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The importance of efficiency analysis for improving public services: Editorial to the special issue on "Efficiency and productivity analysis of public services in practice"

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Abstract

Public services around the world face growing demands, limited budgets, and changing populations. As a result, analyzing efficiency is more important than ever. Techniques like data envelopment analysis, stochastic frontier analysis, and machine learning techniques offer valuable tools for improving how public services are managed. This special issue highlights current research on measuring efficiency in education, healthcare, finance, real estate, and more. It is divided into four main areas: new ways to measure efficiency, factors affecting how well educational institutions perform, improvements in public services such as health and social care, and insights into how businesses use efficiency measures. The findings show how policy settings, governance, and data quality all affect how we measure and improve efficiency. Moreover, the contributions show how combining traditional methods with innovative techniques can provide a better analysis of complex systems and long-term outcomes. Building on the insights from the papers in the special issue, we propose a future research agenda that encourages collaboration between experts in different fields, uses new data tools, and supports evidence-based public service delivery. By connecting theory to practical use, this special issue aims to improve how public services operate, making them more efficient, fair, and based on real data to help decision-makers.

Keywords: public services; efficiency analysis; education

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1. Introduction

Efficiency measurement plays a crucial role in ensuring that resources are allocated effectively in both the public and private sectors. In an era of increased public spending, driven by economic recovery programs (e.g., due to the COVID-19 crisis resulting in learning deficits; Maldonado and De Witte, 2022), demographic shifts (e.g., aging populations putting pressure on health care and declining birth rates), and growing demands for high-quality public services (De Witte and Geys, 2013), the importance of understanding and improving efficiency in the use of public resources has never been greater. Governments worldwide are allocating unprecedented funds to healthcare, education, infrastructure, and social welfare, yet the challenge remains: How can we ensure that these resources are used in the most efficient way, leading to maximum societal benefit? Merely increasing budgets does not guarantee better outcomes, quite the opposite. Instead, optimizing resource allocation and improving efficiency are essential to sustaining long-term economic growth, maintaining fiscal responsibility, and achieving equity in service delivery.

Due to the increasing complexity of decision-making environments, it is important to improve the empirical models that allow us to estimate (in)efficiencies in the public sector (De Witte and Lopez-Torres, 2017; Narbon and De Witte, 2018a, 2018b). Traditional methods, such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA), have been widely used to measure efficiency, but as the nature of production and service provision evolves, so must the analytical tools used to assess them (Mergoni et al., 2025). New approaches, such as machine learning models and Bayesian techniques, are enabling researchers to capture complex interactions between inputs and outputs, account for heterogeneity among decision-making units, and incorporate stochastic elements that reflect real-world uncertainty. Advances in computational power and the availability of large-scale datasets further enable researchers to refine models, moving beyond static efficiency scores to dynamic analyses that capture changes in performance over time (De Witte and Chénier, 2023). The integration between traditional models and new approaches constitutes a new avenue for future research developments (De Witte and Lopez-Torres, 2017).

However, improving efficiency measurement is not solely a matter of methodology—it also depends on the availability and quality of data. Many efficiency studies rely on publicly available datasets, but these often lack granularity, timeliness, or key variables that would enhance precision. The increasing digitization of government records, administrative data, and real-time performance tracking presents new opportunities for efficiency analysis (Rogge et al., 2017), yet challenges remain in ensuring data accessibility, interoperability, and privacy compliance. Future efficiency studies must advocate for better data and collection practices as well as collaborations between researchers and policymakers to improve transparency and measurement accuracy. The relevance of considering policy contexts when evaluating efficiency is increasingly recognized, as policy changes shape institutional behaviors, funding mechanisms, and performance metrics, ultimately influencing the effectiveness and sustainability of public service delivery (de la Torre and Perez-Esparrells, 2019).

Academics can provide evidence-based insights that can guide policy decisions (Agasisti et al., 2023). By conducting rigorous empirical studies, developing new efficiency measurement tools, and engaging in knowledge transfer activities, researchers contribute to more informed policymaking.

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Whether in education, healthcare, or finance, efficiency analyses allow policymakers to identify best practices, allocate resources more effectively, and design policies that maximize societal welfare. This special issue reflects the importance of these contributions, bringing together cutting-edge research that bridges methodological advances with practical applications across multiple sectors—allowing for better informed data-supported decisions.

This special issue is organized into four thematic sections, each addressing a pivotal area of efficiency analysis. First, a set of studies explores innovative methodologies that expand our analytical horizons, integrating machine learning, stochastic methods, and novel DEA variants. Next, a second cluster of articles focuses on efficiency in education, investigating how internal governance, departmental restructuring, and regional disparities shape institutional performance. A third group turns attention to the public sector and social services—courts, hospitals, and broader social goals—applying specialized frontier models to illuminate policy and operational reforms. Finally, contributions in the finance and business realm spotlight managerial ability, real estate valuation, and performance target-setting in networked industries, illustrating the applicability of efficiency measurement to strategic corporate decision-making. These insights might stimulate innovative reflections in the efficiency measurement of public organizations, and vice versa; this is cross-fertilization that should be valorized in future research.

In what follows, we overview the 20 papers included in this special issue and end with a research agenda that stems from them.

2. First thematic section: innovative methodologies pushing the boundaries of traditional efficiency measurement

The first group of articles included in this special issue illustrates innovative methodologies that push the boundaries of traditional efficiency measurement. For instance, the integration of machine learning techniques (such as Random Forest algorithms) into nonparametric production technologies offers a fresh perspective on efficiency evaluation in education. These methodological advancements not only refine existing analytical tools but also open new avenues for research, enhancing the precision and applicability of efficiency assessments.

Amirteimoori (2025) evaluates units with interconnected operations, environmental concerns, and shared resources. By extending a two-stage DEA framework, the author demonstrates how to incorporate both desirable and undesirable outputs—such as pollution or risk exposure—while capturing the interdependence of different production stages. This holistic angle is particularly salient for the banking sector, where loan-making divisions, service branches, and sustainability obligations intersect. Amirteimoori's model highlights otherwise hidden inefficiencies and provides managers and regulators with clear signals on where targeted improvements could yield the highest returns.

Aparicio and Santín (2024) further expand on DEA's analytical possibilities. Traditional approaches often concentrate on local optima or compare units within relatively homogeneous environments. By contrast, this study explores scale efficiency through a more global lens, illustrating how varying operational scales—small, medium, or large—interact with efficiency frontiers under broader, potentially cross-border contexts. This framework not only informs organizations or

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decision-making units about whether they are operating at an optimal size but also provides a richer picture of how different scales can learn from each other's configurations.

Johnes et al. (2025) offer a rigorous, network-inspired take on stochastic frontiers. While single-stage models have historically been the mainstay of SFA, the authors show how partitioning a production process into multiple linked stages (or subsystems) can illuminate how the efficiency level at one point in the network constrains overall performance. This approach is especially relevant to organizations—like supply chains or multicampus institutions—that operate across distinct yet interconnected units. By identifying stage-specific bottlenecks, policy interventions or managerial remedies can be more precisely targeted, accelerating system-wide performance gains.

In España et al. (2025), we see a clear embodiment of the modern drive to merge machine learning and traditional frontier analysis. Adapted Random Forest algorithms are introduced to approximate nonparametric frontiers more flexibly, thus handling datasets in which outputs relate to inputs in nonlinear and often complex ways. By applying the approach to educational settings—where heterogeneity in student populations, institutional missions, and resource mixes can generate highly complex data—the authors demonstrate that advanced predictive models can enrich and refine our understanding of efficiency, going beyond what standard parametric or nonparametric methods alone can reveal.

Completing this cluster of studies, Blank and Heezik (2025) underscore the importance of tailoring analytical approaches to specific institutional realities. A locally least squares frontier method situates efficiency evaluations within the granular context of Dutch municipalities, which face unique demographic structures, budgetary constraints, and policy priorities. By constructing a localized view of production possibilities in youth care, this study offers policymakers context-sensitive benchmarks and improvement strategies. In so doing, Blank and Heezik illustrate the practical value of methodological refinement: highly localized insights can be critical to improving public services where one-size-fits-all policies might fail.

Overall, although each paper highlights distinct methodological advances—two-stage analysis of undesirable outputs, global scale perspectives, multistage SFA, machine learning integration, and local frontier techniques—they collectively converge on a shared proposition. The complexity and variability of modern production processes demand analytical techniques that are robust, flexible, and responsive to local, industrial, or institutional nuances. These new tools and frameworks promise deeper insight into inefficiency drivers and more nuanced pathways for resource optimization, providing applications of such advancements in areas as disparate as banking, education, and youth care.

Beyond their immediate domains of application, these papers also pave the way for broader engagement between research communities and frontline practitioners. As governments and organizations around the world struggle with tight budgets and increased service expectations, the power of well-chosen analytic methods becomes critical for identifying performance gaps, fostering strategic innovation, and justifying policy interventions. Therefore, scholars in the field of efficiency analyses must search for cooperation with academics from different disciplines (e.g., data scientists), with the aim of performing more profound and precise empirical evaluations. By bridging traditional frontier analysis with novel techniques—from network modeling to machine learning—this thematic section sets a forward-looking agenda for efficiency research, foreshadowing the sophisticated applications, and refinements explored in the subsequent sections of this special issue.

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3. Second thematic section: exploring core determinants of efficiency in education

Building on the innovative approaches featured in the first thematic section, this second cluster of articles turns the spotlight on education, where operational complexities and institutional dynamics pose ongoing challenges for efficiency measurement. Spanning multiple countries and contexts—from Russia to Spain, England, and the United States—these studies examine how governance arrangements, structural reforms, regional disparities, and organizational sizes can influence universities' and schools' performance. By discussing both the micro- and macro-level drivers of efficiency, they collectively offer policymakers, university managers, and administrators a nuanced roadmap for resource optimization.

First, in their empirical study of Russian universities, Agasisti et al. (2025) analyze how varying managerial frameworks can significantly affect institutional performance. By linking governance features—such as autonomy levels, leadership structures, and accountability practices—to efficiency outcomes, the authors underscore the importance of tailored management strategies in steering universities toward better resource allocation.

Second, Santín and Tejada (2025) address a pressing question for many institutions seeking to streamline operations. Using DEA, the study pinpoints both the advantages and the potential pitfalls of merging university departments, illustrating how scale economies and knowledge transfers can enhance overall performance while also imposing transition costs.

Third, García-Tórtola et al. (2025) offer a methodologically rigorous lens on the intricate production processes of Spanish universities. By adopting a Bayesian approach, the authors not only refine traditional SFA but also provide richer insights into the uncertainty and variability embedded in university efficiency scores—a crucial factor in policy or funding decisions-.

Next, looking at Spain's diverse regional context, Cordero et al. (2025) highlight how geography, local governance practices, and socioeconomic conditions shape schools' resource utilization and academic outcomes. This longitudinal, cross-regional comparison reveals both structural inefficiencies and emerging success stories, guiding policymakers toward more context-sensitive interventions.

Fifth, Johnes and Perez-Esparrells (2025) focus on the United Kingdom's evolving regulatory and funding landscape. By synthesizing lessons from English universities' experiences with market-oriented policies, the study underscores how well-intentioned reforms—like tuition fee adjustments or performance-based incentives—may spur efficiency but often require careful calibration to mitigate unintended consequences.

Finally, Taylor et al. (2025) broaden the perspective on primary and secondary education in the United States, investigating whether limited economies of scale and potentially disproportionate administrative costs hamper small districts' efficiency. Through allocative analysis, the paper provides a balanced evaluation of how fiscal decisions in these districts can best serve student achievement and broader educational objectives.

Taken together, these six studies underscore education's multifaceted performance drivers, spanning governance, structural reforms, regional disparities, and institutional size. By revealing how these interconnected elements shape efficiency, the papers offer both strategic advice for educational sector leaders and a fertile ground for future research, continuing the important conversation on how education systems worldwide can maximize impact with limited resources.

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4. Third thematic section: efficiency analysis in public policy and social sectors

This third cluster of contributions focuses on efficiency research in public institutions—such as courts and healthcare organizations—and its broader social policy objectives. By exploring how frontier efficiency techniques can capture the complexities of judicial processes, hospital structures, and multicountry policy agendas, these studies underscore the value of tailored analytical approaches for guiding equitable and effective public services.

First, Afonso et al. (2024) address a core challenge in medical service delivery: the multitude of intangible factors and contradictory outcomes. By combining fuzzy set theory with network DEA, the paper provides a robust framework for incorporating both uncertain inputs and undesirable outputs (e.g., infection rates) into efficiency assessment. The result is a more nuanced lens that enables hospital administrators and policymakers to pinpoint bottlenecks and target specific reforms that enhance patient outcomes under real-world uncertainty.

Second, D'Inverno et al. (2025) introduce a benefit-of-the-doubt model, which aggregates multiple performance indicators into a single, context-adjusted metric. Focusing on amenable mortality rates, the study highlights the policy trade-offs inherent in trying to balance service quality, universal coverage, and budget constraints. This work underscores the importance of wide-ranging yet precise measures of health system effectiveness, especially for governments aiming to deliver equitable healthcare on limited resources.

Next, zooming into hospital-level organizational factors, Fulgenzi and Gitto (2025) investigate the evolution of hospital productivity over time in Italy. By measuring how different policy environments—ranging from decentralized governance to varying degrees of managerial autonomy—can accelerate or impede improvements, the authors offer practical guidance on which policy levers might be most effective for sustaining growth and innovation in hospital settings.

Fourth, moving from healthcare to judicial processes, Kapelko (2025) demonstrates how input–output efficiency analysis can be used to diagnose bottlenecks in court operations. By isolating specific inefficiency components—such as personnel shortcomings or backlog dynamics—the study provides actionable insights for legal reform, emphasizing how resource allocation decisions can foster swifter case resolution and improve overall procedural fairness.

Fifth, across the broader landscape of European public policy, Karagiannis and Ravanos (2025) tackle the measurement of social inclusion efforts among member states. By applying a global Malmquist productivity index, the paper compares temporal changes in indicators of poverty, employment, and social equity, highlighting both successes and persistent gaps. This study offers EU policymakers an empirical basis for recalibrating social goals and for better aligning resources with local realities, with the aim of maximizing the impact of social services on citizens' welfare.

Finally, Stumbrienė et al. (2025) examine how efficiency-oriented frameworks can inform the pursuit of transnational targets, in this case, in the European education area. Demonstrating that nations require distinct strategies—even when they aim for the same headline objectives—the paper underscores the nuance needed in policy planning. It also reinforces the notion that efficiency measurement tools can bring clarity to the path for achieving collectively agreed milestones.

Overall, these contributions bring light to how data-driven diagnostics can support reforms in healthcare, justice, and beyond. Taken as a whole, they illustrate both the shared challenges and the sector-specific nuances of applying efficiency analysis in diverse institutional settings—ultimately offering policymakers tangible pathways for bolstering service quality while respecting constrained

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budgets. It highlights how different techniques can be combined and employed in a number of application fields—network-DEA models, benefit-of-the-doubt techniques, and Malmquist indices—suggesting that different problems can be faced by relying on a wide set of methodological approaches.

5. Fourth thematic section: efficiency insights in finance, corporate strategy, and real estate

The last three articles extend efficiency analysis into the spheres of banking, airline operations, and real estate valuation. By exploring how managerial decision-making, strategic target setting, and property market dynamics intersect with frontier methods, these studies underscore the versatility and practical value of efficiency-based insights across diverse business contexts—in and beyond the public sector.

First, Yu and Rakshit (2025) tackle one of the most competitive and network-dependent sectors: air travel. Using a specialized bargaining-based DEA framework, the authors examine how performance targets can be tailored to airlines with intricate operational structures and multiple stakeholder interests. This approach highlights how cooperative negotiation, embedded within efficiency models, offers a structured path for airlines to balance route profitability with service standards and operational constraints.

Second, focusing on the Asian banking sector, Amirteimoori et al. (2025) focus on managerial competence. The study examines how leadership decisions and strategic foresight can propel banks toward sustained competitive advantage. In doing so, it reveals the intangible yet critical influence of managerial expertise in pushing institutions up the efficiency frontier and spurring meaningful technological innovation.

Finally, Lozano et al. (2025) focus on the housing market, offering an empirical assessment of real estate valuation practices. By incorporating frontier-based techniques, the paper demonstrates how efficient property value estimates can emerge from a better understanding of the interplay of housing attributes, neighborhood qualities, and market pressures. This approach offers valuable guidance to appraisers, mortgage lenders, and policymakers aiming to stabilize housing markets.

This last group of studies displays how efficiency-based frameworks can serve as a vital decision-support tool for managers and regulators operating in dynamic, high-stakes environments. From designing collaborative performance targets in networked industries to leveraging managerial capabilities and refining property valuations, each contribution reiterates the overarching message of this special issue: understanding inefficiencies and optimizing resource use remains paramount for organizations seeking sustainable growth and long-term resilience.

6. Research agenda

This special issue highlights both the depth and breadth of contemporary efficiency research, illustrating how innovations in analytical techniques can improve performance measurement and resource allocation across diverse sectors. The articles collectively underscore the importance of improving the theoretical underpinnings of frontier models—whether via stochastic, nonparametric, or integrated machine-learning methods—and aligning them more closely with the complex

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realities of institutional settings such as universities, hospitals, courts, or corporate networks. Building on these insights, several key avenues for further exploration emerge.

First, the methodological cross-fertilization evident in multiple contributions suggests fruitful paths for new studies. Papers adapting Random Forest to nonparametric production technologies (España et al., 2025) or integrating fuzzy logic into network DEA frameworks (Afonso et al., 2025) highlight the potential for data science and artificial intelligence to complement classical efficiency models. Future work can broaden this scope by considering more sophisticated machine learning algorithms—such as gradient boosting, deep neural networks, or ensemble techniques—to capture highly nonlinear relationships or to predict inefficiency under varying environmental constraints. Similarly, the methodological approaches for multistage analyses (Johnes et al., 2025), complex resource-sharing scenarios (Amirteimoori, 2025), and multioutput frontiers can be enriched by integrating Bayesian inference (García-Tórtola et al., 2025) more systematically, thus allowing deeper exploration of parameter uncertainty.

Second, the articles focusing on education (Agasisti et al., 2025; Santin & Tejada, 2025; Cordero et al., 2025; Johnes and Perez-Esparrells, 2025; Taylor et al., 2025) and healthcare (Afonso et al., 2024; D'Inverno et al., 2025; Fulgenzi and Gitto, 2025) highlight the need for broader conceptualizations of outputs and outcomes. As intangible factors—including service quality, equity considerations, and user satisfaction—gain prominence, future efficiency models must better incorporate these dimensions. Researchers may adopt multidimensional frameworks, perhaps building on benefit-of-the-doubt methods (D'Inverno et al., 2025) or new forms of Malmquist indexes (Karagiannis and Ravanos, 2025) that capture temporal shifts in quality and policy targets. Doing so will require stronger collaboration with domain experts as well as improved data collection protocols capable of reliably tracking less tangible performance indicators. Also, analyzing these phenomena in the long-run perspective (i.e., considering variations of efficiency and productivity over longer time ranges) is increasingly becoming a crucial issue in this area of research.

Third, the time dimension is also relevant for studies on corporate strategy (Yu and Rakshit, 2025) and banking (Amirteimoori et al., 2025), where there is scope to explore how exogenous shocks—such as rapid technological innovation, climate risks, and changing regulatory landscapes—impact efficiency and productivity over time. Longitudinal designs and dynamic efficiency models could illuminate how decision-making units adapt under volatile market conditions, shedding light on managerial ability as a key driver of change. These approaches can also be extended to contexts such as real estate valuation (Lozano et al., 2025), where housing markets experience cyclical swings and local shocks, necessitating robust models that flexibly adapt to shifting demand and supply conditions.

Finally, further refinement of public policy applications remains crucial. Studies in judicial systems (Kapelko, 2025) and social inclusion policies (Stumbrienė et al., 2025; Karagiannis and Ravanos, 2025) confirm that frontier models can serve as powerful diagnostic tools for identifying institutional bottlenecks. Future research should delve deeper into multilevel governance contexts, recognizing that local, regional, and national policies interact in complex ways to shape efficiency outcomes. Collaborative research teams—including policymakers, analysts, and interdisciplinary experts—will be vital to translating technical insights into real-world improvements in public services. By actively building on these concepts and bridging methodological advances with policy relevance, the field will be ready to continue evolving, sharpening both its theoretical rigor and practical impact.

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