

Article

Assessing the Efficiency and Total Factor Productivity of Social Protection Expenditure: A Study of CEE Countries

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Abstract

Reducing poverty and income inequality is a major objective of contemporary social policy. Considerable financial resources are spent on social protection to support this purpose. Since these resources are limited, their efficient use is important for improving poverty and income inequality outcomes. The aim of this study is to assess the efficiency and productivity of social protection expenditure in eleven Central and Eastern European (CEE) EU Member States through Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI). Three input-oriented DEA models are estimated for 2016–2023, including two poverty-oriented models and one income-distribution-oriented model. The results indicate high efficiency and scale efficiency across countries, but favourable results in both poverty-oriented models are not necessarily accompanied by similar results in the income-distribution-oriented model. MPI decomposition shows that productivity dynamics in the poverty-oriented models reflect mainly technical efficiency changes before the COVID-19 pandemic and technological change thereafter, whereas productivity dynamics in the income-distribution-oriented model reflect mainly technical efficiency changes throughout the period.

Keywords: CEE; social protection expenditure; efficiency; DEA; poverty; income inequality; income distribution; MPI

1. Introduction

Reducing poverty and income inequality is widely recognized as central and inter-dependent objectives of the contemporary socio-economic policy framework, as explicitly articulated in the 2030 Agenda for Sustainable Development, particularly under Goal 1 (No Poverty) and Goal 10 (Reduced Inequalities) (United Nations, 2015). In this context, social protection policies constitute an important instrument for improving distributive outcomes and reducing socio-economic vulnerability across the life cycle (Oliveira et al., 2023; Carraro & Marzi, 2021). The term “social protection” is closely related to concepts such as social security and welfare (Standing, 2007). More precisely, social protection refers to all measures undertaken by public or private institutions aimed at reducing the burden on individuals and households arising from specific social risks or needs, without involving any direct reciprocal exchange or individual arrangement. Within the European system of the integrated social protection statistics (ESSPROS) framework, social protection covers measures addressing the following: sickness; disability; old age; survivors; family/children; unemployment; housing; social exclusion not elsewhere classified (European Commission, 2019, 2022a). The implementation of these measures requires significant financial resources.



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Accordingly, social protection expenditure is widely recognized as a fundamental component of welfare policies and a main factor for stability and growth (Inam & Murat, 2025; Cammeraat, 2020; Crociata et al., 2020; Marx et al., 2015; Baldini et al., 2018). Recent OECD evidence indicates that the COVID-19 pandemic and the subsequent cost-of-living crisis have highlighted the importance of strengthening social protection systems to better support vulnerable households during periods of economic shocks (Immervoll & Pastiner, 2025). Against this background, an important question concerns not only the scale but also the efficiency with which such expenditure contributes to distributive outcomes. Data Envelopment Analysis (DEA) is one of the most frequently used methods for assessing the efficiency of public expenditure because it allows the simultaneous evaluation of multiple inputs and outputs without imposing restrictive assumptions regarding the underlying functional form (Gonzales-de-Julian et al., 2024; Angelov & Nikolova, 2025; Tone et al., 2020; Simar & Wilson, 2011). Social protection expenditure constitutes a major instrument of state redistribution policy and, while addressing diverse social risks, are generally considered to contribute—either directly or indirectly—to reducing income inequality and poverty (Afonso et al., 2008; Korpi & Palme, 1998; International Labour Office, 2014; World Bank, 2018). In relation to this, the purpose of the present study is to estimate the efficiency and productivity of social protection expenditure in eleven Central and Eastern European (CEE) EU Member States through DEA and MPI. The focus on CEE EU Member States is justified by their shared post-socialist transition, EU-driven institutional transformation, and common catching-up growth model. However, they cannot be considered fully uniform, as different countries have followed different paths and face different challenges (Yotova & Stefanova, 2017; Stefanova & Velichkov, 2020; Landesmann, 2010). Despite ongoing convergence within the EU, CEE economies retain distinct structural characteristics, presented in comparatively lower levels and a different composition of social protection expenditure than those observed in more advanced EU Member States (Schuknecht, 2022).

Empirical evidence on the efficiency of social protection expenditure in CEE EU Member States remains limited and fragmented, particularly in post-transition economies. Existing studies typically focus on public social protection expenditure, while far less attention is paid to the combined contribution of public and private sector expenditure. Therefore, the present study examines social protection expenditure through the lens of poverty reduction and income inequality, in line with the objective of the 2030 Agenda for Sustainable Development, particularly Goal 1 (No Poverty) and Goal 10 (Reduced Inequalities). Focusing on eleven CEE EU Member States over the period 2016–2023, the analysis provides a comparative assessment of the efficiency with which overall social protection expenditure is associated with redistributive outcomes.

The remainder of the paper is structured as follows. Section 2 reviews the literature on the application of DEA in assessing the efficiency of social protection expenditure. Section 3 presents the research methodology and data. Section 4 reports and discusses the empirical findings. Finally, Section 5 concludes the paper.

2. Literature Review

Most of the DEA models are based on the general perception that the social protection expenditure diminishes the level of income inequality and poverty (Yu & Li, 2021; Zhao et al., 2017; Popova, 2023). There is a strong relationship between the latter two phenomena as well as cases in which social expenditure affects the level of income inequality without significantly impacting the level of poverty, as well as the opposite (Amponsah et al., 2023; Cammeraat, 2020; Selim & Küçükçifçi, 2025). In this connection, several studies provide empirical evidence. For example, Atici and Acar (2025) established that higher government expenditure on social protection has a negative effect on the level of inequality

measured with the Gini coefficient, i.e., it reduces it (Atici & Acar, 2025). At the same time, empirical studies examining the reduction in poverty levels as a consequence of government expenditure on social protection indicate that the intended effect has not been achieved primarily due to insufficiently precise targeting of such expenditure towards low-income populations (Kuntjorowati et al., 2024; Hamid, 2021; International Labour Office, 2021). Cyrek (2019) similarly focuses on reducing income inequality and poverty. The author applies two DEA input-oriented models. General government expenditure as percent of GDP in three functional areas according to the Classification of the Functions of Government (COFOG) and namely social protection, education and health are used as inputs while poverty reduction and changes in income inequality are used as outputs. The results show differences in efficiency across countries, with Ireland achieving the highest efficiency scores. The Malmquist Productivity Index (MPI) analysis further reveals declining productivity in poverty reduction in a number of countries and improving productivity in income inequality reduction in several cases. Taken together, these studies suggest that social protection expenditure generally contributes to improving distributive outcomes. However, the reported efficiency levels vary considerably depending on the choice of input–output variables, country coverage and methodological specification.

The efficiency of public expenditure aimed at reducing poverty and income inequality is also examined by Müller et al. (2022). The authors develop two DEA models using public expenditure per capita as input for reducing income inequality and poverty in 27 EU Member States. The first model employs the Gini index and income quintile ratio, while the second uses at-risk-of-poverty-or-social-exclusion rate and at-risk-of poverty rate before and after transfers. The Netherlands, Slovenia, and Finland emerge as the most efficient, whereas Bulgaria and Romania are the least efficient (Müller et al., 2022).

A significant contribution to this literature is provided by Afonso et al. (2008), who evaluate the efficiency of social expenditure in 26 OECD countries using three input-oriented DEA models under variable returns to scale. The common input is average social expenditure as a percentage of GDP, defined according to the OECD methodology (OECD, 2019), while the outputs include transformed measures of income inequality, poverty and the income share of the bottom 40% of the population (Afonso et al., 2008). These internationally comparable indicators are widely used in the literature by other authors such as Andres-Sanches et al. (2021), Antonelli and De Bonis (2017), Niehues (2010) and Cammeraat (2020). Afonso et al. (2008) established moderate efficiency levels, suggesting that similar distributive outcomes could be achieved with lower expenditure levels. Their Tobit analysis also shows that efficiency depends not only on spending levels but also on education, institutional quality, and administrative capacity (Afonso et al., 2008). Raguseo and Kuvicová (2010) combine DEA with MPI to analyze public expenditure on education, healthcare and social services in selected CEE countries. The results show relatively stable efficiency levels and modest productivity growth mainly due to technological progress. The study also finds efficiency reserves, claiming that expenditure level could be reduced without significant loss of outcomes (Raguseo & Kuvicová, 2010). An important methodological development in this literature is the increasing application of the Malmquist Productivity Index alongside DEA, allowing researchers to examine not only efficiency levels but also productivity changes over time.

In addition to overall social protection expenditure, many studies focus on pensions, social exclusion and housing. These components of social protection are important because they contribute to poverty reduction and influence income distribution (Bridgen et al., 2025; Valls Martínez et al., 2021; Wang & Huang, 2023; Morici & Vigna, 2025; Jorgensen, 2024; Iafrazi, 2026; Ayed & Clarke, 2025). In this regard, Halaskova et al. (2021) examine the efficiency of pension expenditure and social exclusion/housing expenditure across 28

European countries using two output-oriented DEA models. The study is based on data from ESSPROS, while the output variables include indicators of pension adequacy, poverty, material deprivation, low work intensity, housing-cost overburden, and overcrowding. The results from the study show differences across countries in the efficiency of pension expenditure, while the efficiency of social exclusion and housing-related expenditure is more similar across the analyzed countries. The MPI also points to an increase in productivity, which is mainly due to technological change rather than improvements in technical efficiency change (Halaskova et al., 2021).

The literature also discusses the role of housing in social protection. Housing conditions affect living standards and the risk of poverty, while inadequate housing protection may contribute to social and economic disadvantages (Martínez del Olmo, 2026; Gouseti et al., 2026; Brigitte, 2024). Additional evidence underlines the role of housing policy, proving that tenants in public rental housing save significantly more than tenants in the private rental sector (Zhang et al., 2025). With regard to pension system efficiency, a related analysis is conducted by Toma and Daniel (2019). They analyze the efficiency and productivity of the pension system in 26 European countries over 2007–2015 using the DEA—Malmquist approach. The results show a slight increase in total factor productivity, mainly as a result of technological change, while improvements in technical efficiency are more limited and differ across countries (Toma & Daniel, 2019).

Another important area concerns active labour market policies, whose effect on poverty and income inequality remains ambiguous in the empirical literature (Niño-Zarazúa & Torm, 2022; World Bank, 2012; Szulk-Obloza & Szczepaniak, 2024; Burniaux et al., 2006). Bordignon et al. (2020) analyze whether public resources directed to active labour market policies are transformed into labour market outcomes across EU Member States. Using public expenditure per capita as the input and employment-related indicators as outputs, they report inefficiency levels ranging from 9% to 33%, implying that such labour market outcomes could be achieved with lower expenditure levels (Bordignon et al., 2020). Since labour market outcomes are influenced by institutional and environmental conditions, DEA efficiency scores should be interpreted with caution (Cichowicz et al., 2021; Rollnik-Sadowska & Bartkutė Norkūnienė, 2024; Arpaia & Mourre, 2009; Huang, 2023). Müller et al. (2022) evaluate the efficiency of active labour market policies across 27 EU Member States using DEA. OECD studies show that short-time work schemes helped maintain employment during the COVID-19 crisis (Müller et al., 2022; OECD, 2020, 2021b).

Beyond the DEA-based literature, Ghetan and Paierele (2020) study the relationship between social protection expenditure, economic growth, income inequality and poverty using panel data for five CEE countries—Bulgaria, Czech Republic, Hungary, Poland and Romania. They find that economic growth reduces poverty, whereas income inequality increases it and emerges as its strongest determinant. Social protection expenditure helps to reduce inequality, but their direct effect on poverty remains limited (Ghetan & Paierele, 2020).

Similarly, Cardoso et al. (2023) analyze the relationship between social protection expenditure and economic growth using a structural VAR model for 42 countries. They find that higher social protection spending is associated with stronger GDP growth, which the authors link to the higher propensity to consume of lower-income households receiving social transfers. Their results also suggest that social protection expenditure supports both economic growth and income redistribution (Cardoso et al., 2023).

The results presented in the literature differ across studies depending on the selected indicators, methodological specifications and country coverage. Most studies focus either on specific components of social protection systems or on groups of developed economies. Evidence for CEE EU Member States is more limited, particularly with regard to social

protection expenditure measured according to the ESSPROS framework and examined from both efficiency and productivity perspectives. The present study addresses this issue by applying DEA and the MPI to assess the efficiency and productivity of social protection expenditure in CEE EU Member States and their association with poverty and income inequality outcomes during a period of continued convergence within the European Union (Olteanu, 2025).

3. Research Methodology

DEA is a non-parametric method for assessing the relative efficiency of a set of decision-making units (DMUs). Based on data on input and achieved output, an empirical efficiency frontier is established, defining the best-performing units in the sample. This frontier represents the maximum attainable outputs for a given level of inputs or the minimum required inputs to achieve a given level of outputs. Efficient DMUs lie on the frontier and receive a score of one, while inefficient units obtain scores below one, indicating potential for improvement (Šporčić & Landekić, 2014; Stefanova & Velichkov, 2019; Krištáková et al., 2021; Neykov et al., 2019).

Two main DEA models are commonly distinguished in the literature. The CCR model, developed by Charnes et al. (1978), is based on the assumption of constant returns to scale (CRS), whereas the BCC model, proposed by Banker et al. (1984), allows for variable returns to scale (VRS) (Banker et al., 1984; Charnes et al., 1978). DEA models can be specified as either input-oriented or output-oriented. In input-oriented models, the objective is to minimize the use of input while maintaining a given level of outputs, whereas output-oriented models aim to maximize outputs for a given level of inputs (Ramanathan, 2003; Huguenin, 2012).

In the present study, an input-oriented BCC model is applied assuming variable returns to scale (VRS). The VRS approach is preferred to the CRS assumption because it accounts for differences in the operational scale of the analyzed DMUs and allows multiple input–output combinations to be evaluated as efficient (Angelov & Nikolova, 2025; Stefanova & Velichkov, 2020). An input-oriented model is additionally considered appropriate, as social protection systems exercise comparatively greater control over the allocation and utilization of input resources, whereas the demand for social services and related social outcomes remains largely exogenous. For this reason, the analysis focuses on the potential of social protection expenditure while maintaining the observed levels of poverty and income inequality. This is in agreement with the objective of assessing the relative efficiency of social protection expenditures across the analyzed countries. An output-oriented model would address a different research question by examining the potential improvement in social outcomes for a given level of expenditure. Therefore, the selected input-oriented specification is considered more appropriate for the purpose of the present study. Such an approach is particularly appropriate in the context of social protection systems, where institutional, demographic and financial heterogeneity limits the ability of the analyzed units to operate at an optimal scale. An input-oriented DEA BCC model has also been applied by Halaskova et al. (2021), Müller et al. (2022), Gaska et al. (2022), Bordignon et al. (2020), Talha and Makhoul (2025), etc., (Halaskova et al., 2021; Müller et al., 2022; Gaska et al., 2022; Bordignon et al., 2020; Talha & Makhoul, 2025). The DEA model based on the BCC framework proposed by Banker et al. (1984) is presented below (Banker et al., 1984; Coelli, 1996; Zhu, 2014):

$$\begin{aligned}
 &\theta^* = \min \theta \\
 &\text{s.t:} \\
 &\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{i0} \quad i = 1, 2, \dots, m \\
 &\sum_{j=1}^n \lambda_j y_{rj} \geq y_{r0} \quad r = 1, 2, \dots, s \\
 &\sum_{j=1}^n \lambda_j = 1; \lambda_j \geq 0, \quad j = 1, 2, \dots, n
 \end{aligned} \tag{1}$$

where θ^* denotes the efficiency score of DMU_0 . A value of $\theta^* = 1$ indicates that DMU_0 is efficient, whereas $\theta^* < 1$ implies inefficiency.

n —the number of DMUs under evaluation;

x_{i0} —the i -th input of DMU_0 , with $i = 1, \dots, m$, where m denotes the total number of inputs;

y_{r0} —the r -th output of DMU_0 , with $r = 1, \dots, s$, where s denotes the total number of outputs;

λ_j —the intensity variable representing the contribution of DMU_j to constructing the hypothetical reference unit for DMU_0 .

The CCR model differs from the BCC model presented above in that it assumes CRS and does not include the convexity constraint $\sum_{j=1}^n \lambda_j = 1$. Based on the estimated technical efficiency scores obtained under the CRS and VRS assumptions, scale efficiency (SE) is calculated as the ratio of CRS to VRS technical efficiency scores (Neykov et al., 2019).

After defining the DEA model, the next step is to select the input and output variables used in the empirical analysis. Three input-oriented models are constructed, using social protection expenditure as the single input variable, measured as a percentage of GDP which allows the controlling of differences in economic size and ensures the comparability of fiscal effort, based on Eurostat data in accordance with ESSPROS. The use of ESSPROS data ensures cross-country comparability as it relies on a harmonized accounting system that records social protection schemes by function, financing source and institutional sector, covering all institutional sectors, including both public and private entities, and providing a comprehensive view of total social protection expenditure financed across sectors (European Commission, 2019, 2022a). The analysis covers the period 2016–2023, which is determined by data availability and comparability across CEE EU Member States, all sourced from Eurostat. The output variables correspond to the core objectives of social protection systems—reducing income inequality and poverty, which are widely recognized in the literature as key dimensions of distributive outcomes. The Gini coefficient is included in all models, while the poverty dimension differs. The first model uses the at-risk-of-poverty rate, defined as the share of individuals with equivalized disposable income below 60% of the national median after social transfers, based on the European Union Statistics on Income and Living Conditions (EU-SILC) (European Commission, 2019, 2022b, 2025; Cassio, 2026). The second model applies a stricter threshold of 40% of median equivalized income, presenting more severe poverty and providing for a more focused assessment of outcomes at the lower end of the income distribution. This formulation provides a stricter assessment of social protection expenditure efficiency with respect to the lowest income groups. The third model combines the transformed Gini coefficient with the income share of the poorest 40% of the population, constructed as the sum of the income share of the first and second quintiles based on EU-SILC data provided by Eurostat. The inclusion of this indicator is supported by Afonso et al. (2008), who identify the income share per quintile as a widely used indicator of income distribution, with the income share of the poorest or the poorest one or two quintiles most commonly examined (Afonso et al., 2008). While the Gini coefficient presents overall inequality, the income share of the bottom 40% provides a direct measure of the distribution of income towards lower-income groups, which is particularly relevant in the context of social protection efficiency analysis. For the

purposes of the analysis, the first two models can be conditionally regarded as poverty-oriented, while the third model can be conditionally regarded as income-distribution-oriented. This distinction is based solely on the second output variable included in each DEA specification. As the Gini coefficient and the poverty indicators (i.e., the at-risk-of-poverty rate at 60% and the severe-poverty threshold at 40% of median equivalized income) represent undesirable outcomes, they are transformed prior to the DEA estimation by applying a linear transformation defined as $y_i^* = 100 - y_i$. This transformation allows these indicators to be treated as desirable outputs in the DEA model. This approach is the same as that used by Afonso et al. (2008), who transform both the Gini coefficient and the poverty rate in the same manner when using them as DEA outputs. Following Afonso et al. (2008), the Gini coefficient is also combined with complementary income distribution indicators, such as poverty measures, which reflect different aspects of income distribution. The selection of these variables is based on the literature review. The analysis covers the complete set of CEE EU Member States for which harmonized ESSPROS and EU-SILC data are available throughout the study period. Consequently, the number DMUs is determined by data availability rather than by sampling decisions. The DEA specifications are deliberately parsimonious, employing one input and two output variables. Accordingly, the proposed DEA models satisfy the commonly applied rule of thumb requiring the number of DMUs to be at least three times the total number of inputs and outputs, thereby preserving adequate discriminatory power (Cooper et al., 2011; Křišťáková et al., 2021).

In line with the classical DEA framework and the predominant methodological approach adopted in studies evaluating the efficiency of social protection expenditures (e.g., Afonso et al., 2008; Cyrek, 2019; Halaskova et al., 2021; Gaska et al., 2022), the input and output variables refer to the same observation period. As DEA is a static benchmarking technique rather than a dynamic causal model (Bordignon et al., 2020), the estimated efficiency scores should be interpreted as measures of contemporaneous relative efficiency rather than evidence of immediate causal effects.

To examine productivity dynamics, the Malmquist Productivity Index (MPI) is used as a non-parametric measure of total factor productivity (TFP) change over time. The distance functions used for the estimation of the MPI are evaluated under VRS technology. The input-oriented MPI is defined as follows (Färe et al., 1989, 1992, 1994; Coelli et al., 1998):

$$MPI_{t+1} = EFFCH_{t,t+1} \times TECHCH_{t,t+1} \quad (2)$$

$$MPI_{t+1} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \times \sqrt{\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}} \quad (3)$$

where MPI_{t+1} denotes the Malmquist Productivity Index measuring the change TFP between periods t and $t + 1$ (Kaur & Aggarwal, 2017).

The first component of Equation (2), denoted as $EFFCH_{t,t+1}$ and expressed in Equation (3) as $\frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}$, measures the change in technical efficiency (catch-up effect) between periods t and $t + 1$ (Johnes, 2006).

The second component of Equation (2), denoted as $TECHCH_{t,t+1}$ and expressed in Equation (3) as $\sqrt{\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}}$, measures shift in the production frontier between periods t and $t + 1$ (Křišťáková et al., 2021; Johnes, 2006).

4. Results and Discussion

4.1. Descriptive Statistics of Social Protection Expenditure and Distributive Outcomes

The descriptive statistics presented in Table 1 indicate moderate cross-country differences in both social protection expenditure and distributive outcomes among the analyzed

CEE EU Member States during 2016–2023. In this regard, social protection expenditure as a percentage of GDP remains relatively stable throughout the analyzed period, despite a temporary increase in 2020 and 2021 associated with the fiscal response to the COVID-19 pandemic (Aidukaite et al., 2021). Average expenditure levels increase from 18.25% in 2016 to 20.49% in 2020 before declining to 19.21% in 2023.

Table 1. Summary descriptive statistics of input and outputs during the period 2016–2023.

Indicators	Descriptive Statistics	2016	2017	2018	2019	2020	2021	2022	2023
Social protection expenditure as % of GDP	Min	14.87	14.88	14.99	15.28	17.77	16.68	15.80	16.62
	Max	23.49	22.82	22.40	22.43	26.38	25.24	24.26	23.12
	Average	18.25	17.83	17.81	17.99	20.49	19.93	18.87	19.21
	SD	2.78	2.65	2.36	2.44	2.89	2.66	2.52	2.30
Gini coefficient	Min	24.30	23.20	20.90	22.80	20.90	21.80	21.20	21.60
	Max	37.70	40.20	39.60	40.80	40.00	39.70	38.40	37.20
	Average	30.75	30.51	30.21	30.17	29.65	29.88	29.42	29.49
	SD	4.93	5.58	6.05	5.78	5.76	5.79	5.56	5.08
Share of individuals with equivalized disposable income below 60% of the national median equivalized income after social transfers, %	Min	9.70	9.10	9.60	10.10	9.50	8.60	10.20	9.80
	Max	25.30	23.60	23.50	23.80	23.80	23.40	22.90	22.50
	Average	18.29	17.84	17.78	17.57	17.34	17.13	17.41	17.38
	SD	4.98	5.26	5.28	5.06	5.11	5.14	4.85	4.52
Share of individuals with equivalized disposable income below 40% of the national median equivalized income after social transfers, %	Min	2.6	2.20	1.80	2.10	1.70	2.20	2.40	2.50
	Max	13.5	12.10	12.60	11.80	11.20	12.40	10.30	11.50
	Average	7.10	6.84	6.69	6.69	6.18	6.21	6.16	6.62
	SD	3.14	3.07	3.35	2.95	3.08	3.07	2.53	2.65
Income share of the poorest 40% of the population, %	Min	17.20	16.50	17.00	16.40	16.60	17.00	16.40	18.00
	Max	24.70	25.00	26.20	25.10	26.10	25.50	26.20	25.60
	Average	20.75	20.94	21.12	21.17	21.51	21.42	21.19	21.59
	SD	2.95	3.16	3.38	3.20	3.16	3.19	3.02	2.86

Source: authors' calculations.

Alongside the expenditure dynamics, the distributive indicators suggest moderate improvements in income distribution and poverty reduction. The average Gini coefficient declines from 30.75 in 2016 to 29.49 in 2023, while the at-risk-of-poverty rate decreases from 18.29% to 17.38% over the same period. Similarly, the severe-poverty indicator declines from 7.10% to 6.62%, whereas the income share of the poorest 40% of the population increases from 20.75% to 21.59%.

4.2. DEA Efficiency Analysis of Social Protection Expenditure

Following the descriptive statistics, Tables 2–4 report the DEA efficiency scores obtained under the three DEA models. The results provide a comparative assessment of the efficiency of social protection expenditure in generating distributive outcomes related to income inequality and poverty reduction across the examined CEE EU Member States during the 2016–2023 period.

Table 2. BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 1: income inequality and at-risk-of-poverty reduction model, 2016–2023.

DMU NAME, Country	2016	2017	2018	2019	2020	2021	2022	2023
Bulgaria	0.88	0.89	0.97	0.93	0.95	0.89	0.84	0.85
Croatia	0.97	0.75	0.76	0.76	0.76	0.77	0.79	0.82
Czechia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Estonia	0.96	0.99	0.99	0.99	0.95	0.99	1.00	0.96
Hungary	0.93	0.94	0.99	1.00	1.00	1.00	1.00	1.00
Latvia	1.00	0.99	0.96	0.95	0.99	0.84	0.84	0.92
Lithuania	1.00	0.99	0.97	0.96	0.92	0.92	0.96	0.98
Poland	0.80	0.83	0.88	0.78	0.78	0.79	0.81	0.77
Romania	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00
Slovakia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Slovenia	0.78	0.79	0.78	0.79	0.72	0.76	0.78	0.85
Average for year	0.94	0.92	0.94	0.92	0.92	0.91	0.91	0.92
SD	0.08	0.09	0.08	0.09	0.10	0.10	0.09	0.08

Source: authors' calculations.

Table 3. BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 2: income inequality and severe-poverty reduction, 2016–2023.

DMU NAME, Country	2016	2017	2018	2019	2020	2021	2022	2023
Bulgaria	0.87	0.89	0.93	0.94	0.95	0.90	0.84	0.86
Croatia	0.77	0.76	0.77	0.77	0.76	0.78	0.79	0.83
Czechia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Estonia	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.98
Hungary	0.93	0.93	0.96	1.00	1.00	1.00	1.00	1.00
Latvia	1.00	1.00	0.99	0.97	0.99	0.85	0.84	0.93
Lithuania	1.00	1.00	0.99	0.97	0.93	0.93	0.95	0.98
Poland	0.81	0.82	0.86	0.80	0.79	0.80	0.83	0.84
Romania	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00
Slovakia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Slovenia	1.00	1.00	0.79	0.81	0.79	1.00	1.00	1.00
Average for year	0.94	0.95	0.94	0.93	0.92	0.93	0.93	0.95
SD	0.08	0.08	0.08	0.09	0.09	0.08	0.08	0.07

Source: authors' calculations.

- **DEA Efficiency Results under Model 1: Income Inequality and At-Risk-of-Poverty Reduction**

The BCC efficiency scores (VRSTE) reported in Table 2 indicate relatively high levels of efficiency in the use of social protection expenditure for reducing income inequality and the at-risk-of-poverty rate across the analyzed CEE EU Member States during 2016–2023. The average annual efficiency scores remain relatively stable throughout the period, ranging between 0.91 and 0.94, which means limited variation in the average level of pure technical efficiency over time.

Table 4. BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 3: income inequality and bottom 40% income share, 2016–2023.

DMU NAME, Country	2016	2017	2018	2019	2020	2021	2022	2023
Bulgaria	0.86	0.88	0.81	0.92	0.95	0.89	0.85	0.86
Croatia	0.77	0.76	0.75	0.76	0.76	0.78	0.79	0.82
Czechia	1.00	1.00	0.94	0.96	0.88	0.88	0.87	0.90
Estonia	0.97	0.99	0.97	0.99	0.95	0.99	1.00	0.96
Hungary	0.92	0.93	0.91	1.00	1.00	1.00	1.00	1.00
Latvia	0.99	0.97	0.92	0.95	0.99	0.84	0.84	0.92
Lithuania	0.96	0.99	0.90	0.94	0.92	0.92	0.94	0.98
Poland	0.80	0.82	0.84	0.78	0.78	0.79	0.81	0.78
Romania	1.00	1.00	0.97	1.00	1.00	1.00	0.95	1.00
Slovakia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Slovenia	0.78	0.79	0.77	0.79	0.72	0.76	0.73	0.83
Average for year	0.91	0.92	0.89	0.92	0.90	0.90	0.89	0.91
SD	0.09	0.09	0.08	0.09	0.10	0.09	0.09	0.08

Source: Authors' calculations.

Nevertheless, cross-country differences in efficiency performance are observed, which is supported by previous evidence showing that social protection expenditure vary in their ability to reduce poverty and income inequality across EU Member States (Wildowicz-Szumarska, 2022; Sánchez & Navarro, 2021). A similar conclusion is reported by Fonayet et al. (2020), who show that higher levels of social expenditure are not necessarily associated with a greater capacity to reduce poverty across EU Member States, highlighting that differences in expenditure levels alone cannot explain differences in social outcomes. As illustrated in Figure 1, Czechia and Slovakia occupy the highest positions in the country ranking and operate on the efficiency frontier throughout the entire period, while Romania and Hungary also achieve efficiency scores equal or close to unity in most years. These countries therefore appear to transform social protection expenditure into poverty- and inequality-reducing outcomes more efficiently than the rest of the sample. This is particularly evident in Czechia and Slovakia, where comparatively favourable poverty and inequality outcomes are achieved without high levels of social protection expenditure (Piekut & Rybaltowicz, 2024).

Latvia, Lithuania and Estonia maintain comparatively high efficiency levels, although a moderate decline is observable after 2020, particularly in Latvia. This deterioration may be associated with the vulnerability of the countries to socio-economic shocks (Masso et al., 2012), with the challenges related to the expansion of social protection measures during the COVID-19 period (Aidukaite et al., 2021).

In contrast, Slovenia, Croatia and Poland record the lowest efficiency levels during most of the analyzed period, indicating a less efficient transformation of social protection expenditure into poverty- and inequality-reducing outcomes. One possible explanation for Slovenia's comparatively lower efficiency is that the European Commission (2024b) identifies persistent shortcomings in the country's social protection system. In particular, old-age poverty remains a challenge, especially among women, while the poverty-reducing effect of social benefits other than pensions declined significantly between 2021 and 2022. These weaknesses may partly contribute to Slovenia's comparatively lower DEA efficiency scores. Bulgaria occupies an intermediate position, remaining close to the sample average

but below the performance of the most efficient countries. The observed differences in poverty- and inequality-related outcomes across CEE countries cannot be explained only by the level of social protection expenditure. As argued by Afonso et al. (2008), Cyrek (2019) and Ghetan and Paierele (2020), institutional capacity and expenditure targeting also play an important role in shaping distributive outcomes. According to Steinbacher (2024), differences in welfare performance depend not only on the level of social expenditure but also on institutional arrangements. This interpretation is supported by the high DEA efficiency scores observed for Czechia and Slovakia throughout the study period. A recent systematic review of the literature on income inequality in Central and Eastern Europe reports that these two countries have demonstrated greater resilience to inequality owing to efficient tax and social policies developed during the post-transition period. Such institutional characteristics may partly explain their high DEA efficiency scores, as they may facilitate a more efficient transformation of social protection expenditure into favourable distributive outcomes (Dorjnyambuu, 2025).

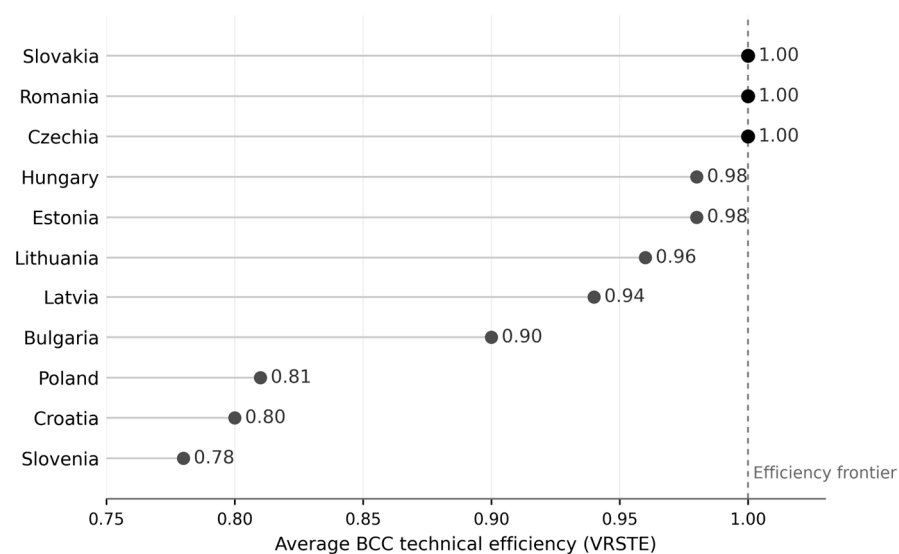


Figure 1. Average BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 1: income inequality and at-risk-of-poverty reduction model, 2016–2023. Source: authors' calculations.

Additional DEA results reported in Appendix A, Table A1, including overall technical efficiency under CRS (CRSTE), scale efficiency (SE) and returns-to-scale (RTS) classifications, indicate generally high scale-efficiency levels throughout the study period, with average scores ranging between 0.91 and 0.99. The high scale-efficiency values give ground for the conclusion that most countries are functioning relatively close to the optimal scale under CRS, leaving limited opportunities for improvements through changes in the scale of social protection expenditure.

- **DEA Efficiency Results Under Model 2: Income Inequality and Severe-Poverty Reduction**

Table 3 presents the DEA results obtained under Model 2, in which the at-risk-of-poverty-rate used in Model 1 is replaced by the severe-poverty indicator, defined as the share of individuals with an equivalized disposable income below 40% of the national median. Average VRSTE scores remain high throughout the analyzed period (0.92–0.95). Czechia and Slovakia operate on the efficiency frontier during the entire period, whereas Romania and Hungary also maintain efficiency scores equal or close to unity in most years. In contrast, Croatia, Poland and Slovenia record the lowest efficiency levels. Figure 2

complements these findings by presenting the average VRSTE scores over the entire study period, confirming the leading positions of Czechia and Slovakia and the comparatively lower efficiency of Croatia and Poland. The similarity of country rankings obtained under Model 1 and Model 2 suggests that the observed efficiency differences are not driven by the choice of poverty threshold. The high efficiency of Czechia and Slovakia is in line with the evidence by [Dorjnyambuu \(2025\)](#), which is presented in the lines above. By contrast, the comparatively lower efficiency observed for Poland is in accordance with the European Commission's assessment that improving the efficiency of public spending and the targeting of social benefits remains a challenge, while universal social programmes could be better targeted to lower-income and vulnerable groups ([European Commission, 2024a](#)). To further examine whether these efficiency differences remain stable over time, the standard deviations of efficiency scores are analyzed. Czechia and Slovakia exhibit no variations in efficiency scores throughout the period, whereas Slovenia records the highest variation (10%), followed by Latvia (6%) and Bulgaria (4%). These results show that countries differ in the stability with which social protection expenditure is transformed into distributive outcomes over time. Annual standard deviations remain within a narrow range of 7–9%, showing that the differences in efficiency scores across countries change very little during the analyzed period. The scale-efficiency results reported in Appendix A, Table A2 provides insight into the role of operating scale. Average scale-efficiency values range between 0.94 and 0.99, showing that most of the analyzed countries operate close to the optimal scale. The RTS classifications remain highly consistent across Models 1 and 2. While decreasing returns to scale predominated at the beginning of the analyzed period, increasing returns to scale became more widespread by 2023. This pattern suggests that the scale properties of social protection systems changed over time, although the high scale-efficiency values indicate that most countries continued to operate close to their optimal scale. The identical distribution of RTS categories between the two models in the first and final years of the period provides additional evidence for the robustness of the DEA results. The close correspondence between the results obtained under Models 1 and 2 supports the thesis that social protection expenditure in the analyzed countries affect both broader poverty risk and severe poverty through similar mechanisms.

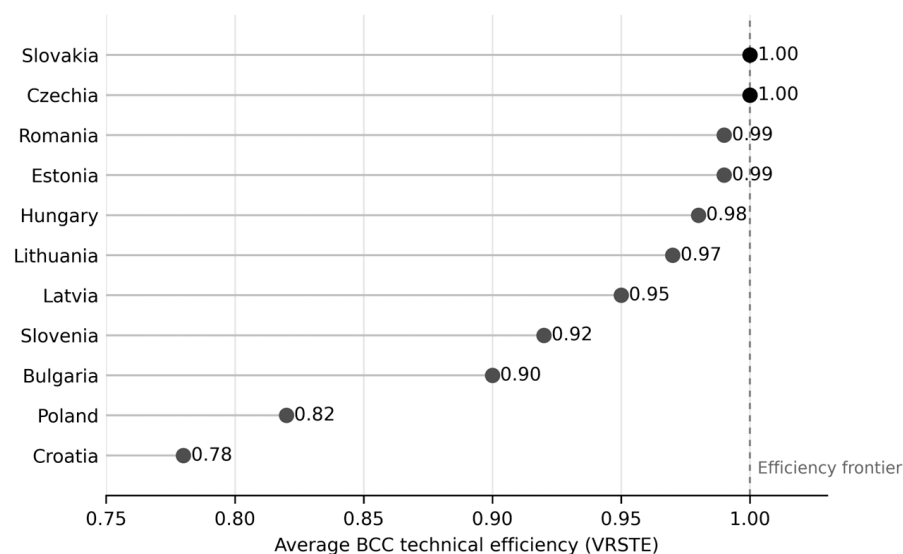


Figure 2. Average BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 2: income inequality and severe-poverty reduction, 2016–2023. Source: authors' calculations.

- **DEA Efficiency Results Under Model 3: Income Inequality and Bottom 40% Income Share**

Table 4 presents the DEA results obtained under Model 3, where the poverty indicators used in Models 1 and 2 are replaced by the income share of the bottom 40% of the population. Average VRSTE scores remain relatively high throughout the analyzed period (0.89–0.92), indicating a generally efficient transformation of social protection expenditure into distributive outcomes. Similarly to the previous models, Slovakia remains efficient through the entire period, while Romania, Estonia and Hungary continue to operate on or close to the efficiency frontier. Croatia, Slovenia and Poland record the lowest efficiency levels during most of the analyzed period. The comparatively lower efficiency of Croatia may partly reflect weaknesses in the targeting of social protection, as the [OECD \(2023\)](#) notes that social transfers other than pensions contribute less to reducing poverty and inequality than in most OECD countries, while a considerable share of social benefits is not means-tested. Similarly, the comparatively lower efficiency of Poland may partly reflect the broad design of recent family benefits, which, according to the [OECD \(2025\)](#), are not sufficiently targeted towards low-income households despite their contribution to reducing child poverty. The variation in VRSTE scores remains low, with standard deviations ranging from 0% in Slovakia to 6% in Latvia, showing relatively stable efficiency performance over time.

Compared to the previous two models, the use of the income share of the bottom 40% of the population leads to some changes in country rankings. The largest change is observed for Czechia, which moves from the group of frontier countries in Models 1 and 2 to a lower position in the ranking under Model 3. Figure 3 complements these findings by presenting the average VRSTE scores over the entire study period. It confirms that Slovakia achieved the highest average technical efficiency, followed by Czechia and Estonia, whereas Croatia and Poland recorded the lowest average efficiency scores. The comparatively lower ranking of Czechia relative to Models 1 and 2 may reflect the fact that, despite Czechia's very low overall poverty risk, important challenges remain for low-income households. The [European Commission \(2023a\)](#) notes that some households continue to struggle to make ends meet and recommends more targeted support for low-income households and community-based social services. This suggests that favourable aggregate poverty outcomes are not necessarily accompanied by equally favourable outcomes in terms of the income share of the bottom 40% of the population. However, the present analysis evaluates the efficiency of transforming social protection expenditure into observed distributive outcomes and does not identify the factors underlying these outcomes. Therefore, the differences across countries should be interpreted in terms of the observed results rather than the processes through which they were achieved. This result supports the point of view that poverty reduction and income distribution, although closely related, may respond differently to social policy interventions ([Fiszbein et al., 2014](#)). A similar conclusion is reached by [Ghetan and Paierle \(2020\)](#), who find that social protection expenditure contributes more strongly to reducing income inequality than to lowering poverty levels.

The scale-efficiency results reported in Appendix A, Table A3 remain high, with average values ranging between 0.94 and 0.99. RTS classifications are similar across the three DEA models and coincide completely by 2023, providing additional support for the stability of the estimated efficiency results. The consistency of the RTS classifications across alternative model specifications suggests that replacing the poverty indicators with the income share of the bottom 40% of the population affects mainly the relative technical efficiency scores rather than the underlying scale characteristics of the social protection systems.

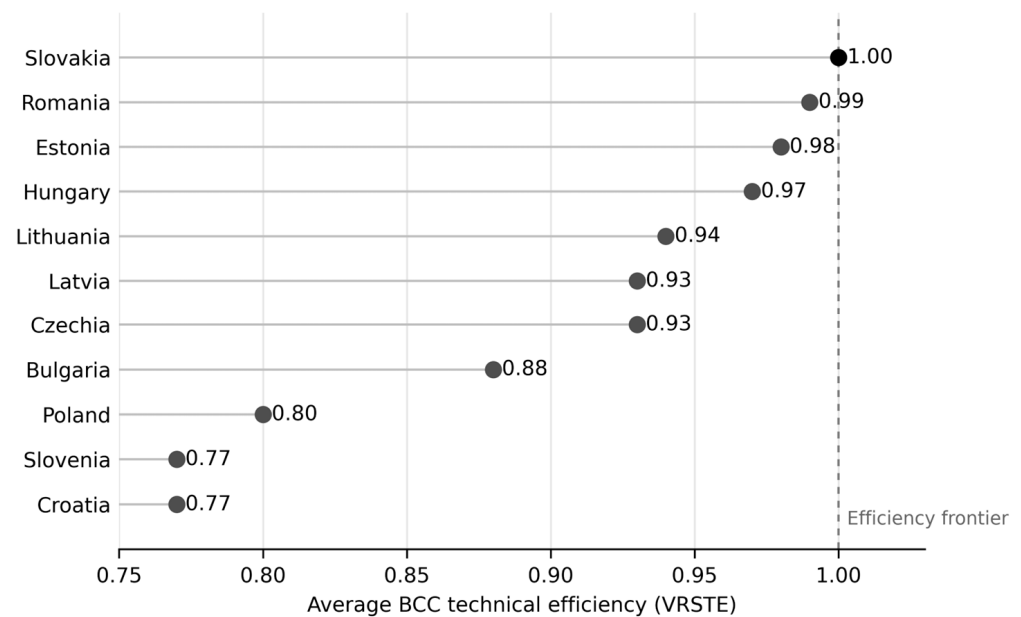


Figure 3. Average BCC technical efficiency scores (VRSTE) for social protection expenditure under Model 3: income inequality and bottom 40% income share, 2016–2023. Source: Authors' calculations.

4.3. Malmquist Productivity Index (MPI) Analysis

The static DEA results presented in Tables 2–4 are complemented by an analysis of TFP dynamics using the MPI. Whereas the DEA scores measure the relative efficiency of social protection expenditure in individual years, the MPI examines productivity changes over time and decomposes them into EFFCH and TECHCH. This decomposition makes it possible to distinguish between improvements resulting from a better use of available resources and those associated with shifts in the production frontier. The MPI is estimated under VRS for all three models. Results are reported for three sub-periods: 2016–2019, 2019–2020, and 2020–2023. This division distinguishes between the pre-pandemic period, the immediate effects of the COVID-19 shock, and the subsequent recovery phase. For the 2016–2019 and 2020–2023 sub-periods, MPI, EFFCH, and TECHCH values are reported as geometric means on the grounds of the standard practice in the Malmquist productivity literature (Färe et al., 1994; Coelli et al., 1998; Chen et al., 2024). For each country, the reported values represent the geometric means of the annual indices within the respective sub-period.

The interpretation of the MPI decomposition results is guided by the interpretative framework proposed by Cyrek (2019). Within this framework, changes in technical efficiency may be interpreted as reflecting differences in the use and allocation of social protection expenditure, including management practices and targeting, while technological change may be associated with institutional reforms and policy adjustments affecting the functioning of social protection systems. However, EFFCH and TECHCH remain measures of movements relative to the empirical production frontier and do not, by themselves, identify the specific managerial, institutional or policy mechanisms underlying these changes. Consequently, these interpretations should be regarded as plausible contextual explanations supported by the relevant literature rather than as causal inferences. Other observed and unobserved factors, including macro-economic conditions, demographic developments, measurement errors and external shocks, may also influence changes in EFFCH and TECHCH and should therefore be considered when interpreting the MPI decomposition results.

• MPI Results Under Model 1: Income Inequality and At-Risk-of-Poverty Outcomes

The results reported in Table 5 indicate that the average MPI value for the 2016–2019 period remains close to unity in most countries, showing relatively stable productivity development prior to the COVID-19 pandemic. The strongest productivity growth is observed in Hungary, mainly due to improvements in technical efficiency change, while Bulgaria, Slovakia and Slovenia exhibit marginal productivity growth. In contrast, Latvia, Lithuania and Romania record a slight decline in productivity. The decomposition results indicate that efficiency change was more heterogeneous across countries, while technological change remains relatively homogeneous.

Table 5. Malmquist Productivity Index Decomposition under VRS: Model 1—Income Inequality and At-Risk-of-Poverty Outcomes, 2016–2023.

Country	2016–2019			2019–2020			2020–2023		
	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH
Bulgaria	1.0149	1.0059	1.0090	0.8798	0.9660	0.9107	1.0007	0.9745	1.0269
Croatia	1.0079	1.0036	1.0043	0.8922	0.9797	0.9106	1.0501	1.0327	1.0168
Czechia	0.9998	0.9904	1.0095	0.8632	0.9524	0.9063	1.0118	0.9887	1.0234
Estonia	1.0074	1.0055	1.0019	0.8530	0.9320	0.9152	1.0252	1.0079	1.0171
Hungary	1.0449	1.0347	1.0099	0.9057	1.0000	0.9057	1.0255	1.0000	1.0255
Latvia	0.9810	0.9715	1.0097	0.9114	1.0033	0.9084	1.0020	0.9799	1.0226
Lithuania	0.9857	0.9769	1.0090	0.8440	0.9267	0.9107	1.0457	1.0183	1.0269
Poland	1.0070	0.9971	1.0099	0.9065	1.0037	0.9032	1.0137	0.9934	1.0204
Romania	0.9965	0.9875	1.0091	0.8711	0.9627	0.9049	1.0383	1.0174	1.0205
Slovakia	1.0122	1.0097	1.0025	0.9367	1.0222	0.9164	0.9887	0.9749	1.0142
Slovenia	1.0190	1.0147	1.0042	0.8529	0.9381	0.9092	1.0455	1.0275	1.0176

Source: Authors' calculations.

A substantially different situation emerges during 2019–2020, when all countries record MPI values below unity, pointing to a productivity decrease after the outbreak of the COVID-19 crisis. The largest declines are observed in Lithuania, Slovenia, Estonia and Czechia. The decomposition results indicate that lower TECHCH values represent the largest contributor to the observed productivity decline, as all countries record lower TECHCH values during the initial pandemic shock. Since TECHCH captures shifts in the empirical production frontier, one possible interpretation is that the COVID-19 pandemic created a less favourable environment for social protection systems to translate expenditure into improvements in poverty and income distribution outcomes. This interpretation is in line with evidence showing that COVID-19 increased poverty risks, reduced household incomes and intensified inequality pressures across EU Member States (Almeida et al., 2021; Baptista et al., 2021). By contrast, efficiency change remains comparatively stable. Slovakia, Poland and Latvia record improvements in EFFCH, while Hungary maintains an EFFCH value equal to unity. These results show that the productivity decline during 2019–2020 is mainly due to changes in the production frontier rather than to changes in technical efficiency.

The average results for the 2020–2023 period show a moderate recovery in productivity across most CEE EU Member States. The strongest productivity growth is recorded in Croatia, Lithuania, Slovenia and Romania, whereas Slovakia remains the only country with an average MPI value below unity. Positive technological change represents the main source of productivity across most CEE EU Member States. Efficiency change varies

across countries. Croatia, Slovenia, Lithuania, Romania and Estonia improve their EFFCH values, whereas Bulgaria, Czechia, Poland, Latvia and Slovakia record a decline in technical efficiency change. In several countries, positive shifts in the production frontier compensate for declines in technical efficiency and support productivity growth. These results indicate that improvements in the TECHCH component account for most of the observed productivity growth during the post-pandemic period, whereas changes in technical efficiency make a comparatively smaller contribution. The important role of TECHCH observed in the present analysis is also reported by Raguseo and Kuvicová (2010) in their study of welfare sector productivity in CEE countries. These findings may partly reflect the broader post-pandemic adjustment of social protection systems discussed in the recent literature (Diamantopoulou et al., 2023; Social Protection Committee, 2023).

To complement the numerical results presented in Table 5, Figure 4 provides a graphical representation of the country-level MPI profiles across the three sub-periods. While Table 5 reports the exact MPI values, the radar diagram facilitates the visual comparison of productivity patterns among countries over time. It highlights the relatively stable productivity levels observed before the COVID-19 pandemic, the generalized productivity contraction during the initial pandemic shock, and the subsequent recovery across most CEE EU Member States. The figure also demonstrates that the post-pandemic productivity recovery was heterogeneous across CEE EU Member States.

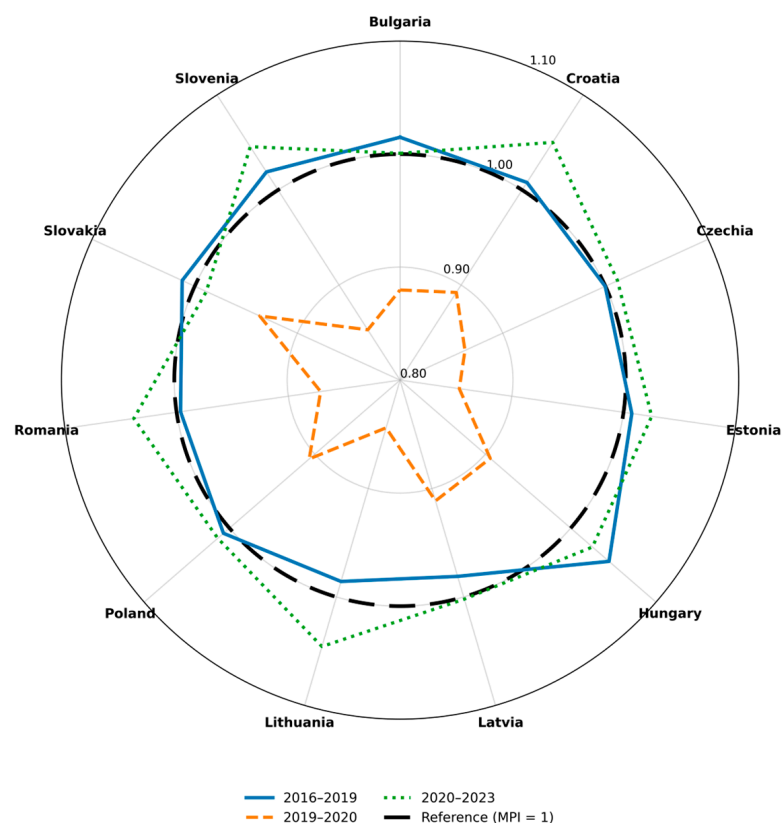


Figure 4. Country profiles of the Malmquist Productivity Index across the three sub-periods under Model 1—Income Inequality and At-Risk-of-Poverty Outcomes, 2016–2023. Source: authors' calculations.

• MPI Results Under Model 2: Income Inequality and Severe-Poverty Outcomes

Table 6 presents the MPI decomposition for Model 2, reporting changes in the productivity of social protection expenditure with respect to income inequality and severe-poverty outcomes during 2016–2023.

Table 6. Malmquist Productivity Index Decomposition under VRS: Model 2—Income Inequality and Severe-Poverty Outcomes, 2016–2023.

Country	2016–2019			2019–2020			2020–2023		
	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH
Bulgaria	1.0171	1.0250	0.9923	0.8897	0.9851	0.9032	0.9958	0.9759	1.0204
Croatia	1.0076	1.0087	0.9990	0.8897	0.9803	0.9076	1.0508	1.0280	1.0222
Czechia	1.0057	1.0048	1.0009	0.8597	0.9481	0.9067	1.0122	0.9908	1.0216
Estonia	1.0054	1.0093	0.9961	0.8506	0.9417	0.9032	1.0289	1.0105	1.0182
Hungary	1.0437	1.0452	0.9985	0.9076	1.0000	0.9076	1.0216	1.0000	1.0216
Latvia	0.9805	0.9877	0.9928	0.9027	0.9994	0.9032	1.0007	0.9808	1.0204
Lithuania	0.9822	0.9895	0.9926	0.8537	0.9451	0.9032	1.0433	1.0225	1.0204
Poland	1.0043	1.0072	0.9971	0.9084	0.9991	0.9092	1.0129	0.9911	1.0220
Romania	0.9948	0.9975	0.9974	0.8669	0.9585	0.9044	1.0320	1.0087	1.0231
Slovakia	1.0150	1.0119	1.0030	0.9379	1.0222	0.9175	0.9896	0.9749	1.0152
Slovenia	1.0184	1.0152	1.0031	0.8543	0.9436	0.9054	1.0451	1.0249	1.0197

Source: authors' calculations.

During the pre-pandemic period, MPI values remain close to unity in most countries, showing relatively stable productivity development. Productivity growth is established in Bulgaria, Czechia, Estonia, Croatia, Hungary, Poland, Slovenia and Slovakia, whereas Latvia, Lithuania and Romania experience slight productivity declines. Compared to Model 1, the MPI results are largely similar, with the exception of Czechia, which records productivity growth in Model 2 instead of the slight productivity decline observed in Model 1. Apart from this difference, the main distinction between Model 1 and 2 concerns the decomposition of productivity change, as EFFCH has a greater contribution to MPI developments, while the role of TECHCH becomes less important. This means that severe-poverty outcomes are more sensitive to expenditure management and targeting mechanisms, whereas the broader at-risk-of-poverty measure appears to be influenced to a higher extent by institutional and policy changes affecting the social protection system as a whole.

The pandemic shock produces a different situation, as all countries register a decline in the MPI values. Similarly to Model 1, technological regress represents the main source of this development. The relatively limited variation in TECHCH across countries may indicate that the pandemic period is associated with a common external shock affecting the empirical production frontier across the region, whereas cross-country differences in EFFCH remain comparatively limited. Since TECHCH captures shifts in the empirical production frontier, one possible interpretation is that the lower TECHCH values observed during 2019–2020 may reflect the more challenging conditions under which social protection systems operate. OECD (2021a) describes the COVID-19 pandemic as an unprecedented health, economic and social crisis that places considerable pressure on public finances and requires governments to rapidly expand support measures, resulting in substantial increases in public expenditure and fiscal deficits. However, the MPI decomposition itself does not identify the specific factors underlying these developments. These results point to more difficult conditions for transforming social protection expenditure into distributive outcomes, rather than problems in expenditure management and targeting practices.

The final sub-period is characterized by a return to productivity growth in almost all countries. The MPI decomposition shows that improvements in productivity are mainly associated with changes in TECHCH, while EFFCH plays a secondary role. The results

indicate a recovery in productivity during 2020–2023, as all countries record positive technological change and nine out of eleven countries achieve MPI values above unity. The post-pandemic period was also characterized by continued policy efforts to mitigate the social consequences of the COVID-19 crisis. According to the [European Commission \(2023b\)](#), the AROPE rate did not experience a more substantial increase during the COVID-19 pandemic, partly due to the mitigating impact of social protection systems and measures taken by the Member States, with EU support. Moreover, the poverty-reducing impact of social transfers reached unprecedented levels in 2021 and remained elevated in 2022. However, the MPI decomposition itself does not identify whether these broader policy developments contributed to the observed frontier shifts. Bulgaria and Slovakia are the only countries with MPI values below unity, indicating that the positive contribution of technological change is insufficient to compensate for the decline in efficiency changes.

Figure 5 further supports the robustness of the results by showing that the productivity patterns identified under Model 2 closely resemble those observed in Model 1.

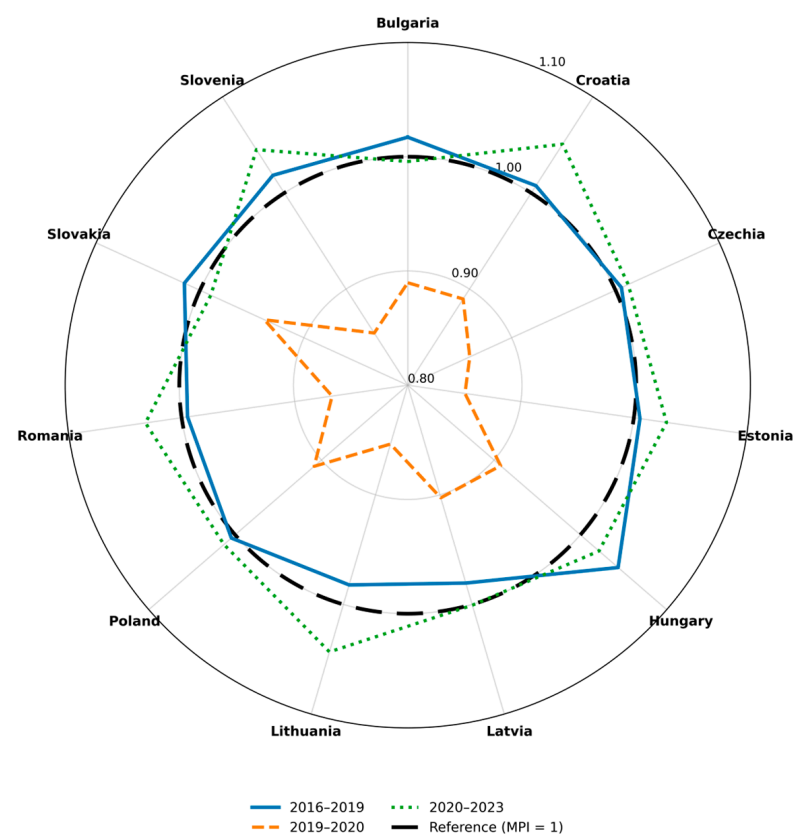


Figure 5. Country profiles of the Malmquist Productivity Index across the three sub-periods under Model 2—Income Inequality and Severe-Poverty Outcomes, 2016–2023. Source: authors' calculations.

• MPI Results under Model 3: Income Inequality and Income Distribution

The results reported in Table 7 reveal greater cross-country variation in productivity development under Model 3 compared to Models 1 and 2. During 2016–2019, Romania, Slovakia, and Poland record relatively strong productivity growth, whereas Estonia, Croatia and Lithuania register a moderate productivity decline. The decomposition results show that cross-country differences in MPI are associated primarily with efficiency change, whereas TECHCH values remain close to unity in most cases, presenting relatively small differences in frontier shift across countries.

Table 7. Malmquist Productivity Index Decomposition under VRS: Model 3—Income Inequality and Income Distribution Outcomes, 2016–2023.

Country	2016–2019			2019–2020			2020–2023		
	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH	MPI	EFFCH	TECHCH
Bulgaria	1.0045	1.0128	0.9918	0.9422	0.9043	1.0420	1.0202	1.0342	0.9866
Croatia	0.9490	0.9483	1.0007	1.2702	1.2391	1.0251	0.9866	1.0086	0.9781
Czechia	0.9886	0.9916	0.9969	0.7900	0.7582	1.0420	1.0642	1.0841	0.9816
Estonia	0.9257	0.9421	0.9826	1.2061	1.1670	1.0335	0.9981	1.0051	0.9930
Hungary	0.9736	0.9850	0.9885	1.2157	1.1667	1.0420	0.9474	0.9772	0.9695
Latvia	0.9781	0.9767	1.0014	1.1675	1.1205	1.0420	0.9253	0.9441	0.9800
Lithuania	0.9662	0.9776	0.9883	1.1222	1.0770	1.0420	0.9284	0.9521	0.9751
Poland	1.0718	1.0758	0.9963	1.1036	1.0678	1.0335	0.9557	0.9642	0.9912
Romania	1.0979	1.0866	1.0104	0.7953	0.7695	1.0335	1.0223	1.0333	0.9893
Slovakia	1.0823	1.0764	1.0054	0.7567	0.7322	1.0335	1.0666	1.1095	0.9614
Slovenia	1.0164	1.0316	0.9852	0.7844	0.7590	1.0335	1.0655	1.0833	0.9836

Source: authors' calculations.

During 2019–2020, unlike Models 1 and 2, several countries register significant productivity growth despite the COVID-19 shock. The strongest increases are observed in Croatia, Hungary, Estonia, and Latvia. The MPI decomposition indicates that productivity growth is driven primarily by improvements in EFFCH, while TECHCH makes a comparatively smaller contribution. This pattern may reflect the short-term effects of policy measures introduced during the COVID-19 crisis to support household incomes and reduce the immediate distributional consequences of the shock (Almeida et al., 2021; Gentilini et al., 2021), although the MPI decomposition itself does not identify the specific mechanisms underlying these changes. In contrast, Slovakia, Slovenia, Romania and Czechia record a productivity decrease caused by declines in technical efficiency change.

The average results for 2020–2023 show increasing differences in productivity performance across countries. Productivity growth is strongest in Slovakia, Slovenia and Czechia, while Latvia and Lithuania record the largest declines. The MPI decomposition indicates that productivity growth continues to be driven mainly by EFFCH, whereas TECHCH remains below unity in most countries. The post-pandemic period also coincided with continued policy efforts to address the social consequences of the COVID-19 crisis. According to the European Commission (2024c), tax-benefit systems contributed substantially to mitigating poverty and inequality, while social outcomes improved slightly, with declining at-risk-of-poverty (AROP) indicators and improving average real income. However, the MPI decomposition itself does not identify whether these broader policy developments contributed to the observed productivity dynamics. Overall, the results indicate that cross-country differences in productivity under Model 3 are associated primarily with changes in EFFCH rather than with shifts in the production frontier.

Figure 6 supports the findings presented in Table 7 by illustrating the greater cross-country variation in productivity performance under Model 3 across the three sub-period.

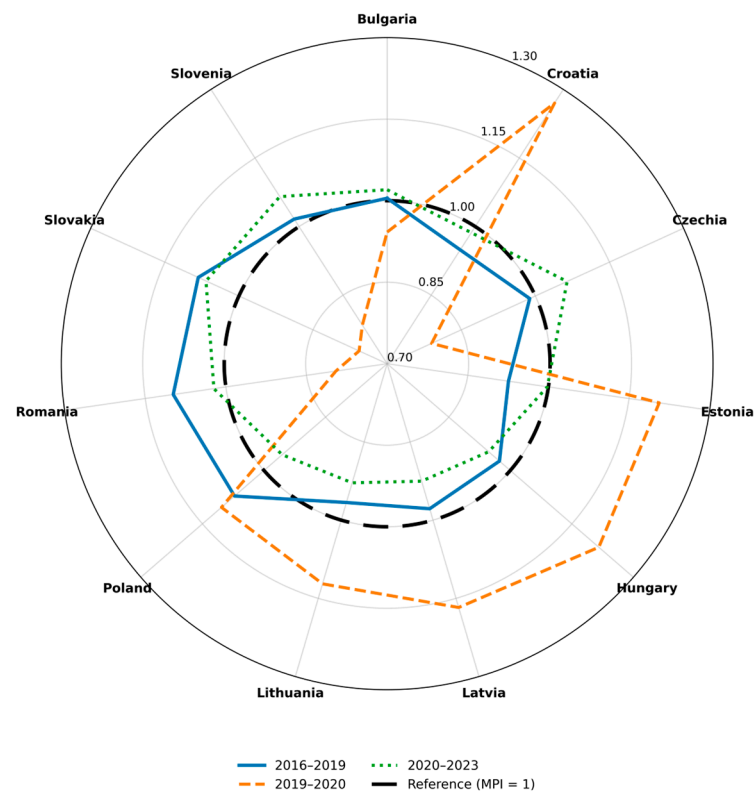


Figure 6. Country profiles of the Malmquist Productivity Index across the three sub-periods under Model 3—Income Inequality and Income Distribution Outcomes, 2016–2023. Source: authors' calculations.

5. Conclusions

In this study, the efficiency and productivity of social protection expenditure in eleven CEE EU Member States are examined using DEA and MPI analysis. Three DEA models are applied using combinations of income inequality and poverty indicators as output variables, including the Gini coefficient, the at-risk-of-poverty rate at 60% of the median equivalized income (standard poverty threshold), the at-risk-of-poverty rate at 40% of median equivalized income (severe-poverty threshold), and the income share of the bottom 40% of the population. Social protection expenditure measured according to the ESSPROS methodology is used as the input variable in all three models.

The DEA results show relatively high efficiency scores under all three models. Czechia and Slovakia remain on the efficiency frontier throughout the analyzed period under Models 1 and 2, while Romania and Hungary also record efficiency scores equal to or close to unity in most years. Croatia, Poland and Slovenia remain among the least efficient countries during most of the analyzed period. The results obtained under Models 1 and 2 show only minor differences, indicating similar efficiency assessments when the standard and severe-poverty thresholds are used as output indicators. Some differences are observed under Model 3, where the income share of the bottom 40% of the population is used as an output variable. In this case, Czechia no longer belongs to the group of efficient countries. This finding suggests that good results in the poverty-oriented models are not necessarily accompanied by similar results in the income-distribution-oriented model.

The scale-efficiency results remain high under all three models, showing that most countries operated relatively close to the optimal scale. The RTS classifications are similar across the three models and coincide entirely in 2023. In 2023, Bulgaria, Croatia, Estonia, Latvia, Lithuania and Romania operate under IRS. Czechia, Poland, Slovakia and Slovenia are characterized by DRS, while Hungary operates under CRS in all three models. The high scale-efficiency values give grounds for the statement that further improvements in

the outcomes of the poverty-oriented models and the income-distribution-oriented model are less likely to result from changes in the scale of social protection expenditure alone.

The MPI results reveal differences both across periods and across the three models. Under Model 1, productivity remains relatively stable during 2016–2019. During this period, differences in productivity development are associated mainly with changes in technical efficiency, while technological change remains relatively homogeneous across countries. During 2019–2020, all countries record a decline in productivity, with technological change accounting for the larger share of the observed change. During the subsequent period, improvements in productivity are also accompanied mainly by changes in technological change. The results under Model 2 are similar. Before the COVID-19 pandemic, productivity developments are influenced to a greater extent by changes in technical efficiency than by technological change. During both 2019–2020 and 2020–2023, technological change accounts for the larger share of the observed productivity changes. The MPI decomposition identifies changes in technical efficiency and technological change but does not identify the factors underlying these changes. The results under Model 3 differ from those obtained under Models 1 and 2. Throughout the analyzed period, productivity developments are associated primarily with changes in technical efficiency, while the contribution of technological change remains comparatively limited.

Although the CEE EU Member States share a common post-socialist transition, EU-driven institutional transformation and a common catching-up growth model, the results reveal considerable differences in the efficiency and productivity of their social protection systems. These findings suggest that the common historical and institutional background of these countries has not resulted in uniform performance. The observed differences may reflect differences in the design of social protection systems, demographic structure, labour market conditions, the macro-economic environment, institutional quality and policy implementation. The present study does not examine the relative importance of these factors, and their analysis remains beyond the scope of this paper. Future research may extend the analysis to a broader group of European countries and investigate the determinants of the observed differences in the efficiency and productivity of social protection expenditure.

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Abbreviations

The following abbreviations are used in this manuscript:

CEE	Central and Eastern Europe
EU	European Union
ESSPROS	European system of integrated social protection statistics
DEA	Data Envelopment Analysis
COFOG	Classification of the Functions of Government
MPI	Malmquist Productivity Index
DMU	Decision-Making Unit

CRS Constant Returns to Scale
 VRS Variable Returns to Scale
 VRSTE Variable Returns-to-Scale Technical Efficiency
 CRSTE Constant Returns-to-Scale Technical Efficiency

Appendix A

Table A1. DEA efficiency scores under Model 1: CRSTE, VRSTE, scale efficiency and returns to scale, 2016–2023.

Countries	2016				2017				2018				2019			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.87	0.88	0.99	irs	0.88	0.89	0.99	drs	0.90	0.97	0.99	drs	0.89	0.93	0.96	irs
Croatia	0.77	0.97	0.97	drs	0.74	0.75	0.98	drs	0.75	0.76	0.99	irs	0.75	0.76	0.98	irs
Czechia	0.96	1.00	0.96	drs	0.97	1.00	0.97	drs	0.97	1.00	0.97	drs	0.93	1.00	0.93	drs
Estonia	0.95	0.96	0.99	drs	0.98	0.99	0.99	drs	0.98	0.99	0.99	irs	0.97	0.99	0.98	irs
Hungary	0.90	0.93	0.97	drs	0.93	0.94	0.98	drs	0.97	0.99	0.98	drs	1.00	1.00	1.00	-
Latvia	1.00	1.00	1.00	-	0.98	0.99	0.99	drs	0.95	0.96	0.99	drs	0.92	0.95	0.96	irs
Lithuania	1.00	1.00	1.00	-	0.98	0.99	0.99	drs	0.96	0.97	0.99	drs	0.93	0.96	0.97	irs
Poland	0.78	0.80	0.98	drs	0.82	0.83	0.99	drs	0.86	0.88	0.98	drs	0.77	0.78	0.99	irs
Romania	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.96	1.00	0.96	irs
Slovakia	0.95	1.00	0.95	drs	0.94	1.00	0.94	drs	1.00	1.00	1.00	drs	0.97	1.00	0.97	drs
Slovenia	0.73	0.78	0.94	drs	0.74	0.79	0.94	drs	0.77	0.78	0.99	drs	0.76	0.79	0.97	drs
Average	0.90	0.94	0.98		0.91	0.92	0.98		0.92	0.94	0.99		0.90	0.92	0.97	
SD	0.10	0.08	0.02		0.09	0.09	0.02		0.08	0.08	0.01		0.09	0.09	0.02	

Countries	2020				2021				2022				2023			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.86	0.95	0.90	irs	0.84	0.89	0.94	irs	0.78	0.84	0.94	irs	0.79	0.85	0.93	irs
Croatia	0.74	0.76	0.97	irs	0.76	0.77	0.98	irs	0.78	0.79	0.99	irs	0.81	0.82	0.98	irs
Czechia	0.89	1.00	0.89	drs	0.87	1.00	0.87	drs	0.87	1.00	0.87	drs	0.85	1.00	0.85	drs
Estonia	0.90	0.95	0.95	irs	0.97	0.99	0.98	irs	0.98	1.00	0.98	irs	0.93	0.96	0.96	irs
Hungary	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-
Latvia	0.92	0.99	0.93	irs	0.78	0.84	0.93	irs	0.79	0.84	0.94	irs	0.86	0.92	0.93	irs
Lithuania	0.86	0.92	0.93	irs	0.88	0.92	0.96	irs	0.92	0.96	0.95	irs	0.91	0.98	0.92	irs
Poland	0.77	0.78	0.99	irs	0.78	0.79	0.99	drs	0.80	0.81	0.99	drs	0.76	0.77	0.98	drs
Romania	0.93	1.00	0.93	irs	0.96	1.00	0.96	irs	0.94	0.96	0.97	irs	0.97	1.00	0.97	irs
Slovakia	1.00	1.00	1.00	-	0.99	1.00	0.99	drs	0.99	1.00	0.99	drs	0.92	1.00	0.92	drs
Slovenia	0.71	0.72	0.99	irs	0.74	0.76	0.96	drs	0.72	0.78	0.92	drs	0.77	0.85	0.91	drs
Average	0.87	0.92	0.95		0.87	0.91	0.96		0.87	0.91	0.96		0.87	0.92	0.94	
SD	0.09	0.10	0.04		0.09	0.10	0.04		0.10	0.09	0.04		0.08	0.08	0.04	

Table A2. DEA efficiency scores under Model 2: CRSTE, VRSTE, scale efficiency and returns to scale, 2016–2023.

Countries	2016				2017				2018				2019			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.86	0.87	0.99	irs	0.88	0.89	0.99	irs	0.92	0.93	0.99	drs	0.93	0.94	0.99	irs
Croatia	0.74	0.77	0.96	drs	0.74	0.76	0.997	drs	0.76	0.77	0.99	drs	0.76	0.77	0.99	irs
Czechia	0.91	1.00	0.91	drs	0.92	1.00	0.92	drs	0.95	1.00	0.95	drs	0.93	1.00	0.93	drs
Estonia	0.97	1.00	0.97	drs	1.00	1.00	1.00	-	0.99	1.00	0.99	drs	1.00	1.00	1.00	-
Hungary	0.87	0.93	0.93	drs	0.87	0.93	0.96	drs	0.94	0.96	0.97	drs	1.00	1.00	1.00	-
Latvia	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.98	0.99	0.99	drs	0.96	0.97	0.99	irs
Lithuania	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.98	0.99	0.99	drs	0.96	0.97	0.99	irs
Poland	0.77	0.81	0.95	drs	0.79	0.82	0.97	drs	0.85	0.86	0.99	drs	0.78	0.80	0.97	drs
Romania	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.99	1.00	0.99	drs
Slovakia	0.94	1.00	0.94	drs	0.94	1.00	0.94	drs	1.00	1.00	1.00	-	0.97	1.00	0.97	drs
Slovenia	0.73	1.00	0.73	drs	0.74	1.00	0.74	drs	0.78	0.79	0.98	drs	0.76	0.81	0.94	drs
Average	0.89	0.94	0.94		0.90	0.95	0.96		0.92	0.94	0.99		0.91	0.93	0.98	
SD	0.10	0.08	0.07		0.10	0.08	0.07		0.08	0.08	0.01		0.09	0.09	0.02	
Countries	2020				2021				2022				2023			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.92	0.95	0.96	irs	0.89	0.90	0.99	irs	0.83	0.84	0.97	irs	0.85	0.86	0.99	irs
Croatia	0.75	0.76	0.99	irs	0.76	0.78	0.99	irs	0.78	0.79	0.99	irs	0.81	0.83	0.98	irs
Czechia	0.88	1.00	0.88	drs	0.86	1.00	0.86	drs	0.86	1.00	0.86	drs	0.86	1.00	0.86	drs
Estonia	0.94	0.95	0.99	irs	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.97	0.98	0.99	irs
Hungary	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-
Latvia	0.96	0.99	0.97	irs	0.83	0.85	0.98	irs	0.82	0.84	0.98	irs	0.90	0.93	0.97	irs
Lithuania	0.91	0.93	0.98	irs	0.92	0.93	0.99	irs	0.94	0.95	0.99	irs	0.97	0.98	0.99	irs
Poland	0.78	0.79	0.99	drs	0.78	0.80	0.81	irs	0.81	0.83	0.97	drs	0.76	0.84	0.91	drs
Romania	0.95	1.00	0.95	irs	0.97	1.00	0.97	irs	0.94	0.95	0.99	irs	0.97	1.00	0.97	irs
Slovakia	1.00	1.00	1.00	-	0.99	1.00	0.99	drs	0.99	1.00	0.99	drs	0.93	1.00	0.93	drs
Slovenia	0.72	0.79	0.91	drs	0.74	1.00	0.74	drs	0.72	1.00	0.72	drs	0.78	1.00	0.78	drs
Average	0.89	0.92	0.97		0.89	0.93	0.94		0.88	0.93	0.95		0.89	0.95	0.94	
SD	0.09	0.09	0.04		0.09	0.08	0.09		0.09	0.08	0.08		0.08	0.07	0.07	

Table A3. DEA efficiency scores under Model 3: CRSTE, VRSTE, scale efficiency and returns to scale, 2016–2023.

Countries	2016				2017				2018				2019			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.82	0.86	0.96	irs	0.79	0.88	0.89	irs	0.81	0.88	0.91	irs	0.80	0.92	0.87	irs
Croatia	0.76	0.77	0.99	irs	0.75	0.76	0.99	irs	0.75	0.76	0.99	irs	0.75	0.76	0.98	irs
Czechia	0.99	1.00	0.99	drs	1.00	1.00	1.00	-	0.94	0.96	0.98	irs	0.95	0.96	0.99	drs
Estonia	0.96	0.97	0.99	irs	0.98	0.99	0.99	irs	0.97	0.99	0.98	irs	0.97	0.99	0.98	irs
Hungary	0.91	0.92	0.99	irs	0.92	0.93	0.99	irs	0.91	0.95	0.97	irs	1.00	1.00	1.00	-
Latvia	0.98	0.99	0.98	irs	0.95	0.97	0.98	irs	0.92	0.96	0.96	irs	0.90	0.95	0.95	irs
Lithuania	0.94	0.96	0.97	irs	0.92	0.99	0.93	irs	0.90	0.96	0.95	irs	0.89	0.94	0.95	irs
Poland	0.79	0.80	0.99	irs	0.81	0.82	0.99	irs	0.84	0.85	0.98	irs	0.77	0.78	0.99	irs
Romania	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.97	1.00	0.97	irs	0.96	1.00	0.96	irs
Slovakia	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.99	1.00	0.99	drs
Slovenia	0.77	0.78	0.99	drs	0.78	0.79	0.99	irs	0.77	0.78	0.99	irs	0.78	0.79	0.99	irs
Average	0.90	0.91	0.99		0.90	0.92	0.98		0.89	0.92	0.97		0.89	0.92	0.97	
SD	0.09	0.09	0.01		0.09	0.09	0.03		0.08	0.08	0.02		0.09	0.09	0.04	
Countries	2020				2021				2022				2023			
	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS	CRSTE	VRSTE	SCALE	RTS
Bulgaria	0.79	0.95	0.83	irs	0.78	0.89	0.88	irs	0.76	0.85	0.89	irs	0.76	0.86	0.89	irs
Croatia	0.73	0.76	0.97	irs	0.77	0.78	0.99	irs	0.78	0.79	0.99	irs	0.81	0.82	0.99	irs
Czechia	0.86	0.88	0.98	irs	0.87	0.88	0.99	irs	0.86	0.87	0.99	irs	0.86	0.9	0.95	drs
Estonia	0.90	0.95	0.95	irs	0.97	0.99	0.98	irs	0.98	1.00	0.98	irs	0.93	0.96	0.96	irs
Hungary	0.97	1.00	0.97	irs	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-
Latvia	0.89	0.99	0.90	irs	0.78	0.84	0.93	irs	0.79	0.84	0.95	irs	0.86	0.92	0.93	irs
Lithuania	0.82	0.92	0.89	irs	0.85	0.92	0.93	irs	0.87	0.94	0.92	irs	0.89	0.98	0.91	irs
Poland	0.76	0.78	0.97	irs	0.78	0.79	0.99	drs	0.80	0.81	0.99	drs	0.76	0.78	0.98	drs
Romania	0.91	1.00	0.91	irs	0.96	1.00	0.96	irs	0.94	0.95	0.98	irs	0.98	1.00	0.98	irs
Slovakia	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	0.93	1.00	0.93	drs
Slovenia	0.71	0.72	0.99	irs	0.75	0.76	0.99	irs	0.72	0.73	0.99	irs	0.79	0.83	0.94	drs
Average	0.85	0.90	0.94		0.86	0.90	0.97		0.86	0.89	0.97		0.87	0.91	0.95	
SD	0.09	0.10	0.05		0.10	0.09	0.04		0.10	0.09	0.03		0.08	0.08	0.03	

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