99. These differences might be explained by the different methodologies applied as well as the different topics studied.

In addition, some studies analyzed German local governments. Kalb et al. (2012) and Geys et al. (2013) analyzed cost efficiency in 1,021 municipalities for data in 2001 and 2004, respectively. The last study considered local government size to measure the effect of economies of scale. Similarly,

[4]See De Borger and Kerstens (2000) for a literature review on Belgian local governments up to the year 1998. They discuss the difficulties involved in measuring local government efficiency.

Bönisch et al. (2011) evaluated local governments in Saxony-Anhalt in 2004 taking into account municipality size. Moreover, Geys et al. (2010) assessed whether voter involvement is related to government performance using 987 German municipalities for the years 1998, 2002, and 2004. Kalb (2010) and Bischoff et al. (2013) studied municipalities from 1990 to 2004, considering the impact of intergovernmental and vertical grants on cost efficiency, while Asatryan and De Witte (2015) evaluated 2,000 Bavarian municipalities in 2011, connecting the efficient provision of local public services with the role of direct democracy. Finally, Lampe et al. (2015) analyzed the effect of new accounting and budgeting regimes in 396 German municipalities from 2006 to 2008. On average, results on German municipalities showed that inputs or costs should be reduced by 1% to 20% of their current level.

Six studies have analyzed local government in Norway. Kalseth and Rattsø (1995) used 407 Norwegian local authorities in 1988, while Borge et al. (2008) and Bruns and Himmler (2011) evaluated between 362 and 374 local governments from 2001 to 2005. The second study investigated whether efficiency in public service provision is affected by political and budgetary institutions, fiscal capacity, and democratic participation, while the last study examined the role of the newspaper market for the efficient use of public funds by elected politicians. Moreover, Sørensen (2014) and Helland and Sørensen (2015) evaluated 430 Norwegian local authorities from 2001 to 2010, both considering whether political variables affect local government efficiency. Finally, Revelli and Tovmo (2007) analyzed 205 local governments located in the 12 southern counties of Norway, investigating whether the efficiency exhibits a spatial pattern that is compatible with the hypothesis of yardstick competition. The only study that used frontier techniques to measure efficiency in Norwegian local governments showed efficiency results from 0.74 to 0.84. The others concluded that efficiency values of the ratios between inputs and outputs ranged from 100 to 104.9.

Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) evaluated cost efficiency of basic welfare service provision in Finnish municipalities for data from 1994 to 2002. This second study examined whether Finnish city managers' characteristics and work environment, in addition to external factors, explain differences in cost efficiency. On average, the results for Finnish municipalities show a high efficiency level, scoring from 0.75 to 0.89. In addition, two studies have focused on the English case. Revelli (2010) studied 148 main local authorities in England from 2002 to 2007. Moreover, Andrews and Entwistle (2015) analyzed 386 local authorities in England in 2007. They investigated the relationship among a commitment to public–private partnership, management capacity, and efficiency. In the English case, the efficiency values of the ratios between inputs and ouputs were 1.05.

Furthermore, 6 papers focused their attention on Italian local governments. Barone and Mocetti (2011) analyzed the links between public spending inefficiency and tax morale using a sample of 1,115 municipalities for data from 2001 to 2004. Moreover, Boetti et al. (2012) evaluated 262 Italian municipalities in the province of Turin in 2005, assessing whether efficiency of local governments is affected by the degree of vertical fiscal imbalance. Similarly, Carosi et al. (2014) analyzed 285 Tuscan municipalities in 2011, while Agasisti et al. (2015) analyzed 331 Lombardy municipalities with more than 5000 inhabitants from 2010 to 2012. Finally, Lo Storto (2013, 2016) used 103 Italian municipalities in 2011 and 2013, respectively. In general, the efficiency scores in Italian municipalities vary drastically (from 0.19 to 0.88), depending on the specification, sample, and method employed.

Five studies have evaluated local governments in Portugal. The studies of Afonso and Fernandes (2003, 2006) analyzed 51 Portuguese municipalities in the regions of Lisbon and Vale do Tejo in

2001. Similarly, Afonso and Fernandes (2008), Da Cruz and Marques (2014), and Cordero et al. (2016) investigated cost efficiency in 278 Portuguese local governments for data from 2001 to 2014. In general, the efficiency results shown in Portuguese municipalities are quite low, scoring from 0.22 to 0.76. Otherwise, there are two studies that assessed cost efficiency in Greek local governments. Athanassopoulos and Triantis (1998) analyzed municipalities with more than 2,000 inhabitants for 1986 data, while Doumpos and Cohen (2014) focused on the period 2002–2009, exploring optimal reallocation of the inputs and outputs. Mean efficiency of Greek municipalities differs from 0.5 to 0.85 depending on the method applied as well as the sample analyzed. In addition, El Mehdi and Hafner (2014) analyzed the efficiency of 91 rural districts in the oriental region of Morocco from 1998 to 1999, showing average efficiency scores ranging from 0.38 to 0.50.

Moreover, Štastná and Gregor (2011, 2015) compared 202 local governments in the Czech Republic in the transition period of 1995–1998 and the posttransition period of 2005–2008. Their results show low efficiency levels, scoring from 0.30 to 0.79 depending on the method used. In addition, other studies focused on data in Central and East European countries. Pevcin (2014a, 2014b) measured efficiency in 200 Slovenian municipalities in 2011. Their results suggested that mean technical inefficiency should be approximately 12–25% above the estimated best-practice frontier. Moreover, Radulovic and Dragutinović (2015) measured efficiency for 143 Serbian local governments in 2012, and Nikolov and Hrovatin (2013) analyzed 74 municipalities in Macedonia. This last study took into account the ethnic fragmentation of municipalities to explain efficiency. Their results show that mean efficiency scores are quite low in Macedonia (0.59), while Serbian local governments should reduce their inputs by 15% to 33%.

Finally, some studies analyzed the case of Spanish municipalities (13 papers). Balaguer-Coll et al. (2007) and Balaguer-Coll and Prior (2009) measured local governments in the Valencian Region for data from 1992 to 1995. The last study considered a temporal dimension of efficiency and applied different output specifications. Similarly, the study of Giménez and Prior (2007) evaluated 258 Catalonian municipalities for data in 1996, decomposing the total cost efficiency into short and long term, while Bosch-Roca et al. (2012) evaluated 102 Catalonian municipalities between 5,000 and 20,000 inhabitants in 2005, connecting efficiency of local public services with citizen's control in a decentralized context. Moreover, Benito et al. (2010) analyzed the efficiency in 31 municipalities of the Murcia Region in 2002, Prieto and Zofio (2001) analyzed 209 municipalities of less than 20,000 people in Castile and Leon Region in 1994, and Arcelus et al. (2015) measured efficiency in small municipalities (fewer than 20,000 inhabitants) from Navarre Region in 2005.

Differently, other studies focused on Spanish data covering most part of the Spanish territory. For instance, Balaguer-Coll et al. (2010a, 2010b) analyzed the links between overall cost efficiency and the decentralization power in Spain with more than 1,164 Spanish local authorities over 1,000 inhabitants for data from 1995 to 2005. Moreover, Cuadrado-Ballesteros et al. (2013) used 129 Spanish municipalities with populations over 10,000 from 1999 to 2007 and Zafra-Gómez and Muñiz-Pérez (2010) measured the cost efficiency of 923 municipalities for the years 2000 and 2005 together with their financial condition. Finally, in Balaguer-Coll et al. (2013) and Pérez-López et al. (2015) an analysis of local government performance is assessed with a sample of municipalities between 1,000 and 50,000 inhabitants for the years from 2000 to 2010. The first study splits municipalities into clusters according to various criteria (output mix, environmental condition, and level of powers). The last study analyzed the long-term effects of the new delivery forms over

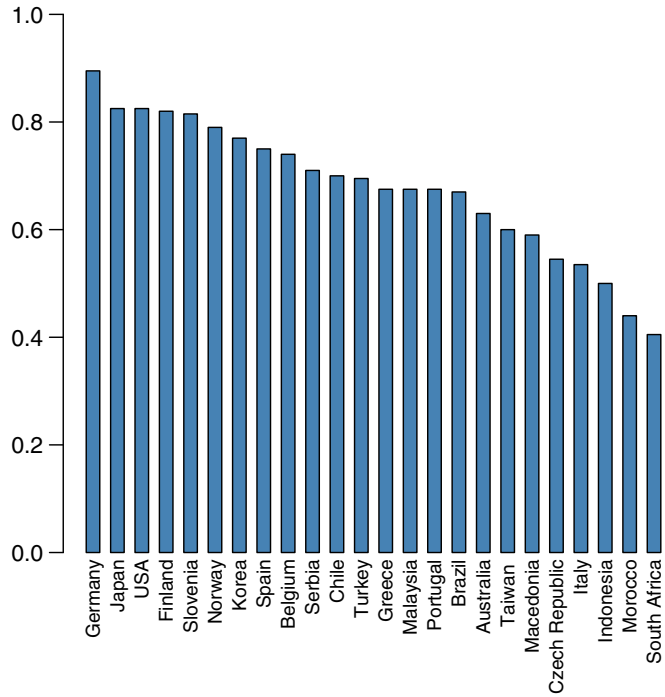

Fig. 1. Average efficiency scores by country.

efficiency. Broadly speaking, efficiency results for Spanish municipalities are really heterogeneous, scoring from 0.53 to 0.97 depending on the different variables specifications, methodologies used, and the data.

To summarize, Fig. 1 presents the average efficiency scores by country, measured as the average between the maximum and minimum scores found in previous literature. We observe that Germany presents the highest average efficiency results (0.90), while South Africa presents the lowest (0.40).

4. Methodological approaches

The literature uses different techniques to analyze local governments' efficiency.[5] It is possible to distinguish two main branches of best-practice frontiers: the nonparametric and parametric methods. Table A2 provides a review of the studies using the different approaches to measure efficiency in local governments.

On the one hand, the most common nonparametric tools used in local government efficiency literature are Data Envelopment Analysis (Charnes et al., 1978), hereafter DEA, and its nonconvex version Free Disposal Hull (Deprins et al., 1984), hereafter FDH. Nonparametric methods have received a considerable amount of interest mainly because they have less-restrictive assumptions

[5]See Coelli et al. (2005) and Fried et al. (2008) for an introduction to efficiency measurement.

and greater flexibility than parametric methods. Moreover, they can easily handle multi-input and multi-output analysis in a simple way (Ruggiero, 2007). As observed in Table A2, in total, 41 papers used DEA, 13 used FDH, and two used the super-efficiency DEA model of Andersen and Petersen (1993).

Nevertheless, the traditional nonparametric methods also present several drawbacks: their deterministic nature (all deviations from the frontier are considered as inefficient and no noise is allowed), the difficulty to make statistical inference, and the influence of outliers and extreme values. In this setting, other recent techniques in the nonparametric field have been used to solve these problems. First, bootstrap methods based on subsampling (Simar and Wilson, 1998, 2000, 2008) have been used to correct DEA or FDH bias.[6] They allow for statistical inference (consistency analysis, bias correction, confidence intervals, hypothesis testing, etc.) in the nonparametric setting. We found 6 papers that used bias-corrected methods. Moreover, Sampaio de Sousa et al. (2005) and Sampaio de Sousa and Stošić (2005) introduced a method known as DEA or FDH with "jackstrap" that combines bootstrap and jackknife resampling to eliminate the influence of outliers and possible measurement errors in the data.

Second, partial frontiers such as order-m (Cazals et al., 2002) are more robust to extremes or outliers in data and they do not suffer from the curse of dimensionality. We only found two studies that employed order-m approach. Finally, Asatryan and De Witte (2015) used the conditional efficiency model (Daraio and Simar, 2005) while Cordero et al. (2016) used the time-dependent conditional frontier model recently developed by Mastromarco and Simar (2015). They are an extension to the traditional FDH and order-m, which allow to account for heterogeneity among municipalities.

On the other hand, some studies used parametric approaches. They determine the frontier on the basis of a specific functional form using econometric techniques. The deviations from the best-practice frontier derived from parametric methods can be interpreted in two different ways. While deterministic approaches interpret the full deviation from the best-practice frontier as inefficiency (standard ordinary least squares (OLS) or corrected ordinary least squares (COLS) method), Stochastic Frontier Approach (Aigner et al., 1977; Meeusen and Van den Broeck, 1977), hereafter SFA, decompose the deviation of the best-practice frontier between the effect of measurement error and inefficiency. In addition, environmental variables can be easily treated with a stochastic frontier. They can adopt different cost or production functions, for instance, the Cobb-Douglas or Translog. As observed in Table A2, in total, 25 papers used SFA, three studies used COLS or OLS, two studies fixed effects regression, and one study used standard cost regression.

Otherwise, some studies have applied a dynamic approach in order to reveal the efficiency changes over the time. The most popular method among the nonparametric field is the Malmquist Productivity Index (Caves et al., 1982), which has been used with DEA, FDH, or bootstrap methods. Moreover, two studies assessed the efficiency scores over time with parametric approaches, using the time-variant SFA analysis.

Finally, four studies measured efficiency by using a index developed by Borge et al. (2008) instead of traditional frontier techniques. The index is defined as the ratio of the total aggregate output to

[6]As stated by Simar and Wilson (2008), DEA and FDH estimators are biased by construction, which means that the true frontier would be located under the DEA-estimated frontier.

local government revenues. Finally, the efficiency measure is normalized to 100, so that deviations from the mean can be interpreted as percentage deviations.

5. Input and output indicators

The selection of variables depends on the availability of data and the specific services and facilities that local government provides in each country. Therefore, many variables cannot be used in all countries.

5.1. Input variables

We review the input variables most widely used in previous literature to proxy for the municipal resources employed for local service provision. The selection of inputs could vary across countries since they depend on specific accounting practices and characteristics of local governments. Moreover, we note that most studies used input variables in cost terms since data on prices and physical units are not available. Public-sector goods and services are frequently unpriced since they have a nonmarket nature (Kalb et al., 2012). Despite some authors have tried to decompose physical inputs and input prices, most of these input prices variables coincide with the input variables in cost terms. In this setting, in our input classification we do not differentiate input prices. Table A3 summarizes the studies containing local inputs from different areas. We discuss the variables from Table A3, describing how different studies have measured them.

5.1.1. Financial expenditures

Input variables within this category come from local public accounts or budget expenditures. We include indicators such as total expenditures, current expenditures, capital expenditures, and financial expenditures.

- Total expenditures (24 papers)
  This variable has been commonly used in local government efficiency analysis to proxy for the total cost of service provision.[7] Mainly, it includes different expenditures categories such as current (or operational), capital, and financial expenditures.
  In addition, other variants of total expenditures have been used. Some studies measured total local government expenditures excluding personnel expenses since these are measured separately.[8] Similarly, Lampe et al. (2015) and Asatryan and De Witte (2015) measured total government expenditures net of transfers from the central government to municipalities arguing that municipalities have no discretion to make decisions on their use.

[7]Kalseth and Rattsø (1995), De Borger and Kerstens (1996a, 1996b), Prieto and Zofio (2001), Afonso and Fernandes (2003, 2006), Coffé and Geys (2005), Afonso and Fernandes (2008), Balaguer-Coll et al. (2010b), Kutlar and Bakirci (2012), Nakazawa (2013, 2014), Ashworth et al. (2014), Pevcin (2014a, 2014b), Mahabir (2014), Yusfany (2015), Andrews and Entwistle (2015).

[8]Sung (2007), Seol et al. (2008), Nijkamp and Suzuki (2009), Cordero et al. (2016).

- Current expenditures (46 papers)
  Current expenditures or operating expenses are the most widely used input indicators to measure the costs incurred by local governments to provide local services.[9] They do not include capital expenditures since they are highly volatile because of investments in large infrastructures.
  Similarly, some studies have used the total net current expenditures in a municipality. These include all spending on the current budget minus interest and amortization repayments from local public debts. Again, spending from the capital budget is not considered, since this mainly refers to large investment events that inflate total spending in the year they emerge.[10]
  In addition, some studies measured current expenditures as the spending on those issues for which they observed government outputs. They aggregate data on expenditures or costs given a number of local services provided.[11]
- Personnel expenditures (26 papers)
  Local personnel expenses can be measured as the number of local government employees[12] or as the total personnel costs or wages and salaries.[13] In addition, Sampaio de Sousa and Stošić (2005) and Sampaio de Sousa et al. (2005) used the number of teachers as a proxy for personnel inputs.
- Capital and financial expenditures (17 papers)
  Capital or financial expenses are related to interest payments and loans. Including capital expenditures means considering the investment expenditure that local entities make on a regular basis, such as expenditure on the maintenance of municipal facilities and equipment.[14] Moreover, the study of Liu et al. (2011) used the accumulation of fixed assets as a proxy for capital inputs, and De Borger et al. (1994) employed the surface of building owned by the municipality as a proxy

[9]Eeckaut et al. (1993), Athanassopoulos and Triantis (1998), Sampaio de Sousa and Ramos (1999), Ibrahim and Karim (2004), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Geys (2006), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a), Zafra-Gómez and Muñiz-Pérez (2010), Bosch-Roca et al. (2012), Šťastná and Gregor (2011), Kutlar and Bakirci (2012), Nikolov and Hrovatin (2013), Balaguer-Coll et al. (2013), Cuadrado-Ballesteros et al. (2013), Pacheco et al. (2014), Monkam (2014), Marques et al. (2015), Šťastná and Gregor (2015), Radulovic and Dragutinović (2015), Arcelus et al. (2015), Pérez-López et al. (2015).

[10]Geys et al. (2010), Kalb (2010), Kalb et al. (2012), Geys et al. (2013), Pacheco et al. (2014), Nakazawa (2014), Lampe et al. (2015).

[11]Hayes and Chang (1990), Loikkanen and Susiluoto (2005), Moore et al. (2005), Geys and Moesen (2009a, 2009b), Benito et al. (2010), Revelli (2010), Barone and Mocetti (2011), Loikkanen et al. (2011), Boetti et al. (2012), Lo Storto (2013), Pacheco et al. (2014), Carosi et al. (2014), Agasisti et al. (2015), Lo Storto (2016).

[12]De Borger et al. (1994), Worthington (2000), Moore et al. (2005), Sung (2007), Seol et al. (2008), Nijkamp and Suzuki (2009), Haneda et al. (2012), Da Cruz and Marques (2014).

[13]Hayes and Chang (1990), Worthington (2000), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Dollery and van der Westhuizen (2009), Benito et al. (2010), Balaguer-Coll et al. (2010a), Zafra-Gómez and Muñiz-Pérez (2010), Bönisch et al. (2011), Liu et al. (2011), Kutlar and Bakirci (2012), Fogarty and Mugera (2013), Bischoff et al. (2013), Nakazawa (2013), Balaguer-Coll et al. (2013), Cordero et al. (2016).

[14]Worthington (2000), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a), Bosch-Roca et al. (2012), Zafra-Gómez and Muñiz-Pérez (2010), Bönisch et al. (2011), Kutlar and Bakirci (2012), Balaguer-Coll et al. (2013), Fogarty and Mugera (2013), Bischoff et al. (2013), Cuadrado-Ballesteros et al. (2013), Da Cruz and Marques (2014).

for capital stocks. In addition, the study of Nijkamp and Suzuki (2009) included the amount of outstanding city bonds as a proxy for financial costs, while Hayes and Chang (1990) used the municipal bond rating.

- Other financial expenditures (6 papers)
  In this category, we include physical expenses that consisted of material purchases and inventory, plants and equipment, contract expenses, utility expenses, insurance costs, and any other costs grouped as other expenses in the financial statements,[15] as well as resources and intermediate inputs that contained all other current expenditures not related to labor or capital expenditures.[16]

5.1.2. Financial resources

Inputs variables within this category come from local public accounts or budget revenues. We include own revenues as well as transfers.

- Local revenues (7 papers)
  Some studies measured total local government revenues as the available resources in local government, which include own tax revenues (tax revenues, fees, and charges) as well as central government grants or subsidies.[17] In addition, El Mehdi and Hafner (2014) used the own receipts of the municipality measured as the total operating receipts minus the subsidies.
- Current transfers (8 papers)
  Current transfers represent transfers and grants received from higher levels of government.[18]

5.1.3. Nonfinancial inputs

We include input indicators not related to local financial statements.

- Public health services (2 papers)
  The studies of Sampaio de Sousa et al. (2005) and Sampaio de Sousa and Stošić (2005) used the number of hospital and health centers (as they are the main providers of health services) to proxy for public health services. Also, they accounted for the rate of infant mortality serves as an input, suggesting that if health services are efficient, this indicator should be as low as possible.
- Area (1 paper)
  Finally, Haneda et al. (2012) included the area in kilometer square considering it as a municipal asset.

[15]Worthington (2000), Giménez and Prior (2007), Fogarty and Mugera (2013).

[16]Bönisch et al. (2011), Bischoff et al. (2013), Da Cruz and Marques (2014).

[17]Revelli and Tovmo (2007), Borge et al. (2008), Bruns and Himmler (2011), Sørensen (2014), Doumpos and Cohen (2014), Helland and Sørensen (2015).

[18]Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2013), Benito et al. (2010), Kutlar and Bakirci (2012), Zafra-Gómez and Muñiz-Pérez (2010).

5.2. Output variables

Measuring local governments' outputs is a complex task that is due to the difficulty to collect data and measure local services (Balaguer-Coll et al., 2013). Indeed, different studies use diverse measures of outputs, even those that analyze efficiency using data from the same country. Also, the number of output variables included in the different studies is varied, since some studies aggregate various municipal services in a global index, while others evaluate a set of specific local services. Table A4 summarizes the studies containing local outputs from 17 different categories.

5.2.1. Global output indicator (14 papers)

A global output indicator represents an index containing a set of services and facilities that municipalities must provide (such as education, health, roads infrastructure, social services, sports and culture, waste collection, water supply, etc.). Given that the services offered by local governments are varied and not all have the same budgetary weight, each output included in the global output indicator is weighted according to different criteria. In this context, Afonso and Fernandes (2003, 2006, 2008), Nijkamp and Suzuki (2009), and Yusfany (2015) gave the same weighting for the different outputs included in the composed index; Bosch-Roca et al. (2012) weighted each output according to the relative weight in the accounts of each municipality; and Nakazawa (2013, 2014) gave specific numerical weights to each different area of public service included.

In addition, other studies have used official indicators of the provision of local services developed by public institutions. For instance, in Norway, the studies of Revelli and Tovmo (2007), Borge et al. (2008), Bruns and Himmler (2011), Sørensen (2014), and Helland and Sørensen (2015) used an aggregate output measure published annually by the Norwegian Advisory Commission on Local Government Finances. This aggregate measure is calculated as the weighted average of the output measures for the individual service sectors using the average spending shares as weights. Moreover, in United Kingdom the studies of Revelli (2010) and Andrews and Entwistle (2015) used an official rating of local government performance (Comprehensive Performance Assessment, CPA) built annually by the Audit Commission (a central government regulatory agency).

5.2.2. Total population (46 papers)

This variable is the output indicator most frequently used in local government efficiency analysis. It reflects the basic administrative tasks performed by municipal governments through the service general administration as well as other services for which more direct outputs do not exist. Eeckaut et al. (1993) was the pioneer study that proposed the use of population as a proxy indicator for public services in the evaluation of local efficiency. The route opened up by the latter study was later expanded by De Borger and Kerstens (1996a, 1996b) and converted as a common standard in governmental efficiency research thus far.[19] Otherwise, the studies of Štastná and Gregor (2011),

[19]Sampaio de Sousa and Ramos (1999), Worthington (2000), Ibrahim and Karim (2004), Coffé and Geys (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Geys et al. (2010), Kalb (2010), Zafra-Gómez and Muñiz-Pérez (2010), Balaguer-Coll et al. (2010a, 2010b), Bönisch et al. (2011), Kalb et al. (2012), Kutlar and Bakirci (2012), Boetti et al. (2012), Balaguer-Coll et al. (2013), Nikolov and Hrovatin (2013), Fogarty and Mugera (2013), Cuadrado-Ballesteros et al. (2013),

Haneda et al. (2012), and Pacheco et al. (2014) used population size as a proxy for the scope of services since bigger municipalities should provide more public goods and services.

In addition, some studies used proxy variables for the services delivered to nonresident population. For instance, local governments in areas with tourist visitors would have higher demand for their services. Therefore, variables such as the share of nonresidents, tourist presence, number of visitors, or number of beds in tourism establishments have been used.[20]

5.2.3. Area of municipality and built area (10 papers)

Municipal area (measured as total municipal surface, urban area, or built-up area) has been used as a proxy for the demand of public services delivered to citizens in several studies.[21] It works as an indirect approximation due to the difficulty of quantifying the supply of public services and facilities. In addition, some studies have used the number of properties or households in the local area[22] as a proxy for the demand of urban services.

5.2.4. Administrative services (9 papers)

Many studies have used variables such as "population" to proxy administrative services. However, others have used more direct outputs designed to measure the provision of services linked to administrative tasks. For instance, Arcelus et al. (2015) used an index measuring the provision of administrative services defined by the Local Administration of the Navarre government. Moreover, Kalseth and Rattsø (1995) defined the administrative activities as the administrative costs of central administration and the sectoral administration of different services. In addition, other studies included civil affairs,[23] the number of certificates and requested documents handled,[24] the number of receipts processed,[25] electoral service,[26] the number of planning applications,[27] the amount of

Nikolov and Hrovatin (2013), Bischoff et al. (2013), Geys et al. (2013), Lo Storto (2013), Pevcin (2014a, 2014b), Carosi et al. (2014), Monkam (2014), Da Cruz and Marques (2014), Lampe et al. (2015), Radulovic and Dragutinović (2015), Agasisti et al. (2015), Pérez-López et al. (2015), Cordero et al. (2016), Lo Storto (2016).

[20]Athanassopoulos and Triantis (1998), De Borger et al. (1994), Kutlar and Bakirci (2012), Carosi et al. (2014).

[21]Athanassopoulos and Triantis (1998), Giménez and Prior (2007), Štastná and Gregor (2011), Lo Storto (2013), Cuadrado-Ballesteros et al. (2013), Štastná and Gregor (2015), Arcelus et al. (2015), Pérez-López et al. (2015), Lo Storto (2016).

[22]Athanassopoulos and Triantis (1998), Štastná and Gregor (2011), Fogarty and Mugera (2013), Arcelus et al. (2015), Štastná and Gregor (2015).

[23]Sung (2007).

[24]Seol et al. (2008), Barone and Mocetti (2011).

[25]Marques et al. (2015).

[26]Barone and Mocetti (2011).

[27]Marques et al. (2015).

internal reports produced,[28] the number of building permits issued,[29] and taxes on construction and square feet of city building space available to proxy for urban and building management.[30]

5.2.5. *Infrastructures*

We include indicators of the basic municipal infrastructures related to street lighting and municipal roads.

- Street lighting (11 papers)
  This variable measures the provision of public street lighting in the municipalities, mostly measured as the number of lighting points.[31]
- Municipal roads (34 papers)
  The length of municipal roads (in kilometers) is a proxy for the provision of local road maintenance services (such as paving or street cleaning), traffic, urban transport, and access to the municipality.[32] Similarly, the study of Moore et al. (2005) included the miles of streets serviced as a proxy for street maintenance, Štastná and Gregor (2011, 2015) used the size of municipal roads measured in hectares, Sung (2007) used the ratio of road length to area, and Lo Storto (2013) used the urban infrastructure development. In addition, Doumpos and Cohen (2014) and Arcelus et al. (2015) used the variable "pavement" to proxy for municipal roads services, while Prieto and Zofio (2001) measured the pavement shortage as well as the pavement condition. Finally, some studies included the number of vehicles as a proxy for surfacing of public roads.[33]

5.2.6. *Communal services*

This group of variables related to "network services" includes indicators such as waste collection, sewerage system, water supply, and electricity as part of municipal outcomes.

- Waste collection (32 papers)

[28] Seol et al. (2008).

[29] Sung (2007), Barone and Mocetti (2011), Cordero et al. (2016).

[30] Cuadrado-Ballesteros et al. (2013), Moore et al. (2005).

[31] Prieto and Zofio (2001), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2010b), Zafra-Gómez and Muñiz-Pérez (2010), Barone and Mocetti (2011), Balaguer-Coll et al. (2013), Doumpos and Cohen (2014), Arcelus et al. (2015), Pérez-López et al. (2015).

[32] Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996b), Worthington (2000), Ibrahim and Karim (2004), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Geys (2006), Geys and Moesen (2009a, 2009b), Balaguer-Coll and Prior (2009), Zafra-Gómez and Muñiz-Pérez (2010), Balaguer-Coll et al. (2010a, 2010b), Barone and Mocetti (2011), Boetti et al. (2012), Nikolov and Hrovatin (2013), Fogarty and Mugera (2013), Balaguer-Coll et al. (2013), Da Cruz and Marques (2014), Carosi et al. (2014), Ashworth et al. (2014), Doumpos and Cohen (2014), Marques et al. (2015), Agasisti et al. (2015), Radulovic and Dragutinović (2015).

[33] Moore et al. (2005), Sung (2007), Giménez and Prior (2007).

The municipal waste collection and treatment of waste collected are mainly measured as the amount of waste collected in tons, quintals, or kilograms.[34] Moreover, the study of Liu et al. (2011) included the volume of garbage generation measured in kilos as an undesirable output.

In addition, some studies have used the number of properties receiving domestic waste management service or the population served to proxy for waste collection service.[35] Similarly, Geys and Moesen (2009a, 2009b) used the share of municipal waste picked up through door-to-door collections. Otherwise, Hayes and Chang (1990) and Štastná and Gregor (2011, 2015) used the expenditures on waste collection.

- Sewerage system (10 papers)
  The sewerage network and cleansing of residuals water can be measured as the number of properties receiving sewerage services,[36] or as the number of sewerage connections.[37] Similarly, Sung (2007) used the penetration rate of sewage as the share of the households with sewage over all households. In addition, the study of Da Cruz and Marques (2014) measured the wastewater treated in thousands of cubic meters. Finally, Prieto and Zofio (2001) measured the treated flow, sewerage network shortage, and sewerage network condition.
- Water supply (16 papers)
  Different variables have been used to proxy for water supply. Some studies have used the number of properties or consumers receiving water services.[38] In a similar way, Sung (2007) used the penetration rate of water supply measured as the share of households with water supply over all households.

  Moreover, other studies used the amount of water supplied or produced in megaliters or thousands of cubic meters.[39] In addition, Benito et al. (2010) used the number of new connections to potable water network conduct while Pérez-López et al. (2015) used the water network length. Finally, Prieto and Zofio (2001) measured the treated flow, the water tanks' capacity, the water distribution net shortage, and their quality condition.
- Electricity (3 papers)
  Only three studies measure the provision of electricity by a municipality, measured as the number of consumer units or households receiving electricity.[40]

[34]Ibrahim and Karim (2004), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2010b), Zafra-Gómez and Muñiz-Pérez (2010), Benito et al. (2010), Barone and Mocetti (2011), Boetti et al. (2012), Balaguer-Coll et al. (2013), Pacheco et al. (2014), Da Cruz and Marques (2014), Ashworth et al. (2014), Pérez-López et al. (2015), Agasisti et al. (2015), Cordero et al. (2016).

[35]Sampaio de Sousa and Ramos (1999), Worthington (2000), Moore et al. (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Benito et al. (2010), Mahabir (2014), Monkam (2014).

[36]Worthington (2000), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Pacheco et al. (2014), Monkam (2014), Mahabir (2014).

[37]Marques et al. (2015).

[38]Sampaio de Sousa and Ramos (1999), Worthington (2000), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Moore et al. (2005), Mahabir (2014), Monkam (2014), Radulovic and Dragutinović (2015).

[39]Moore et al., 2005; Benito et al., 2010; Da Cruz and Marques, 2014; Marques et al., 2015; Cordero et al., 2016.

[40]Dollery and van der Westhuizen (2009), Monkam (2014), Mahabir (2014).

5.2.7. Parks, sports, culture, and recreational facilities

In this section, we include indicators related to leisure and recreational facilities that municipalities must provide. We found five indicators.

- Sport facilities (4 papers)
  This service can be measured as the surface of indoor and outdoor sporting facilities,[41] or as the number of users registered in municipal sport activities.[42] Štastná and Gregor (2015) also proxy the expenses related to sport clubs and sporting events. Additionally, Prieto and Zofio (2001) measured the quality of the sport facilities as the indoor sporting facilities condition.
- Cultural facilities (4 papers)
  This variable is used as a proxy for the expenses related to subsidies for theatres, cinemas, municipal museums and galleries, and the costs of monument preservation Štastná and Gregor (2011, 2015). Additionally, Benito et al. (2010) employed the number of visits to municipal museums and Štastná and Gregor (2011, 2015) included the number of monuments and the number of museums and galleries. Finally, Prieto and Zofio (2001) measured the surface of cultural facilities as well as their quality condition.
- Libraries (4 papers)
  Different variables have been used to proxy for the public library services, such as the number of volumes in public libraries and collection turnover,[43] total loans,[44] and the number of library registrations or visits.[45]
- Parks and green areas (16 papers)
  Municipal parks and green areas are mainly measured as the registered surface area of public parks.[46] Similarly, Sung (2007) used the area of urban parks per person, Moore et al. (2005) used the acres of park space in use, Ibrahim and Karim (2004) and Ibrahim and Salleh (2006) used the number of trees planted, and Štastná and Gregor (2011, 2015) used nature reserves and the size of urban green areas to reflect spending on parks' maintenance.
- Recreational facilities (20 papers)
  Some studies included the total surface of public recreational facilities (in hectares) as an indicator of municipalities' surface of parks, sports, leisure, and other recreational facilities.[47] In addition, Da Cruz and Marques (2014) used the variable "infrastructures," which includes cultural (municipal museums, auditoriums, libraries, and cultural and congress centers) and sports

[41] Prieto and Zofio (2001), Benito et al. (2010), Štastná and Gregor (2011, 2015).

[42] Benito et al. (2010).

[43] Moore et al. (2005), Benito et al. (2010)

[44] Loikkanen and Susiluoto (2005), Loikkanen et al. (2011)

[45] Moore et al. (2005)

[46] Prieto and Zofio (2001), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Benito et al. (2010), Balaguer-Coll et al. (2010a), Zafra-Gómez and Muñiz-Pérez (2010), Balaguer-Coll et al. (2010b, 2013), Pacheco et al. (2014), Pérez-López et al. (2015).

[47] De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Coffé and Geys (2005), Geys (2006), Geys and Moesen (2009a), Geys et al. (2010), Bönisch et al. (2011), Kalb et al. (2012), Bischoff et al. (2013), Ashworth et al. (2014), Doumpos and Cohen (2014), Lampe et al. (2015), Asatryan and De Witte (2015).

facilities (municipal pools, sports halls, courts, and race tracks) managed by municipalities, while Balaguer-Coll et al. (2010a, 2010b, 2013) used "public building surface area" to proxy for public libraries and public sports facilities.

5.2.8. *Health (6 papers)*

Few studies measured basic municipal services in health. Pacheco et al. (2014) captured the provision of health services by the number of health centers, while Kutlar and Bakirci (2012) used the number of beds in hospitals. Moreover, Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) measured basic health care and dental care as the number of visits and bed wards, and Moore et al. (2005) reported emergency medical services as the response time in minutes. In addition, the study of Marques et al. (2015) used the number of food handling premises inspected as a variable related to community and health safety activities.

5.2.9. *Education*

The variables included in this category are related to kindergarten provision and primary and secondary education as part of municipal outcomes.

- Kindergartens or nursery places (14 papers)
  The number of students in kindergartens is assumed to proxy for kindergarten places facilitated by the municipality.[48] In addition, Lo Storto (2013) used the number of nursery schools, Radulovic and Dragutinović (2015) used the number of preschool institutions, Asatryan and De Witte (2015) included "child population" measured as the ratio of the number of children at kindergartens to population, and Carosi et al. (2014) and Nikolov and Hrovatin (2013) considered population from 0 to 5 years old proxy the services for kindergarten.
- Primary and secondary education (33 papers)
  The main indicator used for the provision of education services in primary and secondary levels is the number of students enrolled in primary and secondary schools.[49] Similarly, Asatryan and De Witte (2015) used "pupil population" measured as the ratio of the number of students at secondary schools to population, while Sampaio de Sousa and Ramos (1999), Sampaio de Sousa et al. (2005), and Sampaio de Sousa and Stošić (2005) used literate population to proxy for educational services. Moreover, Carosi et al. (2014) considered the school-age population (i.e., from 3 to 13 years old), while Nikolov and Hrovatin (2013) used population ages from 5 to 19 to proxy for primary and secondary schools.
  In addition, other variables have been employed to proxy for educational service provision. Pacheco et al. (2014) used the number of public schools in a municipality. Moreover, Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) included the number of hours of teaching in

[48]Geys et al. (2010), Šťastná and Gregor (2011), Barone and Mocetti (2011), Boetti et al. (2012), Kalb et al. (2012), Geys et al. (2013), Šťastná and Gregor (2015), Lampe et al. (2015).

[49]Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Sampaio de Sousa et al. (2005), Geys (2006), Coffé and Geys (2005), Geys and Moesen (2009a, 2009b), Kalb (2010), Geys et al. (2010), Bönisch et al. (2011), Šťastná and Gregor (2011), Boetti et al. (2012), Kalb et al. (2012), Geys et al. (2013), Bischoff et al. (2013), Ashworth et al. (2014), Pevcin (2014a, 2014b), Pacheco et al. (2014), Šťastná and Gregor (2015), Lampe et al. (2015).

comprehensive and senior secondary schools. Also, Radulovic and Dragutinović (2015) used the number of school institutions. Finally, Sampaio de Sousa et al. (2005) and Sampaio de Sousa and Stošić (2005) chose schooling variables that reflected problems of the Brazilian education system: the enrolment per school, student attendance per school, students who get promoted to the next grade per school, and students in right grade per school.

5.2.10. Social services

We include as social services the indicators related to subsidence grants, care for elderly, care for children, and social organizations.

- Beneficiaries of minimal subsistence grants (12 papers)
  The number of minimal subsistence grants are related to services provided to low-income families.[50] They proxy for the extent of social welfare.
- Care for elderly (21 papers)
  Care for elderly reflects the supply of social services to the elderly, such as retirement or geriatric homes, general assistance for the elder, and medical assistance in public hospitals. The main indicators to proxy for provisions for the elderly are the number of senior citizens or the share of populations older than 65 years.[51] In addition, the studies of Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) used the days of institutional care of the elderly, while Asatryan and De Witte (2015) used the elderly patient population as a proxy for the capacity in public care centers.
- Care for children (4 papers)
  Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) measured care for children as the days in children's day centers and family day care. Otherwise, Bönisch et al. (2011) and Bischoff et al. (2013) used the number of approved places in childcare centers.
- Social services and organizations (12 papers)
  Social services are considered essential for social welfare. They include areas such as care services, education, and economic subsistence. To measure the amount of social services in a municipality, Pacheco et al. (2014) included the variable social organizations, which registers all social organizations by municipality. Moreover, Balaguer-Coll et al. (2010a, 2010b, 2013) measured the provision of social services as the surface area of assistance centers. Sung (2007) included the seating capacity of social welfare institutions per 100 persons. Also, Cuadrado-Ballesteros et al. (2013) used unemployed population as a proxy for social services, while Carosi et al. (2014) included the immigrant population to proxy the need of these people. In addition, Radulovic and Dragutinović (2015) used the share of social protection users in total resident population (Radulovic and Dragutinović, 2015). Otherwise, Štastná and Gregor (2011, 2015) included the

[50] Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Geys (2006), Coffé and Geys (2005), Geys and Moesen (2009a, 2009b), Ashworth et al. (2014).

[51] Eeckaut et al. (1993), De Borger and Kerstens (1996a, 1996b), Coffé and Geys (2005), Kalb (2010), Geys et al. (2010), Štastná and Gregor (2011), Boetti et al. (2012), Kalb et al. (2012), Kutlar and Bakirci (2012), Nikolov and Hrovatin (2013), Geys et al. (2013), Pevcin (2014a, 2014b), Carosi et al. (2014), Ashworth et al. (2014), Lampe et al. (2015), Štastná and Gregor (2015), Arcelus et al. (2015).

number of homes for disabled, while Loikkanen and Susiluoto (2005) and Loikkanen et al. (2011) measured the institutional care of the handicapped as the number of days in social centers.

5.2.11. Public safety (9 papers)

Public safety involves municipal police and fire services. Police services pursue the prevention of crimes, patrolling the geographical area of the municipality, while fire service has the objective to reduce the probability of fires and limit losses when fires occur. Different variables have been used to proxy for public safety services. Štastná and Gregor (2011, 2015) used a dummy for municipal police, while Hayes and Chang (1990) used the expenditures on police and fire protection.

Moreover, Eeckaut et al. (1993) used the number of crimes registered in the municipality, and Moore et al. (2005) employed a crime index to proxy for police services. Similarly, Benito et al. (2010) included the number of interventions and detentions made. In addition, Barone and Mocetti (2011) and Agasisti et al. (2015) used kilometers covered by local police, and Cuadrado-Ballesteros et al. (2013) used the number of police vehicles in circulation. Otherwise, Moore et al. (2005) used the number of civilian fire deaths and total losses as fire-protection proxies, while Cuadrado-Ballesteros et al. (2013) included population density representing the probability of fire spreading.

5.2.12. Market (5 papers)

Some studies have measured the market surface area to proxy for the provision of local markets.[52] Similarly, Ibrahim and Karim (2004) and Ibrahim and Salleh (2006) used the number of business lots and stall spaces.

5.2.13. Public transport (2 papers)

Only two studies have used direct outputs for measuring public transportation, proxied as the number of bus stations in a municipality.[53]

5.2.14. Environmental protection (5 papers)

This variable includes services related to environmental protection and regulations in matter of health, air, soil and water protection, and nature preservation. Different variables have been used to proxy for environmental services. Lo Storto (2013) measured the urban ecosystem quality. Moreover, Cuadrado-Ballesteros et al. (2013) used the number of economic activities as a proxy for health services related to environmental protection and business regulations in matters of health and consumer protection. Also, Athanassopoulos and Triantis (1998) included the heavy industrial area since it reflects the need to provide pollution measurement due to the heavy industrial activities. Finally, Štastná and Gregor (2011) used the variable "pollution area" that includes environmentally harming areas such as built-up area and arable land, while Liu et al. (2011) employed "air pollution" as an undesirable output measured by the emissions of ozone and sulfur dioxide per year.

[52]Balaguer-Coll et al. (2010a, 2010b, 2013).

[53]Štastná and Gregor (2011, 2015).

5.2.15. Business development (12 papers)

Business development accounts for the government's role in the need to offer infrastructure to companies. As a proxy for infrastructure and business development services, some studies have included the number of employees paying social security contributions in a municipality based on the idea that such services are associated with employment, that is, the number of jobs in a municipality are correlated with the need to provide production related to infrastructure and services.[54] Otherwise, the study of Liu et al. (2011) included the unemployment rate as an undesirable output.

In addition, Athanassopoulos and Triantis (1998) included the average industrial size area to reflect the spatial concentration of industrial activities in local government, while Arcelus et al. (2015) used the percentage of inhabitants employed in manufacturing because the more industrialized a town is, the more and costlier services will be.

5.2.16. Quality index (5 papers)

Some studies have included a quality indicator designed to measure not only the quantity but also the quality of the services provided, measured as a weighted average quality and the number of physical units of each service and infrastructures.[55] In addition, Balaguer-Coll and Prior (2009) also included the number of votes as a variable to proxy the level of citizen satisfaction, and Haneda et al. (2012) used the number of employees per 10,000 residents, since the familiarity between local government and the residents implies that the local administration can give careful instructions to residents.

5.2.17. Others (6 papers)

Finally, we include other outputs that are not classified in previous subcategories. Athanassopoulos and Triantis (1998) included the average house area as an indication of wealth, suggesting that wealthier population would pressure municipalities to provide more services related to recreation, the development and maintenance of local parks, repairs and maintenance, and street lighting and cleaning. Moreover, Grossman et al. (1999) used the aggregate market value of residential and business property as an indicator of municipal services. They argue that if a city generates the highest attainable market value of aggregate property within its boundaries given the local fiscal choices that it has made, then it is producing local government in a technically efficient manner. In addition, Pérez-López et al. (2015) included the municipal cemetery area to proxy for cemetery service provision.

Otherwise, two studies included variables related to local revenue to proxy for local service delivery. El Mehdi and Hafner (2014) used the financial autonomy, defined as ratio of the own receipts of the municipality and its operating expenses, while Nijkamp and Suzuki (2009) used local revenues by local governments. Finally, Doumpos and Cohen (2014) employed the cost of services as a proxy for the value of resources used to provide citizens with all sorts of municipality services,

[54]Geys et al. (2010), Kalb (2010), Bönisch et al. (2011), Kalb et al. (2012), Bischoff et al. (2013), Geys et al. (2013), Pevcin (2014a, 2014b), Asatryan and De Witte (2015), Lampe et al. (2015).

[55]Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010b), Zafra-Gómez and Muñiz-Pérez (2010).

assuming that the higher the net book value of assets as well as the value of goods and services rendered, the higher the quality and the range of options offered to citizens.

6. Conclusion

In this paper, we have presented a systematic review of the existing literature on local government efficiency from a global point of view. We identified 84 empirical studies on the subject, the most complete source of references on local government efficiency analysis up to now. We summarized the input and output variables used in previous literature, as well as the methodologies applied. As the efficiency results depend heavily on the variable selection and methods used, this paper provides a good basis for researchers in the field of local governments' efficiency.

The literature review leads us to five main considerations or conclusions. First, we found differences in the popularity of local governments' efficiency analysis across countries. The best-studied countries are in Europe, Spain being the most analyzed country (13 papers), followed by Belgium (9 papers) and Germany (8 papers). Some studies have also attempted to analyze the relationship between local government efficiency and other important topics, which converts it into a multidisciplinary subject. The most important related area is economics, followed by management, public administration, urban studies, and political science.

Second, most previous studies have analyzed cross-sectional data. A minority of papers have an underlying panel structure in the data but do not exploit this intertemporal variation as they use cross-sectional efficiency techniques. Time period analysis provides interesting managerial and policy-making insights into the efficiency effect of long-term decision. More research is needed in dynamic efficiency analysis in order to investigate the evolution of local government efficiency over time.

Third, there is a wide variety of input and output variables to measure local government efficiency. The accurate definition of local governments' inputs and outputs is a complex task, which is due to the difficulty to collect data and measure local services. The selection of variables depends on the availability of data and the specific services and facilities that local government must provide in each country. Moreover, the number of output variables included in previous literature varies drastically. Some studies aggregate various municipal services in a global index, while others evaluate a set of specific local services.

Based on the literature review, we see various avenues for further research. First, given the earlier discussed issues to define the bundle of services and facilities that municipalities must provide, it would be interesting to consider alternative input–output models, in order to assess whether the different choices might explain the heterogeneity among local governments, and to determine how the number of outputs can affect the efficiency scores. Second, some measures are too generic or unspecific. It would be necessary to develop better proxy variables for local government services and facilities as well as indicators that measure the quality of local services. The latter are interesting and informative for local governments, since performance decisions may have an impact on their quality and not on their quantity.

As a third stream for further research, the earlier literature interprets its results in a causal way, neglecting the endogeneity issues in the data (e.g., arising from selection bias, unobserved heterogeneity, or reversed causality). The issue of endogenous data in local government efficiency literature

has received little attention. More research, using insights from quasi-experimental methodologies, is needed.

Finally, the large majority of the previous studies have focused only on one approach, in most cases DEA, FDH, or SFA. We must take care when interpreting results from research studies using one particular methodology because the results of the efficiency analysis are affected by the approach taken. In general, it is necessary to apply more-advanced techniques to measure efficiency.

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Appendix

Table A1
Studies on efficiency in local governments in several countries

Country	Author(s)	Sample	Period studied	Main results
Australia	Worthington and Dollery (2000b)	177 New South Wales local governments	1993	Mean efficiency differs from 0.69 to 0.86.
	Fogarty and Mugera (2013)	98 Western Australian local councils	2009 and 2010	Mean efficiency differs from 0.40 to 0.72.
	Marques et al. (2015)	29 Tasmanian local councils	From 1999 to 2008	Mean efficiency differs from 0.70 to 0.80.
Belgium	Eeckaut et al. (1993)	235 Walloon municipalities	1985	—
	De Borger et al. (1994)	589 municipalities in Belgium	1985	Mean efficiency differs from 0.86 to 0.99. They applied different input specifications.
	De Borger and Kerstens (1996a)	589 municipalities in Belgium	1985	Mean efficiency differs from 0.57 to 0.93.
	De Borger and Kerstens (1996b)	589 municipalities in Belgium	1985	Mean efficiency differs from 0.81 to 0.97 depending on the specification used.
	Coffé and Geys (2005)	305 Flemish municipalities	2000	Mean efficiency is 0.70. They study the relationship between social capital and institutional performance in Flemish municipalities.
	Geys (2006)	304 Flemish municipalities	2000	Mean efficiency is 0.84. They analyze the existence of spatial interdependence in local government policies.
	Geys and Moesen (2009b)	304 Flemish municipalities	2000	Mean efficiency differs from 0.49 to 0.95.
	Geys and Moesen (2009a)	300 Flemish municipalities	2000	Mean efficiency is 0.86.
	Ashworth et al. (2014)	308 Flemish municipalities	2000	Mean efficiency is 0.58. They analyze whether different aspects of the extent of competition in the political arena within the municipality affect local government performance.
Brazil	Sampaio de Sousa and Ramos (1999)	3,756 Brazilian municipalities	1991	—
	Sampaio de Sousa and Stošić (2005)	4,796 Brazilian municipalities	1991	Mean efficiency differs from 0.52 to 0.92. Smaller cities in Brazil tend to be less efficient than the larger ones.

Continued

Table A1
Continued

Country	Author(s)	Sample	Period studied	Main results
	Sampaio de Sousa et al. (2005)	4,796 Brazilian municipalities	2000	Mean efficiency is 0.52. Smaller cities in Brazil tend to be less efficient than the larger ones.
Chile	Pacheco et al. (2014)	309 Chilean municipalities	From 2008 to 2010	Mean efficiency is 0.70.
Czech Republic	Štastná and Gregor (2011)	202 local governments in Czech Republic	From 2003 to 2008	Mean efficiency differs from 0.30 to 0.79.
	Štastná and Gregor (2015)	202 local governments in Czech Republic	From 1995 to 1998 and 2003 to 2008	Comparison of public sector efficiency in and beyond transition. Mean efficiency scores increase from 0.62 in 1995-1998 to 0.69 in 2005-2008.
Finland	Loikkanen and Susiluoto (2005)	353 Finnish municipalities	From 1994 to 2002	Mean efficiency differs from 0.85 to 0.89. They applied different output specifications.
	Loikkanen et al. (2011)	353 Finnish municipalities	From 1994 to 1996	Mean efficiency differs from 0.75 in 1994 to 0.82 in 1996. They examined whether Finnish city managers' characteristics and work environment, in addition to external factors, explain differences in cost efficiency.
Germany	Geys et al. (2010)	987 German municipalities	1998, 2002, and 2004	They analyze whether voter involvement in the political sphere is related local government performance.
	Kalb (2010)	1,111 German municipalities	From 1990 to 2004	They analyze the impact of intergovernmental grants on local cost efficiency.
	Bönisch et al. (2011)	46 independent municipalities and 157 administrative collectivities in Saxony-Anhalt	2004	On average cost should be reduced by 7% to 18%. They study the relevance of population size in local governments' efficiency.
	Kalb et al. (2012)	1,015 German municipalities	2004	Local governments should reduce inputs by 17% to 20%.
	Bischoff et al. (2013)	46 independent municipalities and 157 municipal associations in Saxony-Anhalt	2004	On average, cost should be reduced by 18%. They study the impact of intergovernmental and vertical grants on cost efficiency.
	Geys et al. (2013)	1,021 German municipalities	2001	On average cost should be reduced by 12% to 14%. They study the relevance of population size in local governments' efficiency.

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Table A1
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Country	Author(s)	Sample	Period studied	Main results
	Asatryan and De Witte (2015)	2,000 Bavarian municipalities	2011	On average cost should be reduced by 1% to 3%. They study the role of direct democracy in explaining efficiency.
	Lampe et al. (2015)	396 German municipalities	From 2006 to 2008	They analyze the effect of new accounting and budgeting regimes on local government efficiency.
Greece	Athanassopoulos and Triantis (1998)	172 Greek municipalities	1986	Mean efficiency differs from 0.50 to 0.85.
	Doumpos and Cohen (2014)	2,017 Greek municipalities	From 2002 to 2009	Mean efficiency differs from 0.65 to 0.75.
Indonesia	Yusfany (2015)	491 municipalities in Indonesia	2010	Mean efficiency is 0.50.
Italy	Barone and Mocetti (2011)	1,115 Italian municipalities	From 2001 to 2004	On average, cost should be reduced by 81%. They analyze links between public spending inefficiency and tax morale.
	Boetti et al. (2012)	262 Italian municipalities from Turin province	2005	Mean efficiency differs from 0.74 to 0.80. They assessed whether efficiency of local governments is affected by the degree of vertical fiscal imbalance.
	Lo Storto (2013)	103 Italian municipalities	2011	Mean efficiency differs from 0.85 to 0.88.
	Carosi et al. (2014)	285 Tuscan municipalities	2011	Mean efficiency is 0.43.
	Agasisti et al. (2015)	331 Italian municipalities	From 2010 to 2012	Mean efficiency differs from 0.66 to 0.67.
	Lo Storto (2016)	108 Italian municipalities	2013	Mean efficiency differs from 0.69 to 0.82.
Japan	Nijkamp and Suzuki (2009)	34 cities in Hokkaido prefecture in Japan	2005	Mean efficiency differs from 0.75 to 0.82.
	Haneda et al. (2012)	92 municipalities from Ibaraki prefecture	From 1979 to 2004	Mean efficiency differs from 0.80 to 0.89.
	Nakazawa (2013)	479 Japanese municipalities	2005	On average cost should be reduced by 10% to 14%. They examine the cost inefficiency of municipalities after amalgamation (municipalities that were amalgamated from 2000 to 2005).
	Nakazawa (2014)	479 Japanese municipalities	2005	On average, cost should be reduced by 15% to 16%. They examine the effect of differences in facility distribution methods on municipal cost inefficiency after amalgamation.

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Table A1
Continued

Country	Author(s)	Sample	Period studied	Main results
Korea	Seol et al. (2008)	106 Korean local governments	2003	Mean efficiency is 0.77. They examine the impact of information technology on organizational efficiency in public services.
	Sung (2007)	222 Korean local governments	From 1999 to 2001	Mean efficiency differs from 0.57 to 0.97. They examine the impact of information technology on local government performance.
Macedonia	Nikolov and Hrovatin (2013)	74 municipalities in Macedonia	—	Mean efficiency is 0.59. They take into account the ethnic fragmentation of municipalities as a determinant of efficiency.
Malaysia	Ibrahim and Karim (2004)	46 local governments in Malaysia	2000	Mean efficiency is 0.76.
	Ibrahim and Salleh (2006)	46 local governments in Malaysia	2000	Mean efficiency is 0.59.
Morocco	El Mehdi and Hafner (2014)	91 rural districts in the oriental region of Morocco	1998/1999	Mean efficiency differs from 0.38 to 0.50.
Norway	Kalseth and Rattsø (1995)	407 Norwegian local authorities	1988	Mean efficiency differs from 0.74 to 0.84.
	Revelli and Tovmo (2007)	205 local governments in the 12 southern counties of Norway	—	Mean efficiency is 100. They investigate whether the production efficiency of Norwegian local governments exhibits a spatial pattern that is compatible with the hypothesis of yardstick competition.
	Borge et al. (2008)	362–384 Norwegian municipalities	From 2001 to 2005	Median values differ from 100.9 to 104.8. They investigate whether efficiency is affected by political and budgetary institutions, fiscal capacity, and democratic participation.
	Bruns and Himmler (2011)	362–384 Norwegian municipalities	From 2001 to 2005	Mean efficiency efficiency is 103.73. They examine the role of the newspaper market for the efficient use of public funds by elected politicians.
	Sørensen (2014)	430 Norwegian local authorities	From 2001 to 2010	Mean efficiency is 100. They study whether political competition and party polarization affect government performance.

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Table A1
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Country	Author(s)	Sample	Period studied	Main results
	Helland and Sørensen (2015)	430 Norwegian local authorities	From 2001 to 2010	Mean efficiency is 1.04. They study whether partisan bias and electoral volatility affect government performance.
Portugal	Afonso and Fernandes (2003)	51 Portuguese municipalities Region of Lisboa e Vale do Tejo	2001	Mean efficiency differs from 0.41 to 0.61.
	Afonso and Fernandes (2006)	51 Portuguese municipalities Region of Lisboa e Vale do Tejo	2001	Mean efficiency differs from 0.32 to 0.73.
	Afonso and Fernandes (2008)	278 Portuguese municipalities	2001	Mean efficiency differs from 0.22 to 0.68.
	Da Cruz and Marques (2014)	308 Portuguese municipalities	2009	Mean efficiency differs from 0.73 to 0.84.
	Cordero et al. (2016)	278 Portuguese mainland municipalities	From 2009 to 2014	Mean efficiency differs from 0.67 to 0.76.
Serbia	Radulovic and Dragutinović (2015)	143 Serbian local governments	2012	On average, cost should be reduced by 15% to 33%.
Slovenia	Pevcin (2014a)	200 Slovenian municipalities	2011	Mean efficiency differs from 0.75 to 0.78.
	Pevcin (2014b)	200 Slovenian municipalities	2011	Mean efficiency differs from 0.75 to 0.88.
Spain	Prieto and Zofio (2001)	209 municipalities in Castile and Leon Region	1994	—
	Balaguer-Coll et al. (2007)	414 municipalities Valencian Region	1995	Mean efficiency differs from 0.53 to 0.90.
	Giménez and Prior (2007)	258 municipalities in Catalonia Region	1996	The mean cost excess of inefficient municipalities is 25%. They decompose the total cost efficiency into short and long term.
	Balaguer-Coll and Prior (2009)	258 municipalities Valencian Region	From 1992 to 1995	Mean efficiency differs from 0.69 to 0.75. They tested the temporal evolution of efficiency and applied different output specifications.

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Table A1
Continued

Country	Author(s)	Sample	Period studied	Main results
	Balaguer-Coll et al. (2010a)	1,221 Spanish municipalities	1995 and 2000	Mean efficiency differs from 0.85 to 0.91. They analyze links between overall cost efficiency and the decentralization power in Spain.
	Bosch-Roca et al. (2012)	102 Catalonian municipalities	2005	Mean efficiency is 0.71. They connect efficiency with citizen's control in a decentralized context.
	Balaguer-Coll et al. (2010b)	1,164 Spanish municipalities	1995, 2000 and 2005	Mean efficiency differs from 0.96 in 1995–2000 to 0.89 in 2000–2005. They analyzed the links between devolution and efficiency of Spanish municipalities from a dynamic perspective.
	Benito et al. (2010)	31 municipalities in Murcia Region	2002	Mean efficiency differs from 0.53 to 0.90.
	Zafra-Gómez and Muñiz-Pérez (2010)	923 Spanish municipalities	2005 and 2010	Mean efficiency is 0.71 in 2000 and 0.69 in 2005. They evaluate the cost efficiency with the financial condition.
	Balaguer-Coll et al. (2013)	1,198 Spanish municipalities	2000	Mean efficiency is 0.91. They analyze efficiency after splinting municipalities into clusters according to various criteria (output mix, environmental conditions, level of powers).
	Cuadrado-Ballesteros et al. (2013)	129 Spanish municipalities	From 1999 to 2007	Mean efficiency differs from 0.92 to 0.97. They analyze the effect of functional decentralization and externalization processes on the efficiency of Spanish municipalities.
	Arcelus et al. (2015)	260 municipalities from Navarre Region	2005	Mean cost-inefficiency is 1.264.
	Pérez-López et al. (2015)	1,058 Spanish municipalities	From 2001 to 2010	Mean efficiency is 0.85. They analyzed the long- term effects of the new delivery forms over efficiency.
South Africa	Dollery and van der Westhuizen (2009)	231 local municipalities and 46 district municipalities in South Africa	2006/2007	Mean efficiency differs from 0.30 to 0.64.
	Mahabir (2014)	129 municipalities in South Africa	From 2005 to 2010	Mean efficiency differs from 0.42 to 0.46.
	Monkam (2014)	231 local municipalities in South Africa	2007	Mean efficiency is 0.17.

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Table A1
Continued

Country	Author(s)	Sample	Period studied	Main results
Taiwan	Liu et al. (2011)	22 Local Governments in Taiwan	2007	Mean efficiency differs from 0.38 to 0.82.
Turkey	Kutlar and Bakirci (2012)	27 municipalities in Turkey	From 2006 to 2008	Mean efficiency differs from 0.53 to 0.86.
United Kingdom	Revelli (2010)	148 local authorities in England	From 2002 to 2007	—
	Andrews and Entwistle (2015)	386 local authorities in England	2007	Mean efficiency is 1.05. They examine the relationship among a commitment to public–private partnership, management capacity, and the productive efficiency of English local authorities.
United States	Hayes and Chang (1990)	191 U.S. municipalities	1982	Mean efficiency is 0.81. They study whether or not the Council Management form is more efficient than the Mayor Council form of government in formulating and implementing public policies.
	Grossman et al. (1999)	49 U.S. central cities	1967, 1973, 1977, and 1982	Mean efficiency differs from 0.81 to 0.84. They measure technical inefficiency in the local public sector based upon a comparison of local property values.
	Moore et al. (2005)	46 largest cities in the United States	From 1993 to 1996	—

Table A2
Approaches to measure efficiency in local governments

A. Nonparametric approaches and semiparametric approaches
1. DEA
Eeckaut et al. (1993), Kalseth and Rattsø (1995), De Borger and Kerstens (1996a), Athanassopoulos and Triantis (1998), Sampaio de Sousa and Ramos (1999), Worthington (2000), Prieto and Zofio (2001), Ibrahim and Karim (2004), Coffé and Geys (2005), Moore et al. (2005), Loikkanen and Susiluoto (2005), Afonso and Fernandes (2006), Balaguer-Coll et al. (2007), Afonso and Fernandes (2008), Geys and Moesen (2009b), Seol et al. (2008), Nijkamp and Suzuki (2009), Dollery and van der Westhuizen (2009), Balaguer-Coll and Prior (2009), Bosch-Roca et al. (2012), Benito et al. (2010), Zafra-Gómez and Muñiz-Pérez (2010), Štastná and Gregor (2011), Loikkanen et al. (2011), Bönisch et al. (2011), Boetti et al. (2012), Nikolov and Hrovatin (2013), Lo Storto (2013), Fogarty and Mugera (2013), Monkam (2014), Ashworth et al. (2014), Pevcin (2014b), Carosi et al. (2014), El Mehdi and Hafner (2014), Marques et al. (2015), Yusfany (2015), Lo Storto (2016)
1.2. Malmquist index with DEA
Doumpos and Cohen (2014), Haneda et al. (2012), Sung (2007), Kutlar and Bakirci (2012)
1.3. DEA super-efficiency
Da Cruz and Marques (2014), Liu et al. (2011)
2. Free Disposal Hull (FDH)
Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Sampaio de Sousa and Ramos (1999), Afonso and Fernandes (2003), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Geys and Moesen (2009b), Balaguer-Coll et al. (2010a), El Mehdi and Hafner (2014), Mahabir (2014)
2.2. Malmquist index with FDH
Balaguer-Coll et al. (2010b)
3. DEA or FDH bias-corrected
Bönisch et al. (2011), Fogarty and Mugera (2013), Bischoff et al. (2013), El Mehdi and Hafner (2014)
3.2. Malmquist index with DEA bias-corrected
Cuadrado-Ballesteros et al. (2013), Agasisti et al. (2015)
4. DEA or FDH with "Jackstrap"
Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005)
5. Order-m
Balaguer-Coll et al. (2013), Pérez-López et al. (2015)
6. Conditional efficiency
Asatryan and De Witte (2015), Cordero et al. (2016)
B. Parametric approaches
1. SFA
De Borger and Kerstens (1996a), Athanassopoulos and Triantis (1998), Grossman et al. (1999), Worthington (2000), Geys (2006), Ibrahim and Salleh (2006), Geys and Moesen (2009a, 2009b), Geys et al. (2010), Kalb (2010), Barone and Mocetti (2011), Kalb et al. (2012), Boetti et al. (2012), Geys et al. (2013), Nakazawa (2013), Nikolov and Hrovatin (2013), Nakazawa (2014), Pacheco et al. (2014), Pevcin (2014a, 2014b), Arcelus et al. (2015), Lampe et al. (2015), Radulovic and Dragutinović (2015)
1.2. SFA time variant
Štastná and Gregor (2011, 2015)
2. COLS, OLS, fixed effects regressions
Hayes and Chang (1990), Kalseth and Rattsø (1995), De Borger and Kerstens (1996a), Revelli (2010), Sørensen (2014), Helland and Sørensen (2015)
C. Ratios
Revelli and Tovmo (2007), Borge et al. (2008), Revelli (2010), Bruns and Himmler (2011), Andrews and Entwistle (2015)

Table A3
Overview of inputs

Variables	Studies
1. Financial expenditures	
Total expenditures	Kalseth and Rattsø (1995), De Borger and Kerstens (1996a, 1996b), Prieto and Zofio (2001), Afonso and Fernandes (2003), Coffé and Geys (2005), Afonso and Fernandes (2006), Sung (2007), Afonso and Fernandes (2008), Seol et al. (2008), Nijkamp and Suzuki (2009), Balaguer-Coll et al. (2010b), Kutlar and Bakirci (2012), Nakazawa (2013, 2014), Ashworth et al. (2014), Pevcin (2014a, 2014b), Mahabir (2014), Yusfany (2015), Andrews and Entwistle (2015), Asatryan and De Witte (2015), Lampe et al. (2015), Cordero et al. (2016)
Current expenditures	Hayes and Chang (1990), Eeckaut et al. (1993), Athanassopoulos and Triantis (1998), Sampaio de Sousa and Ramos (1999), Ibrahim and Karim (2004), Loikkanen and Susiluoto (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Moore et al. (2005), Geys (2006), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Geys and Moesen (2009a, 2009b), Balaguer-Coll and Prior (2009), Geys et al. (2010), Kalb (2010), Balaguer-Coll et al. (2010a), Zafra-Gómez and Muñiz-Pérez (2010), Bosch-Roca et al. (2012), Benito et al. (2010), Revelli (2010), Štastná and Gregor (2011), Barone and Mocetti (2011), Loikkanen et al. (2011), Kutlar and Bakirci (2012), Kalb et al. (2012), Boetti et al. (2012), Lo Storto (2013), Geys et al. (2013), Nikolov and Hrovatin (2013), Balaguer-Coll et al. (2013), Cuadrado-Ballesteros et al. (2013), Pacheco et al. (2014), Carosi et al. (2014), Monkam (2014), Pacheco et al. (2014), Marques et al. (2015), Štastná and Gregor (2015), Radulovic and Dragutinović (2015), Arcelus et al. (2015), Pérez-López et al. (2015), Nakazawa (2014), Lampe et al. (2015), Agasisti et al. (2015), Lo Storto (2016)
Personnel expenditures	Hayes and Chang (1990), De Borger et al. (1994), Worthington (2000), Moore et al. (2005), Sampaio de Sousa and Stošić (2005), Sampaio de Sousa et al. (2005), Sung (2007), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Seol et al. (2008), Nijkamp and Suzuki (2009), Balaguer-Coll and Prior (2009), Dollery and van der Westhuizen (2009), Benito et al. (2010), Balaguer-Coll et al. (2010a), Zafra-Gómez and Muñiz-Pérez (2010), Bönisch et al. (2011), Liu et al. (2011), Kutlar and Bakirci (2012), Haneda et al. (2012), Fogarty and Mugera (2013), Bischoff et al. (2013), Nakazawa (2013), Balaguer-Coll et al. (2013), Da Cruz and Marques (2014), Cordero et al. (2016)
Capital and financial expenditures	Hayes and Chang (1990), De Borger et al. (1994), Worthington (2000), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Nijkamp and Suzuki (2009), Balaguer-Coll et al. (2010a), Bosch-Roca et al. (2012), Zafra-Gómez and Muñiz-Pérez (2010), Bönisch et al. (2011), Liu et al. (2011), Kutlar and Bakirci (2012), Balaguer-Coll et al. (2013), Fogarty and Mugera (2013), Bischoff et al. (2013), Cuadrado-Ballesteros et al. (2013), Da Cruz and Marques (2014)
Other financial expenditures	Worthington (2000), Giménez and Prior (2007), Bönisch et al. (2011), Bischoff et al. (2013), Fogarty and Mugera (2013), Da Cruz and Marques (2014)
2. Financial resources	
Local revenues	Revelli and Tovmo (2007), Borge et al. (2008), Bruns and Himmler (2011), Sørensen (2014), Doumpos and Cohen (2014), El Mehdi and Hafner (2014), Helland and Sørensen (2015)
Current transfers	Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2013), Benito et al. (2010), Kutlar and Bakirci (2012), Zafra-Gómez and Muñiz-Pérez (2010)
3. Nonfinancial inputs	
Public health services	Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005)
Area	Haneda et al. (2012)

Table A4
Overview of outputs

Variables	Studies
1. Total output indicator	
	Afonso and Fernandes (2003, 2006), Revelli and Tovmo (2007), Afonso and Fernandes (2008), Borge et al. (2008), Bosch-Roca et al. (2012), Revelli (2010), Bruns and Himmler (2011), Nakazawa (2013), Nijkamp and Suzuki (2009), Sørensen (2014), Nakazawa (2014), Yusfany (2015), Andrews and Entwistle (2015), Helland and Sørensen (2015)
2. Population	
	Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Athanassopoulos and Triantis (1998), Sampaio de Sousa and Ramos (1999), Worthington (2000), Ibrahim and Karim (2004), Coffé and Geys (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Balaguer-Coll and Prior (2009), Geys et al. (2010), Kalb (2010), Zafra-Gómez and Muñiz-Pérez (2010), Balaguer-Coll et al. (2010a, 2010b), Bönisch et al. (2011), Šťastná and Gregor (2011), Haneda et al. (2012), Kalb et al. (2012), Kutlar and Bakirci (2012), Boetti et al. (2012), Fogarty and Mugera (2013), Cuadrado-Ballesteros et al. (2013), Nikolov and Hrovatin (2013), Bischoff et al. (2013), Geys et al. (2013), Nikolov and Hrovatin (2013), Balaguer-Coll et al. (2013), Lo Storto (2013), Pevcin (2014a, 2014b), Pacheco et al. (2014), Carosi et al. (2014), Monkam (2014), Da Cruz and Marques (2014), Lampe et al. (2015), Radulovic and Dragutinović (2015), Agasisti et al. (2015), Pérez-López et al. (2015), Cordero et al. (2016), Lo Storto (2016)
3. Area of municipality and built area	
	Athanassopoulos and Triantis (1998), Giménez and Prior (2007), Šťastná and Gregor (2011), Lo Storto (2013), Cuadrado-Ballesteros et al. (2013), Fogarty and Mugera (2013), Šťastná and Gregor (2015), Arcelus et al. (2015), Pérez-López et al. (2015), Lo Storto (2016)
4. Administrative services	
	Kalseth and Rattsø (1995), Moore et al. (2005), Sung (2007), Seol et al. (2008), Barone and Mocetti (2011), Cuadrado-Ballesteros et al. (2013), Arcelus et al. (2015), Marques et al. (2015), Cordero et al. (2016)
5. Infrastructures	
Street lighting	Prieto and Zofio (2001), Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2010b), Zafra-Gómez and Muñiz-Pérez (2010), Barone and Mocetti (2011), Balaguer-Coll et al. (2013), Doumpos and Cohen (2014), Arcelus et al. (2015), Pérez-López et al. (2015)
Municipal roads	Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996b), Worthington (2000), Prieto and Zofio (2001), Ibrahim and Karim (2004), Moore et al. (2005), Ibrahim and Salleh (2006), Geys (2006), Balaguer-Coll et al. (2007), Sung (2007), Giménez and Prior (2007), Geys and Moesen (2009a, 2009b), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2010b), Zafra-Gómez and Muñiz-Pérez (2010), Barone and Mocetti (2011), Šťastná and Gregor (2011), Boetti et al. (2012), Lo Storto (2013), Fogarty and Mugera (2013), Nikolov and Hrovatin (2013), Balaguer-Coll et al. (2013), Doumpos and Cohen (2014), Carosi et al. (2014), Da Cruz and Marques (2014), Ashworth et al. (2014), Šťastná and Gregor (2015), Marques et al. (2015), Agasisti et al. (2015), Radulovic and Dragutinović (2015), Arcelus et al. (2015)

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Table A4
Continued

Variables	Studies
6. Communal services	
Waste collection	Hayes and Chang (1990), Sampaio de Sousa and Ramos (1999), Worthington (2000), Ibrahim and Karim (2004), Moore et al. (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Giménez and Prior (2007), Geys and Moesen (2009a, 2009b), Balaguer-Coll and Prior (2009), Benito et al. (2010), Balaguer-Coll et al. (2010a, 2010b), Zafra-Gómez and Muñiz-Pérez (2010), Benito et al. (2010), Šťastná and Gregor (2011), Barone and Mocetti (2011), Boetti et al. (2012), Balaguer-Coll et al. (2013), Pacheco et al. (2014), Mahabir (2014), Monkam (2014), Da Cruz and Marques (2014), Ashworth et al. (2014), Pérez-López et al. (2015), Šťastná and Gregor (2015), Agasisti et al. (2015), Cordero et al. (2016).
Sewerage system	Worthington (2000), Prieto and Zofio (2001), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Sung (2007), Liu et al. (2011), Pacheco et al. (2014), Monkam (2014), Mahabir (2014), Da Cruz and Marques (2014), Marques et al. (2015)
Water supply	Sampaio de Sousa and Ramos (1999), Worthington (2000), Prieto and Zofio (2001), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Moore et al. (2005), Sung (2007), Benito et al. (2010), Mahabir (2014), Monkam (2014), Da Cruz and Marques (2014), Marques et al. (2015), Pérez-López et al. (2015), Arcelus et al. (2015), Radulovic and Dragutinović (2015), Cordero et al. (2016)
Electricity	Dollery and van der Westhuizen (2009), Monkam (2014), Mahabir (2014)
7. Parks, sports, culture, and recreational facilities	
Sport facilities	Prieto and Zofio (2001), Benito et al. (2010), Šťastná and Gregor (2011, 2015)
Cultural facilities	Prieto and Zofio (2001), Benito et al. (2010), Šťastná and Gregor (2011, 2015)
Libraries	Benito et al. (2010), Loikkanen and Susiluoto (2005), Moore et al. (2005), Loikkanen et al. (2011)
Parks and green areas	Prieto and Zofio (2001), Ibrahim and Karim (2004), Moore et al. (2005), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2007), Sung (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010a, 2010b), Benito et al. (2010), Zafra-Gómez and Muñiz-Pérez (2010), Šťastná and Gregor (2011), Balaguer-Coll et al. (2013), Pacheco et al. (2014), Šťastná and Gregor (2015), Pérez-López et al. (2015)
Recreational facilities	De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Coffé and Geys (2005), Geys (2006), Geys and Moesen (2009a, 2009b), Geys et al. (2010), Balaguer-Coll et al. (2010a, 2010b), Bönisch et al. (2011), Kalb et al. (2012), Geys et al. (2013), Balaguer-Coll et al. (2013), Bischoff et al. (2013), Doumpos and Cohen (2014), Ashworth et al. (2014), Da Cruz and Marques (2014), Lampe et al. (2015), Asatryan and De Witte (2015)
8. Health	
	Loikkanen and Susiluoto (2005), Moore et al. (2005), Loikkanen et al. (2011), Kutlar and Bakirci (2012), Pacheco et al. (2014), Marques et al. (2015)
9. Education	
Kindergartens or nursery places	Geys et al. (2010), Revelli (2010), Barone and Mocetti (2011), Boetti et al. (2012), Šťastná and Gregor (2011), Kalb et al. (2012), Lo Storto (2013), Nikolov and Hrovatin (2013), Geys et al. (2013), Carosi et al. (2014), Lampe et al. (2015), Šťastná and Gregor (2015), Radulovic and Dragutinović (2015), Asatryan and De Witte (2015)

Continued

Table A4
Continued

Variables	Studies
Primary and secondary education	Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Sampaio de Sousa and Ramos (1999), Coffé and Geys (2005), Sampaio de Sousa et al. (2005), Loikkanen and Susiluoto (2005), Sampaio de Sousa and Stošić (2005), Geys (2006), Geys and Moesen (2009a, 2009b), Geys et al. (2010), Kalb (2010), Revelli (2010), Šťastná and Gregor (2011), Loikkanen et al. (2011), Bönisch et al. (2011), Boetti et al. (2012), Kalb et al. (2012), Kutlar and Bakirci (2012), Bischoff et al. (2013), Nikolov and Hrovatin (2013), Geys et al. (2013), Carosi et al. (2014), Ashworth et al. (2014), Pacheco et al. (2014), Pevcin (2014a, 2014b), Radulovic and Dragutinović (2015), Šťastná and Gregor (2015), Asatryan and De Witte (2015), Lampe et al. (2015)
10. Social services	
Grants beneficiaries	Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a, 1996b), Coffé and Geys (2005), Sampaio de Sousa et al. (2005), Sampaio de Sousa and Stošić (2005), Geys (2006), Geys and Moesen (2009a, 2009b), Loikkanen et al. (2011), Ashworth et al. (2014)
Care for elderly	Eeckaut et al. (1993), De Borger and Kerstens (1996a, 1996b), Loikkanen and Susiluoto (2005), Coffé and Geys (2005), Kalb (2010), Geys et al. (2010), Šťastná and Gregor (2011), Kutlar and Bakirci (2012), Boetti et al. (2012), Kalb et al. (2012), Nikolov and Hrovatin (2013), Geys et al. (2013), Pevcin (2014a, 2014b), Carosi et al. (2014), Ashworth et al. (2014), Lampe et al. (2015), Šťastná and Gregor (2015), Asatryan and De Witte (2015), Arcelus et al. (2015)
Care for children	Loikkanen (2005, 2011), Bönisch et al. (2011), Bischoff et al. (2013)
Social services and organizations	Loikkanen and Susiluoto (2005), Sung (2007), Loikkanen et al. (2011), Balaguer-Coll et al. (2010a, 2010b), Radulovic and Dragutinović (2015), Šťastná and Gregor (2011), Balaguer-Coll et al. (2013), Cuadrado-Ballesteros et al. (2013), Carosi et al. (2014), Šťastná and Gregor (2015)
11. Public safety	
	Eeckaut et al. (1993), Hayes and Chang (1990), Moore et al. (2005), Benito et al. (2010), Šťastná and Gregor (2011), Barone and Mocetti (2011), Cuadrado-Ballesteros et al. (2013), Šťastná and Gregor (2015), Agasisti et al. (2015)
12. Markets	
	Ibrahim and Karim (2004), Ibrahim and Salleh (2006), Balaguer-Coll et al. (2010a, 2010b, 2013)
13. Public transport	
	Šťastná and Gregor (2011, 2015)
14. Environmental protection	
	Athanassopoulos and Triantis (1998), Šťastná and Gregor (2011), Liu et al. (2011), Lo Storto (2013), Cuadrado-Ballesteros et al. (2013)
15. Business development	
	Geys et al. (2010), Kalb (2010), Bönisch et al. (2011), Liu et al. (2011), Kalb et al. (2012), Bischoff et al. (2013), Geys et al. (2013), Pevcin (2014a, 2014b), Asatryan and De Witte (2015), Lampe et al. (2015), Arcelus et al. (2015)
16. Quality index	
	Balaguer-Coll et al. (2007), Balaguer-Coll and Prior (2009), Balaguer-Coll et al. (2010b), Zafra-Gómez and Muñiz-Pérez (2010), Haneda et al. (2012)
17. Others	
	Athanassopoulos and Triantis (1998), Grossman et al. (1999), Nijkamp and Suzuki (2009), El Mehdi and Hafner (2014), Doumpos and Cohen (2014), Pérez-López et al. (2015)