

In the globalized, highly competitive and volatile environments such as in the nowadays time, it is crucial for the decision making units (DMUs), such as firms, once they implement a certain strategic plan (for example, a production plan) to analyze whether they managed to efficiently implement the plan or, on the contrary, if they failed in some aspects of its implementation. It is usual, using a sample of DMUs representing a similar technology (for example, companies in the same sector), to determine the frontier of the best practice DMUs and to evaluate the distance of each evaluated DMU to this frontier, estimating the technical efficiency and/or productivity change over time. This enables also to determine the targets in the input and output levels to follow in order to improve the efficiency in the future as well as the leading DMUs that could serve as benchmarks for the learning process and improvement.

The measurement of efficiency and productivity change over time of DMUs continues to attract a considerable attention in the scientific literature, at the same time being a relevant topic for managers and policy-makers. This measurement allows to answer the question on how well the unit transforms its inputs into outputs relative to the benchmark of the best practice units (that is so called efficient frontier), and as a result to measure units' performance. Among the methods for the measurement of efficiency and productivity change, the envelopment techniques of Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) gained popularity, because they are flexible and do not impose restrictive assumptions on the parametric specification of the technology and the distribution of efficiency.

From the methodological point of view, the major challenge in DEA and FDH research is that the standard versions of these methods are deterministic that is they assume that sample data is observed without measurement errors, sample noise or specification errors of the model's variables. Related challenge is the investigation of the efficiency scores obtained using DEA and FDH regarding their robustness or sensitivity against some changes in data such as adding or omitting DMUs, or adding or withdrawing some input or output measures. Recently, investigations of DEA and FDH have been enriched with machine learning techniques. Machine learning is used mainly to estimate production frontier to move DEA and FDH towards more stochastic approaches, or to analyze the results obtained in calculations using DEA and FDH. In essence, machine learning is a set of modern techniques based on computer algorithms that make improvements automatically from the experience. These include e.g., classification and regression trees, bagging, random forest, neural networks, boosting and support vector machine.

From the empirical point of view, DEA and FDH were widely applied for the analysis in many different fields, including banking, education, health care, agriculture, manufacturing, energy, tourism and transportation. There exists relatively little research in the areas of application regarding the efficiency and/or productivity change of justice system in Poland as well as the analysis of investment portfolios' efficiency and/or productivity with inclusion of the sustainability dimension of performance.

An in-depth literature review indicates that although an intensive research has been done for DEA and FDH techniques on the deterministic nature of these methods and the robustness of the findings, and in terms of empirical applications for court and portfolio efficiency and/or productivity change, still many important research problems have not been solved so far. The main objectives of this project are, on the one hand, to move the frontier of the methodological knowledge within the field of DEA and FDH regarding their deterministic nature and robustness of the findings using machine learning techniques, and, on the other hand, to apply DEA and FDH techniques to less investigated empirical contexts including courts in Poland and portfolios with sustainability criteria.

In addition to scientific aspect, the results of the investigations undertaken in the project may be important to various stakeholders such as managers of DMUs, other decision makers and public policy makers. Efficiency measures based on DEA and FDH that will be developed and applied in the project consist of performance indicators, therefore they supply useful information which may help both the worst and the best DMUs to make improvements in the future. The results of the project's investigations may be also important to policy makers to design the public policies to improve the performance of sectors or to assess the effectiveness of policies already implemented.