

A Review of Public Expenditure Efficiency Evaluation Using Data Envelopment Analysis: A Case Study of Research Expenditure Efficiency in Iranian Industrial Universities

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ABSTRACT

The efficiency of government expenditures is the ability to generate greater outputs using specified resources. Due to constraints on government resources, improving public expenditure efficiency has become crucial for reducing public budget consumption. Calculating the efficiency of public expenditures and implementing performance-based budgeting has led to the use of mathematical methods to optimize and assess government organizations' efficiency. One effective approach is Data Envelopment Analysis, a technique that evaluates the relative efficiency of decision-making units by comparing inputs and outputs. When combined with other econometric or statistical methods, DEA offers a broader perspective on how units and organizations perform in terms of budget utilization. Furthermore, comparing similar units highlights the strengths and weaknesses of each system, guiding decision-makers. The objective of this study is to evaluate the challenges in calculating public expenditure efficiency using DEA, by reviewing studies comparing the performance of various governments in international comparisons. The review highlights the methodological challenges, indicator selection, and decision-making unit selection. A case study evaluates the efficiency of public expenditures in research and development for 9 industrial universities in Iran, across four scenarios. Two DEA models are employed: the weighted sum model and the multi-layer weighted sum model. The indicators include university research budgets and output performance metrics for research, such as the number of articles, books, theses, and patents. The results show that university efficiency varies depending on the inputs and outputs considered. Finally, policy recommendations are provided for applying these models in higher education.

Keywords: Efficiency of public expenditures, DEA, Performance-based budgeting, Industrial universities of Iran.

Introduction

Government expenditure efficiency is defined as the ability to achieve greater outputs with a fixed amount of resources. As fiscal constraints intensify, improving the efficiency of public spending has become a central concern for reducing government expenditures. Assessing efficiency and adopting performance-based budgeting provide a foundation for applying quantitative and optimization techniques to evaluate public institutions. Data Envelopment Analysis (DEA) is one of the most effective methods in this regard, as it allows for an accurate assessment of resource utilization. When combined with econometric and statistical models, DEA offers a broader understanding of institutional performance and enables policymakers to identify both strengths and weaknesses across comparable units.

The main objective of this study is to identify and analyze challenges in measuring public expenditure efficiency using DEA. The research reviews national-level studies that compare government performance, excluding state-level analyses due to differences in geography, institutional structures, and scale that may lead to inconsistent results. After reviewing these studies, three major challenges were identified—methodological design, selection of indicators, and definition of decision-making units (DMUs). A case study was then conducted to evaluate the efficiency of research and development (R&D) expenditures among nine Iranian industrial universities across four scenarios. Two DEA-based models, the Common Set of Weights (CSW-DEA) and the Multi-Layer Common Set of Weights (CSW-MLDEA), were applied. Inputs consisted of universities' research budgets, while outputs included the number of publications, books, theses, and international patents. The results demonstrated that the relative efficiency of universities varied with different input–output combinations. Policy recommendations were also proposed for applying these models within Iran's higher education system.

Methodology

The research follows a positivist, data-driven methodology to systematically analyze the efficiency of public expenditures among governments. A structured review of international studies was conducted, focusing on models used, study periods, country samples, public sectors analyzed, and derived policy implications. The analysis relied on empirical data and quantitative comparisons to capture the relationship between government spending (inputs) and public service outcomes (outputs). This approach moves beyond descriptive review by identifying analytical patterns of spending efficiency and establishing an empirical framework for evaluating governmental performance.

The case study employed a descriptive–analytical approach, using secondary data from official sources such as annual budget laws, the Planning and Budget Organization, and the Ministry of Science's research database. In some cases, data were supplemented through direct correspondence with universities. Research budgets served as input variables, while outputs included publications, books, patents, and theses. Efficiency analysis across the four scenarios demonstrated stable results, confirming the robustness of the model and helping to evaluate sensitivity in university performance when input–output structures were altered.

Findings

The qualitative results highlight recurring challenges across three main aspects: identifying DMUs, selecting suitable indicators, and choosing appropriate analytical models. In defining DMUs, scholars emphasize considering institutional, structural, and technological differences among countries and grouping them by income level or region to avoid biased comparisons. Indicator selection remains complex—especially in education, health, and infrastructure—owing to data limitations and the lack of qualitative measures. Researchers therefore recommend combining quantitative and qualitative indicators and including control variables such as per capita income. Methodologically, DEA remains the dominant tool for efficiency evaluation due to its flexibility and independence from theoretical assumptions. Recent developments, including CRS, VRS, Malmquist Index, three-stage DEA, conditional DEA, and hybrid techniques integrating Tobit regression or bootstrap, have strengthened the ability to analyze dynamic changes, identify inefficiency sources, and control for environmental effects. Together, these advances contribute to the design of a comprehensive and realistic framework for assessing public expenditure efficiency.

Quantitative findings from the case study reveal significant variation in R&D expenditure efficiency among Iranian industrial universities. Although Amirkabir, Iran University of Science and Technology, Sharif, and Isfahan University of

Technology have larger budgets and research outputs, they are not necessarily the most efficient. In contrast, Amirkabir, Noshirvani Babol, and Sahand University of Technology consistently demonstrate higher relative efficiency across most scenarios, whereas Sharif, Isfahan, and Iran University of Science and Technology appear less efficient despite higher funding levels. These results suggest that greater financial allocations do not automatically yield better performance; effective resource management and focus on high-quality outputs are more important. The comparison of four scenarios using CSW-DEA and CSW-MLDEA models shows that as the models incorporate greater complexity and hierarchical relationships between inputs and outputs, their precision and discriminatory power improve. The fourth scenario, which integrates dual-layer R&D budgeting, offers a more realistic reflection of how subprograms influence total research outcomes.

Conclusion

Overall, the integration of international literature with a national case study offers a more comprehensive understanding of public and research expenditure efficiency. The study confirms that DEA is a powerful analytical tool for evaluating public sector efficiency, though challenges in selecting DMUs, indicators, and model types remain. The evaluation of nine industrial universities using CSW-based models showed varying performance levels, with multi-layer models providing a better representation of complex research processes. Amirkabir University achieved the highest efficiency, while smaller universities also performed well despite lower budgets. Differences in results are likely due to variations in funding policies, research infrastructure, and management practices across universities.

Despite limitations—such as the use of 2018 cross-sectional data and a reliance on quantitative measures—the findings underline the importance of establishing a performance-based budgeting system, developing an integrated national research database, and considering institutional differences in university management. The study concludes that DEA can serve as an effective decision-support instrument for optimizing research resource allocation and improving financial efficiency within Iran's higher education system. Future research should incorporate multi-year datasets, qualitative indicators like citation rates and technological impact, and hybrid models such as Bootstrap-DEA and DEA-Tobit to enable more precise assessments of higher education efficiency and facilitate meaningful international comparisons of public expenditure performance.

References

- Adam, A., Delis, M., & Kammas, P. (2011). Public sector efficiency: Leveling the playing field between OECD countries. *Public Choice*, 146, 163-183. <https://doi.org/10.1007/s11127-009-9588-7>
- Afonso, A., & Fraga, G. B. (2024). Government spending efficiency in Latin America. *Empirica*, 51(1), 127-160. <https://doi.org/10.1007/s10663-023-09599-4>
- Afonso, A., Jalles, J. T., & Venâncio, A. (2021). Structural tax reforms and public spending efficiency. *Open Economies Review*, 32(5), 1017-1061. <https://doi.org/10.1007/s11079-021-09644-4>
- Afonso, A., & Kazemi, M. (2017). Assessing public spending efficiency in 20 OECD countries. In B. Bökemeier & A. Greiner (Eds.), *Inequality and finance in macrodynamics* (pp. 7-42). Springer International Publishing. https://doi.org/10.1007/978-3-319-54690-2_2
- Afonso, A., Schuknecht, L., & Tanzi, V. (2005). Public sector efficiency: An international comparison. *Public Choice*, 123, 321-347. <https://doi.org/10.1007/s11127-005-7165-2>
- Afonso, A., Schuknecht, L., & Tanzi, V. (2010). Income distribution determinants and public spending efficiency. *The Journal of Economic Inequality*, 8, 367-389. <https://doi.org/10.1007/s10888-010-9138-z>
- Alizadeh, P., & Gholipour, M. (2022). A framework for allocating public research and development budgets to universities using robust optimization. *Iranian Journal of Applied Economic Studies*, 11(43), 99-135. <https://doi.org/10.22084/aes.2022.25447.3383>
- Brini, R., & Jemmali, H. (2015). Efficiency in public spending, governance, political and economic policies: An analysis of interlinkages in selected MENA countries.
- Buljan, A., Deskar-Škrbić, M., & Šimović, H. (2019). Determinants of public health care, education and administration efficiency in Central, Eastern and South Eastern Europe. *Hrvatska i Komparativna Javna Uprava*, 19, 537-563. <https://doi.org/10.31297/hkju.19.4.2>
- Chan, S. G., Ramly, Z., & Karim, M. Z. A. (2017). Government spending efficiency on economic growth: Roles of value-added tax. *Global Economic Review*, 46(2), 162-188. <https://doi.org/10.1080/1226508X.2017.1292857>
- Chrysanthakopoulos, C., Bouloumpasis, P., Skotoris, M., & Tagkalakis, A. (2025). The macroeconomic effects of public sector efficiency in advanced economies. *International Economics*, 182, 100600. <https://doi.org/10.1016/j.inteco.2025.100600>
- Cristóbal García, J., Ehrenstein, M., Domínguez Ramos, A., Galán Martín, Á., Pozo Fernández, C., Margallo Blanco, M., Aldaco García, R., Jiménez Esteller, L., Irabien Guliás, Á., & Guillén Gosálbez, G. (2021). Unraveling the links between public spending and Sustainable Development Goals: Insights from data envelopment analysis. <https://doi.org/10.1016/j.scitotenv.2021.147459>
- Cuadrado-Ballesteros, B., & Peña-Miguel, N. (2024). Privatisation and government spending efficiency: An empirical analysis in Europe. *Scottish Journal of Political Economy*, 71(4), 625-648. <https://doi.org/10.1111/sjpe.12386>

- De Oliveira, A., Montes, G., & Bastos, J. (2018). Fiscal transparency, government effectiveness and government spending efficiency: A panel data approach for developed and developing countries. <https://www.sciencedirect.com/science/article/pii/S026499931830693X>
- Halaskova, M., Halaskova, R., & Prokop, V. (2018). Evaluation of efficiency in selected areas of public services in European Union countries. *Sustainability*, 10(12), 4592. <https://doi.org/10.3390/su10124592>
- Herrera, S., Isaka, H., & Ouedraogo, A. (2025). Efficiency of public spending in education, health, and infrastructure: An international benchmarking exercise. *Journal of Applied Economics*, 28(1), 2480985. <https://doi.org/10.1080/15140326.2025.2480985>
- Javaid, M. F., Bashir, F., & Shauket, H. (2024). Fiscal prudence and economic growth in Asia: The role of efficient public spending. *Pakistan Journal of Humanities and Social Sciences*, 12(2), 1549-1562. <https://doi.org/10.52131/pjhss.2024.v12i2.2266>
- Khaalqi, S. F., Abolqasemi, M., Gharayi Nezhad, G., & Dolu, M. (2017). Designing a model for allocation of higher education resources in Iran. *Quarterly Journal of Financial Economics*, 11(39), 147-169.
- Khodabakhshi, M., & Aryavash, K. (2017). The cross-efficiency in the optimistic-pessimistic framework. *Operational Research*, 17(2), 619-632. <https://doi.org/10.1007/s12351-016-0243-z>
- Khodabakhshi, M., Hosseinzadeh Lotfi, F., & Aryavash, K. (2012). Review of input congestion estimating methods in DEA. *Journal of Applied Mathematics*, 2014, 963791. <https://doi.org/10.1155/2014/963791>
- Khodabakhshi, M., & Mirkooshesh, M. (2024). Performance analysis of capital asset acquisition credits in Lorestan Province by functions and subfunctions using Data Envelopment Analysis method. *Decision Science and Intelligent Systems*, 1(2), 22-52. <https://dsisj.com/index.php/dsisj/article/view/19>
- Málek, J., Hudečková, V., & Matějka, M. (2014). System of evaluation of research institutions in the Czech Republic. *Procedia Computer Science*, 33, 315-320. <https://doi.org/10.1016/j.procs.2014.06.050>
- Mihaylova-Borisova, G., & Nenkova, P. (2021). DEA efficiency approach in comparing macroeconomic performance of EU and Balkan countries. *Economic Studies*, 30(6). <https://www.cceol.com/search/article-detail?id=977035>
- Msann, G., & Saad, W. (2020). Assessment of public sector performance in the MENA region: Data envelopment approach. *International Review of Public Administration*, 25(1), 1-21. <https://doi.org/10.1080/12294659.2019.1702777>
- Naderi Roshanavand, A., Fath-Tabar Firoozjaei, K., Ezzati, M., & Dinmohammadi, M. (2023). A decision support system for financial resource allocation in universities: Requirements and consequences. *Journal of Research and Planning in Higher Education*, 29(2), 27-50. <https://doi.org/10.61838/irphe.29.2.2>
- Nourian, M., & Ghaleh-Golabi, M. (2021). Using Data Envelopment Analysis (DEA) to evaluate the efficiency of education in faculties of Persian Gulf University: A case study. *Iranian Journal of Engineering Education*, 22(88), 73-90. <https://doi.org/10.22047/ijee.2020.227359.1738>
- Rayp, G., & Van De Sijpe, N. (2007). Measuring and explaining government efficiency in developing countries. *The Journal of Development Studies*, 43(2), 360-381. <https://doi.org/10.1080/00220380601125230>
- Sameti, M., & Rezvani, M. A. (2001). Evaluating the efficiency of major public universities in Iran using the DEA method. *Economic Research*, 59, 117-147. <https://sid.ir/paper/12077/fa>
- Trabelsi, N., & Boujelbene, Y. (2023). Assessing public sector efficiency in developing countries with DEA and bootstrap analysis. *Journal of Smart Economic Growth*, 8(2), 95-125.
- Ubago Martínez, Y., Arzoz, P. P., & Apezteguía, B. I. (2018). Does decentralization contribute to efficiency? Evidence from OECD countries. *Applied Economics*, 50(7), 726-742. <https://doi.org/10.1080/00036846.2017.1340572>
- Wang, E., & Alvi, E. (2007). Relative efficiency of government spending and its determinants: Evidence from East Asian countries. *Eurasian Economic Review*, 1, 3-28. <https://doi.org/10.14208/BF03353822>
- Zamani, A., & Pour-Atashi, M. (2024). Efficiency and effectiveness of graduate theses and dissertations in higher education disciplines in solving higher education problems and meeting national needs: Barriers and solutions. *Quarterly Journal of Research and Planning in Higher Education*, 30(4), 81-102. <https://doi.org/10.61838/KMAN.IRPHE.30.4.5>