Public or Private? An Efficiency Analysis of Urban Waste Management in Italian Municipalities

Massimo Del Gatto ("G.d'Annunzio" University of Chieti-Pescara)
Sandra Carballar Leal ("G.d'Annunzio" University of Chieti-Pescara)
Marialisa Mazzocchitti ("G.d'Annunzio" University of Chieti-Pescara)

Introduction

The urban waste management sector represents a crucial area for the efficiency of local public services, with significant environmental, economic, and social implications. The reform introduced by Legislative Decree No. 201 of 23 December 2022 redefined the regulatory framework for local public services, with particular attention to the principles of efficiency, effectiveness, cost-effectiveness, and sustainability, as well as the need to guarantee uniform essential performance levels across the national territory.

In this context, the analysis of the performance of municipal solid waste collection and transport services takes on strategic importance, as it makes it possible to evaluate the ability of operators – public and private – to transform resources into outputs, while at the same time ensuring service quality and cost sustainability.

This policy brief presents and comments on some results based on analyses carried out within the PODIUWM research project, which developed a geo-referenced municipal-level database (covering all Italian municipalities) designed for efficiency and productivity analyses concerning urban hygiene services.[1] In particular, the discussion focuses on the distinction between public and private management of the service.

From a policy perspective, through a comparative examination of performance, the work aims to provide evidence useful for promoting policies oriented toward improving productive efficiency, reducing territorial disparities, and strengthening governance capacity in the urban waste sector.

Analysis

The statistical information, referring to Italian municipalities in 2023, is obtained from the PODIUWM database. The database consists of two sections. PODIUWM DATA, containing information (from various sources) such as: quantities of waste (urban and special) collected and managed; expenditures and other information on the organization of waste collection by Italian municipalities; expenditures and other information on waste collection activity carried out by companies entrusted with the service; and contextual data on the socio-economic environment in which urban hygiene services are delivered. PODIUWM INDICATORS, containing efficiency and productivity indicators for municipal waste

[1] The database was obtained under the project "Production Of Data and Indicators for Urban Waste Management benchmarking – PODIUWM", financed by PE GRINS - GRINS - GROWING RESILIENT, INCLUSIVE AND SUSTAINABLE" (cod. PE0000018 CUP: J33C22002910001). Avviso 341/2022 "Partenariati estesi alle università, ai centri di ricerca, alle aziende per il finanziamento di progetti di ricerca di base". Piano Nazionale di Ripresa e Resilienza, Missione 4 "Istruzione e ricerca" – Componente 2 "Dalla ricerca all'impresa" – Investimento 1.3, finanziato dall'Unione europea – NextGenerationEU – Bando a Cascata SPOKE 0 E 2.

management. The indicators are estimated based on the information provided by PODIUWM DATA.
The analysis refers to the two most widely used approaches in the efficiency analysis of local public services. Stochastic Frontier Analysis (SFA), a parametric method that estimates the frontier based on a production function specified a priori, taking into account a stochastic error term that allows the distinction between technical efficiency and random variability. Data Envelopment Analysis (DEA), a non-parametric method that estimates the efficient frontier using linear programming models, without assuming any specific functional form in advance.
The indicators, named respectively IEN_SFA and IEN_DEA_R [2], are obtained by comparing the performance of each Italian municipality with the entire national sample. They vary between 0 and 1, with values close to 1 indicating high technical efficiency.
The unit of analysis is therefore the municipality, and the evaluation concerns the various factors that determine municipal performance in organizing urban hygiene services.
Table 1 reports the variables used for calculating the IENs:

- rifiuti_pc: kilograms of waste collected per inhabitant, indicating the average waste load per resident.
- sp_comunale_pc: annual current expenditure by the municipality for urban hygiene services, relative to the resident population, used as an indicator of per-capita costs.
- dens_urbana: urban density (residents per km²).
- altitudine: average altitude of the municipality.
- letti_ricettivi: total number of beds in accommodation facilities, to capture the impact of tourism on waste production.
- RD_%: share of waste collected separately, indicating the effectiveness of the separate collection system.
- reddito_pc: average income per taxpayer, reflecting the socio-economic context.

Results

Table 2 reports the average technical efficiency values of the municipal waste collection service in Italy in 2023, estimated using the SFA, by nature of corporate control of municipal waste managers (public vs. private) and by demographic class of municipalities. Reading the data highlights how the nature of corporate control is a significant factor in the efficiency of the municipal waste collection service. At the national level, publicly controlled companies show an average higher level of efficiency (0.826) than privately controlled companies (0.784). This trend appears fairly homogeneous across the different macro-areas, albeit with varying intensities: in the North-East, public companies achieve an average efficiency of 0.864 versus 0.877 for private companies, with a small gap and still high values for both types; Conversely, in Southern Italy, the gap widens, with 0.750 for public control and 0.741 for private control, but in a context of overall lower efficiency.

[2] The "R" in the name indicates that the calculation is based on a bias-corrected DEA methodology, which uses bootstrapping techniques to correct the systematic bias in technical efficiency scores attributable to the deterministic nature of the traditional model. In general, the SFA methodology produces a more accurate estimate of stochastic error but is suitable for small samples; the DEA methodology does not provide an estimate of statistical error but is more suitable for analyzing small samples.

The most interesting finding emerges from observing the interaction between the nature of control and the demographic size of the municipality. In small towns, public companies tend to perform better (0.788) than private ones (0.724), suggesting that public governance can ensure greater coordination in contexts characterized by limited resources and management difficulties. In medium-sized and large municipalities, the gap tends to narrow: in cities with over 50,000 inhabitants, private companies achieve an efficiency value (0.909) entirely comparable to that of public companies (0.916). This indicates that economies of scale and the structured organization typical of urban centers also allow private companies to achieve high performance, reducing the differences compared to the public model.
The data analysis reveals a rather varied picture at the regional level, confirming the importance of the nature of corporate control but at the same time highlighting significant regional differences.
In Northern Italy, regions such as Emilia-Romagna, Veneto, and Friuli-Venezia Giulia stand out for their higher average efficiency values. Central Italy presents a heterogeneous picture. In Tuscany, public and private companies show similar performance, while in Umbria and Marche the difference tends to favor public companies. The most marked gap is observed in Southern Italy. In regions such as Calabria, Basilicata, and Molise, the efficiency values of privately controlled companies are significantly lower than those of public companies. In Sicily and Sardinia, efficiency levels are low for both types, but a relative advantage of public companies is confirmed in smaller municipalities.
Overall, the regional data confirm that public governance tends to ensure greater stability in peripheral areas and smaller municipalities, where private companies show less satisfactory performance. In the northern regions and large urban centers, however, the gap narrows to near zero, with private companies achieving efficiency levels comparable to or even superior to those of public companies. This heterogeneity suggests that territorial variability plays a decisive role in determining performance, while the nature of control emerges as a more discriminating factor in areas characterized by low population density and more stringent management constraints.

Table 3 shows the technical efficiency values of the municipal waste collection service in Italy in 2023, estimated through the DEA. Overall, the national results show an average efficiency level of 0.717 for publicly controlled companies and 0.700 for privately controlled companies, with a limited but persistent advantage for the public model. This suggests that, in the Italian context, public governance is able to ensure slightly better performance, especially in more complex areas and management conditions.
Looking at the distribution by population size, it emerges that public companies achieve relatively more stable results: efficiency ranges from 0.684 in small municipalities to 0.746 in medium-sized ones, while decreasing to 0.697 in large ones. For private companies, however, the values are more heterogeneous, peaking in medium-sized municipalities (0.709), but with lower performance in large cities (0.679). This trend appears to partially reverse what was observed in studies based on SFA, suggesting that with DEA the benefits of scale are not linear and may depend on specific management characteristics.
At the regional level, the differences are marked. In the Northeast, public companies achieve high levels (0.793), higher than those of private companies (0.720), indicating a solid organizational capacity of regional public operators. A similar situation is observed in Emilia-

Romagna, where the public model is more efficient than the private one, especially in large municipalities. In Veneto, however, a reversal is observed: private companies reach very high levels, surpassing public ones. In the Northwest, the difference between public and private is minimal, with similar average values around 0.716–0.717.

In Central Italy, the situation is more heterogeneous. In Tuscany and Umbria, divergent results emerge: in the former case, public companies show significantly higher efficiency than private ones, while in Umbria the opposite occurs. The Marche region, on the other hand, is characterized by similar performance between public and private sectors. In Lazio, both types of companies show lower performance than the national average, with a moderate advantage for the private model.

In Southern Italy, efficiency values are lower than in the rest of Italy, but a comparison between models reveals interesting differences. In regions such as Campania and Puglia, private companies outperform public ones, while in Calabria and Sicily, performance is comparable, with slight variations between demographic groups. Sardinia is an exception, showing very high values for both public and private sectors, indicating a particularly efficient management environment.

Overall, the nature of corporate control appears to have a significant impact on performance, but with significant regional and size differences. Public companies tend to be more capable of ensuring efficiency in more complex and heterogeneous contexts, such as small municipalities or regions in the Northeast, while private companies perform better in some specific cases, such as in Veneto and parts of Southern Italy. Evidence suggests that management effectiveness does not depend solely on the nature of control, but on the interaction between governance model, demographic scale, and territorial specificities.

Conclusions – Policy recommendations

The analysis of municipal waste collection efficiency in 2023, conducted through SFA and DEA, provides a nuanced but robust picture.

Ownership matters: SFA results indicate greater efficiency for publicly controlled companies, especially in small municipalities and Southern regions. DEA results confirm this in many cases but also highlight private successes (e.g., Veneto, Campania). Public control is not a drag on efficiency; often it stabilizes performance.

Territorial divides: Northern regions (especially the North-East) show higher efficiency than Central and Southern Italy, reflecting stronger infrastructure and organizational conditions.

Economies of scale: SFA highlights strong scale effects, with large municipalities performing best. DEA suggests more complex dynamics, where small municipalities may benefit from managerial quality and coordination capacity.

Hence, the policy implications are clear. Improving efficiency requires stronger institutional and managerial coordination, especially in small municipalities and in the South. Promoting joint management forms and well-regulated public-private partnerships could reduce territorial disparities. Strengthening efficient public experiences is a key tool to improve service quality and sustainability nationwide.

Table 1 – Variables used

Metodo	Input	Output	Variabili ambientali
IEN_SFA	sp_comunale_pc	rifiuti_pc	dens_urbana altitudine letti_ricettivi RD_%
IEN_DEA_R	sp_comunale_pc	Percentuale_RD_% Pop_residente	dens_urbana altitudine letti_ricettivi reddito_pc

Source: our elaboration on PODIUWM data.

Table 2 – IEN_SFA by type of waste collection service provider and demographic class of municipalities. Year 2023.

	Società a controllo pubblico				**Società a controllo privato**				**Totale**
	< 2000	2.000-50.000	> 50.000	Totale pubblico	< 2000	2.000-50.000	> 50.000	Totale privato	
Piemonte	0,794	0,853	0,916	0,810	0,787	0,837	0,901	0,807	0,809
Valle d'Aosta	-	-	-	-	-	0,885	-	0,885	0,885
Lombardia	0,810	0,849	0,917	0,834	0,812	0,852	0,904	0,839	0,835
Trentino A.A.	0,817	0,837	0,910	0,830	0,793	0,838	-	0,810	0,818
Veneto	0,830	0,876	0,944	0,867	-	0,858	0,937	0,877	0,867
Friuli V.G.	0,825	0,894	0,930	0,866	-	-	-	-	0,866
Liguria	0,756	0,842	0,919	0,796	0,768	0,900	-	0,793	0,795
Emilia-Romagna	0,835	0,915	0,933	0,898	0,879	0,911	0,943	0,907	0,905
Toscana	0,844	0,888	0,931	0,881	0,897	0,868	-	0,882	0,881
Umbria	0,833	0,874	0,917	0,862	0,821	0,870	-	0,846	0,860
Marche	0,804	0,873	0,931	0,846	0,775	0,878	-	0,826	0,840
Lazio	0,690	0,808	0,901	0,775	0,668	0,799	0,905	0,768	0,762
Abruzzo	0,683	0,809	0,893	0,733	0,684	0,816	0,937	0,759	0,738
Molise	-	0,846	-	0,846	0,623	0,729	-	0,654	0,644
Campania	0,685	0,795	0,894	0,760	0,686	0,815	0,906	0,777	0,764
Puglia	0,794	0,862	0,912	0,887	0,736	0,856	0,887	0,842	0,844
Basilicata	-	0,776	-	0,776	0,587	0,706	0,869	0,656	0,650
Calabria	0,588	0,775	0,918	0,679	0,618	0,723	0,886	0,682	0,665
Sicilia	0,668	0,740	-	0,723	0,634	0,749	0,888	0,725	0,731
Sardegna	0,745	0,800	0,902	0,779	0,671	0,787	0,909	0,715	0,722
Nord-Ovest	0,798	0,849	0,917	0,823	0,793	0,846	0,903	0,820	0.822
Nord-Est	0,826	0,880	0,932	0,864	0,827	0,898	0,942	0,877	0,864
Centro	0,798	0,871	0,920	0,851	0,721	0,815	0,905	0,786	0,825
Sud e Isole	0,683	0,797	0,902	0,750	0,656	0,794	0,897	0,741	0,732
Italia	**0,788**	**0,855**	**0,916**	**0,826**	**0,724**	**0,824**	**0,909**	**0,784**	**0,801**

Source: our elaboration on PODIUWM data.

Table 3 –IEN_DEA_R by type of waste collection service provider and demographic class of municipalities. Year 2023.

	Società a controllo pubblico				**Società a controllo privato**				**Totale**
	< 2000	2.000-50.000	> 50.000	Totale pubblico	< 2000	2.000-50.000	> 50.000	Totale privato	
Piemonte	0,683	0,720	0,731	0,693	0,666	0,744	0,700	0,696	0,694
Valle d'Aosta	-	-	-	-	-	0,721	-	0,721	0,721
Lombardia	0,668	0,784	0,776	0,738	0,714	0,771	0,769	0,751	0,739
Trentino A.A.	0,847	0,823	0,806	0,833	0,843	0,770	-	0,817	0,783
Veneto	0,812	0,805	0,790	0,806	-	0,864	0,908	0,875	0,807
Friuli V.G.	0,753	0,784	0,769	0,771	-	-	-	-	0,771
Liguria	0,674	0,691	0,555	0,679	0,618	0,490	-	0,593	0,666
Emilia-Romagna	0,538	0,786	0,882	0,732	0,495	0,710	0,804	0,676	0,684
Toscana	0,520	0,664	0,666	0,635	0,316	0,365	-	0,341	0,631
Umbria	0,512	0,651	0,699	0,607	0,759	0,750	-	0,754	0,638
Marche	0,712	0,746	0,723	0,732	0,702	0,753	-	0,727	0,731
Lazio	0,659	0,668	0,710	0,668	0,651	0,703	0,771	0,691	0,664
Abruzzo	0,740	0,688	0,588	0,718	0,709	0,722	0,446	0,711	0,713
Molise	-	0,554	-	0,554	0,607	0,662	-	0,623	0,599
Campania	0,625	0,604	0,626	0,614	0,712	0,685	0,539	0,689	0,670
Puglia	0,620	0,727	0,662	0,678	0,567	0,659	0,663	0,648	0,637
Basilicata	-	0,628	-	0,628	0,610	0,665	0,721	0,642	0,577
Calabria	0,589	0,663	0,289	0,598	0,588	0,616	0,497	0,602	0,578
Sicilia	0,660	0,712	-	0,700	0,712	0,728	0,622	0,721	0,718
Sardegna	0,794	0,796	0,654	0,789	0,817	0,793	0,740	0,809	0,804
Nord-Ovest	0,676	0,765	0,741	0,717	0,676	0,755	0,742	0,715	0,716
Nord-Est	0,780	0,800	0,796	0,793	0,706	0,722	0,814	0,720	0,760
Centro	0,624	0,685	0,691	0,667	0,673	0,711	0,771	0,699	0,670
Sud e Isole	0,705	0,667	0,620	0,682	0,695	0,684	0,594	0,687	0,667
Italia	**0,684**	**0,746**	**0,697**	**0,717**	**0,688**	**0,709**	**0,679**	**0,700**	0,702

Source: our elaboration on PODIUWM data.