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The efficiency of public spending on education: Lower and higher secondary education

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Abstract

Research on the efficiency of public spending on the education sector hardly addresses the territorial distribution of educational attainment. This paper tries to fill in the gap by verifying whether the analysis of spatial differentiation of educational attainment could provide crucial information on the financial policy in this sphere and assess the impact of the socio-economic factors upon the education level evaluated through school tests. Our article aims to identify the relationship between spending on public education and the degree of educational attainment and inter-regional inequality in Poland. The research results showed that the spatial approach should not be ignored when assessing the relationship between public education expenditure and the degree of educational achievement. We note that the applied public financing of second-level education in Poland does not reduce regional disparities in education but maintains them at a constant level.

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Introduction

As presented in the literature, the primary advantage of decentralisation is the increase in management efficiency of public funds and better matching of public expenditure to the needs of the population compared to a centralised system. However, decentralisation can lead to inequality, since access to public goods becomes differentiated across the country. This results from the geographical location, differences in local governments' financial capabilities, or even residents' various expectations regarding the direction of public spending. The structure of the local education system is also important, e.g., the number and dispersion of schools and educational institutions or the teachers' employment structure and qualifications. These factors as well as the importance assigned to education mean that the decentralisation is incomplete (Kopańska and Sztanderska, 2015). Differences in school systems' characteristics across countries, including the organisation of institutional structures, account for a large part of the differences in students' achievements, not only internationally, but also between regions (Woessmanm, 2016, 1). Socioeconomic background and cultural factors are an important part of the variation in students' performance.

The shape of detailed regulations which impact the operation of the education system at the primary and secondary levels, as well as the role of various public entities in this system vary quite substantially from one country to another. The differences in the systems, changes in their functioning in subsequent years, and their impact on the education systems as well as public expenditures related to it have become the subject of several studies. The existing publications provide information on average and global heights of public sector expenditure on education. It is primarily related to using data requiring a minimum level of homogeneity for international comparisons. The availability of OECD data such as Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) allows for comparing educational development levels from an international perspective. Cordero, Polo and Simancas (2020) provided a broad overview of research findings focused on assessing the effectiveness of education systems internationally using OECD data. Aparicio, Cordero and Ortiz (2019) used data from students and schools participating in PISA to point out that measures of school performance based on aggregate data may present an inaccurate picture when compared to the performance of all students in the same school. Therefore, in order to assess the impact of specific policies on educational performance, the broader information provided by all students must be taken into account, as representative values, averaged at the national level, may differ significantly from those found in individual regions, localities, institutions, or representative groups.

Research on the efficiency of public spending on the education sector hardly addresses the issues of the territorial distribution of educational attainment and

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the interpretation of the factors determining this variation. A major contributor to that may be the shortage of relevant data taking into account not only financial policy, but also data on educational processes. As a result, the spatial dimension of human capital quality is a persistently ignored issue. However, the analysis of the spatial variation of educational attainment can provide vital information on the education sector efficiency level, particularly in countries with stratified social standards or interregional disparities (Herbst, 2012, 80). It can particularly provide helpful information on the spending efficiency in education, which competes with other areas involving public expenditure in the budget allocation process. Effective use of the existing resources can improve educational outcomes (Cirol and García, 2018). This issue has not been fully explored in the literature, with few studies showing the impact of funding policies on quality, productivity, and equity in access to education at the intra-regional level.

This paper tries to fill in the gap by verifying whether the analysis of spatial differentiation of educational attainment could provide crucial information on the financial policy in this sphere and assess the impact of socio-economic factors upon the education level evaluated through school tests (in second-level education). Our article aims to identify the relationship between the spending on public education and the degree (growth) of educational attainment as well as inter-regional inequality in Poland. We will attempt to assess the impact of socio-economic factors which may be relevant to the allocation of public funds for education in order to increase its efficiency. We seek to verify the hypothesis that the level of second-stage education (lower[1] and upper high schools) is more dependent on socio-economic factors rather than on the amount of public expenditure on education.[2] Simultaneously, we wish to investigate whether the public financing of second-stage education in Poland reduces regional differences in its level. We are interested in examining the impact of these contextual variables on exam outcomes in the analysed regions of the country so that we can see if their impact is the same in all voivodeships. We also want to show that the analysis of spatial variation of educational attainment can bring vital information about the functioning (quality) of education and the links between education or other cultural processes and socio-economic development. Using econometric techniques, we evaluated the education quality variables in different voivodeships. We used the non-parametric DEA method in the

[1] In Poland, *gimnazjum* (lower high school) existed between 1999 and 2018, encompassed grades 7–9, and was the last stage of compulsory education. In accordance with the International Standard Classification of Education standards from 2011, we include *gimnazjum* in lower secondary education and high schools in upper/higher secondary education.

[2] *Gimnazjums* in Poland were abolished in 2019 and we have reverted to the pre-reform education system. That means primary school now spans 8 years (grades 1–8) and the lower high school exam has been replaced by an eighth-grade exam, with no particular changes to the public education funding system. We therefore assume that an analysis of the factors which influence the results of lower high school examinations will also adequately explain the outcomes of the eighth-grade examinations.

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input-oriented version to compare the efficiency of expenditure for education in all Polish voivodeships in 2007–2018. The Malmquist index with decomposition was used to measure the change in efficiency over time.

1. Theoretical framework of the research

The efficient use of resources assures the achievement of the educational outcomes desired by society. It is noted, in this context, that efficient use of public expenditures is determined by observable educational results (e.g. results of test, exams) occurring at the lowest level of these expenditures. In this view, the results of education are usually the outcomes of examinations or relevant tests. In contrast, efficiency evaluation can be described as the ability to transfer inputs into outputs (Carrillo and Jorge, 2016, 15).

Commonly used educational quality measures include the average results of standardised aptitude tests administered to students in many countries (Siyongwana and Chanza, 2020). In this view, research cited in the literature tends to attribute at least two desirable effects to public spending on education: stimulating economic growth and reducing income inequality. Hanushek and Woessmann (2007; 2012, 267–321; 2015) analysed the role of education in promoting economic prosperity, focusing on the meaning of education quality. The results showed strong evidence that people's cognitive skills are strongly related to individual earnings, income distribution, and economic growth. This means that the education quality explains the differences in per capita income levels and the rate of economic development better than its "quantity." Relative teacher salaries, class size, teacher education endogenously determine the education quality (teachers' human capital) and affect the economic growth rate (Hanushek and Kimko, 2000, 1184–1208).

Previous attempts to apply school examination results in growth regressions for Polish regions (Herbst, 2007, 204) have yielded rather unexpected results, disclosing a negative correlation between the quality of education and economic growth. This is mainly because historical and cultural circumstances largely determine the geographical distribution of educational attainment of young people in Poland. Furthermore, a close relationship between resource levels and learning outcomes is hard to demonstrate empirically. Cross-sectional data only reveal a weak correlation between national per-pupil expenditure or teaching resources and students' average outcome on standardised tests (Sutherland, Price and Gonand, 2009). Cordero, Polo, Santín and Simancas (2018, 45–60) assumed that it is worthwhile to study the potential impact of heterogeneity between countries by including some additional contextual factors at the national level. Such variables may have a more significant impact on the effectiveness of education systems than environmental factors in schools do. Keller (2010, 51–77) studied the impact of

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public spending on first-stage education. In his research, he proved that spending per pupil in primary education significantly improves income distribution, especially in less developed countries. At the same time, he stressed that this expenditure must keep pace with the growth of student cohorts by promoting high school recruitment. It can be interpreted that (increasing) expenditure on education does not determine the level of income differentiation in society; it is rather due to its skilful spending. Public expenditure does not necessarily ensure high-quality education, but it is believed that education of high quality requires resources. Keller (2010, 65) points out that, with limited resources, it is worth undertaking research on how to use them most effectively. To this end, researchers focused on comparing the relative results in particular countries' education systems.

An analysis of the results obtained by the students was to indicate whether the achieved results differ significantly. However, the picture of educational outcomes measured solely by test scores is incomplete, to say the least (Agasisti, 2014). Education is a process which requires taking into account many elements that influence it. That is why education was more and more often perceived as a kind of production process, a production function which should consider the level of inputs, different institutional systems of individual countries, or factors determining the individual achievement of particular students. Allison (1982) presented the educational function of production based on analysing the impact of participation in program activities as well as time devoted to self-education and leisure. From this perspective, she analysed the regression of student results. Herbst (2012) provides a generalisation of views on the educational function of production. The common feature of the presented approaches is the attempt to demonstrate the influence of various factors which may stimulate society's educational results. Consequently, the results of the research taking into account the educational function of production are highly ambiguous. While some studies suggest that the so-called contribution of the school is statistically positively significant on students' educational attainment, others concluded that such an effect does not exist. Hanushek (2020, 169) points out that, taking into account teacher's experience and training or class size, education policies do not systematically relate to students' performance. As a consequence, the author points out that the way of using resources is often more important than their amount. There are also voices that the varied results may be a consequence of errors in the applied econometric techniques (Todd and Wolpin, 2003).

A different approach examines the effectiveness of public spending on education. The resources spent (inputs) are compared with the outputs (results) using the non-parametric Data Envelopment Analysis (DEA). In this perspective, Afonso and St. Aubyn's (2006, 476–491) research contributed significantly to the literature on the subject. Using the DEA method, they modelled the relationship between inputs and outputs and showed that apart from monetary categories, environmental conditions are also essential elements of properly measuring the effectiveness of

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public educational spending (e.g. GDP and population education level). Agasisti (2014, 550), when examining the effectiveness of expenditure in the field of education, used data on expenditure per student as the inputs and the results of PISA tests as the outputs. His research confirms that there is no linear relationship between spending and educational performance. At the same time, he emphasised that there are countries which manage to achieve good results even when investing little resources, and countries which, despite (relatively) large financial outlays, do not (Agasisti, 2014, 543–557). Therefore, in research on the effectiveness of public spending, one should look for additional variables on the expenditure side which are characteristic of a given country or region and could potentially impact the obtained results.

2. Research methodology

The paper estimates and analyses the efficiency of expenditure in Poland's 16 voivodeships (NUTS-2) in 2007–2018. Two approaches were followed to assess the effectiveness of government spending on education. The first approach identifies the determinants of education quality in different voivodeships using regression — the classic method of least squares, ordinary least squares (Barro and Lee, 2001, 465–488). In the second approach, the results of the public spending effectiveness are estimated with the DEA procedure. This non-parametric technique treats each educational system as a decision-making unit, using the input data to generate output products. Such an approach showed the relative assessment of effectiveness and the distance between regions as well as the change in effectiveness in 2018 compared to 2007. The use of DEA is widespread in the literature concerning, i.a., the education sector, both for cross-country and country-level analyses. The DEA method was used to evaluate the effectiveness (a standard variant of the DEA method) in the input-oriented version. We used the solution adopted by Guzik (2009). In order to measure the change in efficiency over time and to assess the relative technical effectiveness of public expenditure on secondary education in Poland, the Malmquist Total Factor Productivity Index (TFP) was calculated along with its decomposition (Coelli, Prasada, O'Donnell and Battese, 2005).

The determinants (input) of educational outcomes taken into consideration in these studies include resources allocated to education (public expenditure — by the national government and local authorities — for education per person aged 7–19), as well as other factors such as the number of students per lower high school class or per high school class, GDP per capita (GDPpc), percentage of people with higher education, and the average monthly salary per person in the voivodeship. In the study, we have used variables retrieved from the Central Statistical Office's Local Data Bank (Bank Danych Lokalnych Głównego Urzędu Statystycznego).

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The results of lower high school exams (in % of points possible to score, mathematics part) and the pass rate of the baccalaureate examination (in %) were the dependent variables (output). The average number of students per class is the most critical determinant of the unit cost of teaching. Additionally, expenditure on education in Poland varies significantly depending on the level of education, types of schools, and the mode of learning undertaken by students. The educational subsidy, which is the primary source of financing for education in Poland, is granted based on an algorithm which takes into consideration, i.a., kinds and types of schools and institutions operated by LGU, teachers' professional promotion grades, the number of students in schools and institutions, or school location taking into account the number of inhabitants (ustawa z dnia 13 listopada 2003 roku o dochodach jednostek samorządu terytorialnego, Dz.U. z 2017 r., poz. 1453).

GDPpc is a variable showing the wealth of society, and remuneration was used to measure private expenditure on educating children. The above factors are taken into account by the literature as the ones which may affect the output variables. The paper presents models for individual results (Y) separately.

The performance of educational activity according to voivodeships were expressed by the results of junior high school and baccalaureate examinations. The expenditure was measured by outlays on education incurred both by the state budget and LGU, as well as by the average monthly salary as a measure of private expenditure on educating children. The Malmquist index was used to evaluate changes in efficiency over the period under consideration. This indicator is defined by means of technical efficiency measures (Coelli et al., 2005):

$$M\left(x_{t+1}, y_{t+1}, x_t, y_t\right) = \left[\frac{D^t(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)} * \frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^{t+1}(x_t, y_t)}\right]^{\frac{1}{2}} \quad (1)$$

where,

$D^t(x_t, y_t)$ — technical efficiency in the t period and technology in t period,
$D^{t+1}(x_t, y_t)$ — technical efficiency in the t period and technology in t + 1 period,
$D^t(x_{t+1}, y_{t+1})$ — technical efficiency in the t + 1 period and technology in t period,
$D^{t+1}(x_{t+1}, y_{t+1})$ — technical efficiency in the t + 1 period and technology in t + 1 period.

3. Research results

Table 1 shows the modelling of the results of lower high school exams (in % of points possible to score, mathematics part).

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Table 1. Modelling of the results of lower high school exams in 2007–2018

Voivodeship	R^2	p-Value				
		Model parameters				
		higher education	public expenditure	salary	GDP pc	average students per class
Dolnośląskie (DL)	0.61	0.7041	0.4202	0.0520*	0.0667	0.8713
		-52.7470	0.0030	0.0210	-0.0020	0.3770
Kujawsko-pomorskie (KP)	0.75	0.1387	0.8521	0.1257	0.3369	0.0349**
		-187.7731	0.0004	0.0283	-0.0013	4.8093
Lubelskie (LB)	0.18	0.7865	0.3429	0.6924	0.8831	0.9546
		21.0250	-0.0043	0.0119	0.0004	0.1920
Lubuskie (LS)	0.48	0.8672	0.8672	0.8672	0.8672	0.3512
		78.5625	-0.0030	0.0469	-0.0036	2.4513
Łódzkie (LD)	0.63	0.2495	0.0526*	0.0507*	0.1240	0.5753
		106.6765	-0.0067	0.0629	-0.0037	1.3083
Małopolskie (MP)	0.64	0.7859	0.4724	0.1398	0.2614	0.1600
		29.7488	-0.0013	0.0358	-0.0024	3.7628
Mazowieckie (MZ)	0.75	0.5683	0.1895	0.0195**	0.5160	0.2492
		-34.4046	-0.0068	0.0304	-0.0006	-3.8430
Opolskie (OP)	0.24	0.6013	0.2411	0.7110	0.9004	0.9530
		-69.9003	-0.0031	0.0113	0.0003	-0.1862
Podkarpackie (PK)	0.55	0.8706	0.3765	0.6154	0.8745	0.0736
		20.5641	-0.0020	0.0192	-0.0005	4.7967
Podlaskie (PD)	0.71	0.1509	0.1943	0.0137**	0.1060	0.5835
		-208.5320	-0.0027	0.0530	-0.0032	0.9977
Pomorskie (PM)	0.44	0.7982	0.5577	0.1149	0.3087	0.6271
		31.8791	-0.0018	0.0228	-0.0013	1.7432
Śląskie (SL)	0.74	0.6302	0.1174	0.0129**	0.1218	0.2627
		-64.0206	-0.0041	0.0367	-0.0011	2.3345
Świętokrzyskie (SW)	0.24	0.3464	0.7601	0.3771	0.4564	0.4934
		-126.6980	0.0010	0.0270	-0.0030	2.3630
Warmińsko-mazurskie (WM)	0.68	0.1441	0.4006	0.0149**	0.0181**	0.7504
		-111.8070	-0.0020	0.0800	-0.0070	0.6980
Wielkopolskie (WP)	0.56	0.2739	0.2080	0.0950	0.5416	0.7360
		-115.6250	-0.0060	0.0380	-0.0010	-0.7100
Zachodniopomorskie (ZP)	0.63	0.5156	0.0923	0.1093	0.1633	0.5714
		-74.5720	-0.0060	0.0550	-0.0030	1.3500

** $p < 0.05$, * $p < 0.1$

Source: own study basing on data from LDB.

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The adjustment of most of the constructed models to the actual data (lower high school exams) was at a weak or medium level. The worst model in this regard was the one for LB, the best — for MZ and KP. At the level of $\alpha = 0.05$, the variable regarding education had a negligible effect on the results of lower high school exams. For 15 of the 16 models examined, the public expenditure, GDPpc, and the number of students generally did not contribute to explaining the effectiveness of the education system. The variable which turned out to be the "most common" was "remuneration." Based on the conducted research, it can be concluded that only remuneration seems to affect the variable Y, which we interpret as the impact of expenses on children's education incurred by parents.

Modelling the pass rate of the baccalaureate examination results is shown in Table 2.

Table 2. Modelling the pass rate of the baccalaureate examination results in 2007–2018

Voivodeship	R^2	p-Value				
		Model parameters				
		higher education	public expenditure	salary	GDP pc	average students per class
Dolnośląskie	0.76	0.2883	0.3670	0.7934	0.4593	0.0423**
		137.0900	0.0020	-0.0020	-0.0010	4.6300
Kujawsko-pomorskie	0.69	0.6567	0.4038	0.7749	0.8734	0.3812
		68.1185	-0.0027	0.0083	-0.0003	1.9410
Lubelskie	0.73	0.1932	0.4185	0.8022	0.3385	0.2447
		-102.6280	-0.0035	-0.0071	0.0026	2.8494
Lubuskie	0.09	0.8665	0.9443	0.7575	0.7970	0.2485
		-39.5820	-0.0003	0.0099	-0.0007	0.2737
Łódzkie	0.79	0.0829	0.8319	0.6944	0.6684	0.2746
		-244.5500	0.0011	0.0111	-0.0009	2.8960
Małopolskie	0.65	0.2816	0.1288	0.4305	0.5603	0.6574
		162.8850	-0.0050	0.0220	-0.0020	-0.9510
Mazowieckie	0.52	0.3508	0.3473	0.9830	0.4025	0.7148
		-112.8900	-0.0040	0.0000	0.0010	1.6960
Opolskie	0.66	0.1855	0.0515*	0.0781	0.3034	0.4920
		-139.6790	-0.0040	0.0410	-0.0020	1.1030
Podkarpackie	0.58	0.7345	0.2060	0.8365	0.6183	0.9069
		66.6489	-0.0048	-0.0113	0.0023	0.2523
Podlaskie	0.75	0.0783	0.1213	0.2764	0.7830	0.8470
		-312.4950	-0.0041	0.0224	0.0005	-0.2471

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Pomorskie	0.73	0.8590	0.1288	0.2856	0.1509	0.0957
		15.7071	-0.0028	-0.0124	0.0015	3.5725
Śląskie	0.66	0.3852	0.1078	0.8288	0.5485	0.6051
		144.9038	-0.0056	0.0034	0.0007	0.7807
Świętokrzyskie	0.89	0.0019**	0.0917	0.0420**	0.0313**	0.4969
		-279.1910	0.0022	0.0289	-0.0036	0.6075
Warmińsko-mazurskie	0.85	0.0077**	0.0401**	0.0210**	0.3085	0.0461**
		-280.9400	-0.0101	0.0779	-0.0021	5.6675
Wielkopolskie	0.49	0.9408	0.2648	0.2290	0.5773	0.1870
		-9.7643	-0.0056	0.0316	-0.0008	3.3503
Zachodniopomorskie	0.59	0.3566	0.7643	0.9733	0.8815	0.7397
		148.8725	-0.0012	-0.0013	-0.0004	-0.5617

** $p < 0.05$, * $p < 0.1$

Source: own study based on data from LDB.

The adjustment of most of the constructed models to the actual data (baccalaureate examination) was similar to that of the models presented above — for lower high school examinations. In fact, only one model (LB) virtually did not reflect the changes taking place in the dependent variable. In these models, the parameters were also practically insignificant at the level of $\alpha = 0.05$. As in the case of lower high school examinations, the signs for some parameters in some models can be surprising — in this case, even the salary. The models presented above show that, given the assumed variables, there is no uniform set of indicators describing the quality of education in individual regions of the country. Moreover, as the research shows, the variables in most voivodeships turned out to be statistically insignificant, which reduces their importance in explaining the examinations pass rate. Consequently, both public expenditure on education and other variables did not reflect the changes occurring in the pass rate in particular voivodeships. It may mean that a different set of variables should be used, reflecting the so-called school contribution to a greater extent. Unfortunately, the shortage of statistical data in this area makes it impossible to conduct comparative studies at the regional or local levels. The construction of individual models considering variables reflecting the characteristics of each region, including cultural and social ones, might lead to better results.

In the next stage of the research, the effectiveness of public expenditure on education was estimated using DEA. In the DEA model, expenditure on education incurred both by the state budget and LGU as well as salaries as a measure of private expenditure on educating children were taken as inputs. The results were expressed through the number of points scored by students in the lower high school exam in mathematics and the percentage of people who passed the baccalaure-

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ate examination. Therefore, data on technical efficiency was obtained — to what extent the voivodeship transforms the funds into improving examination results. The best voivodeship is considered one where the relatively highest examination results can be obtained with the available resources. The worst one — where the resources are not used effectively (compared to the others).

Table 3. DEA indicators by voivodeships in 2007 and 2018

Voivodeship	2007	2018
Dolnośląskie	0.9582	0.8655
Kujawsko-pomorskie	0.9582	0.9976
Lubelskie	0.9543	0.9563
Lubuskie	0.9358	1.0000
Łódzkie	0.9886	0.9795
Małopolskie	0.9647	1.0000
Mazowieckie	0.8894	0.9127
Opolskie	0.9547	0.9352
Podkarpackie	1.0000	1.0000
Podlaskie	1.0000	0.9587
Pomorskie	0.8968	0.9112
Śląskie	0.9272	0.8963
Świętokrzyskie	0.9627	0.9799
Warmińsko-mazurskie	0.9668	0.9872
Wielkopolskie	0.9524	0.9699
Zachodniopomorskie	0.9032	0.9352

Source: own study.

In 2007, two eastern voivodeships (PD and PK) were characterised by the highest productivity, i.e. the efficiency of transforming outlays into effects. The worst efficiency was recorded in MZ, where the capital city of Poland is located, and at the seaside, in PM. The difference between the studied voivodeships was not significant, but there was a noticeable increase in the coefficient of variation — from 3.4% to 4.2%.

The values of the Malmquist index calculated in the years 2007–2018 show a slight deterioration in the effectiveness of public spending (Table 4). However, the average results differ in particular regions. The highest productivity was recorded in 2018 in LB, where the index was 1.038, i.e. productivity increased by 3.8% compared to 2007. Productivity deteriorated the most in DL, where TFP in 2018 was 5.6% lower than in 2007.

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Table 4. Change of rates of TFP and its components (%) in 2007–2018

Voivodeship	TFP	Technical efficiency change	Technological change
Dolnośląskie	0.9441	0.9032	1.0453
Kujawsko-pomorskie	1.0026	1.0411	0.9630
Lubelskie	0.9848	1.0020	0.9828
Lubuskie	1.0377	1.0686	0.9711
Łódzkie	0.9859	0.9908	0.9951
Małopolskie	1.0086	1.0366	0.9730
Mazowieckie	0.9885	1.0261	0.9634
Opolskie	1.0058	0.9795	1.0268
Podkarpackie	1.0000	1.0000	1.0000
Podlaskie	0.9843	0.9587	1.0266
Pomorskie	0.9907	1.0160	0.9751
Śląskie	0.9901	0.9667	1.0242
Świętokrzyskie	1.0021	1.0178	0.9845
Warmińsko-mazurskie	1.0019	1.0210	0.9813
Wielkopolskie	1.0243	1.0183	1.0059
Zachodniopomorskie	0.9906	1.0355	0.9567
mean	0.9962	1.0044	0.9918

Source: own study.

The changes in the average public expenditure and TFP in 2007–2018 are shown in Figure 1. The distribution of points shows that if there was a relationship between public expenditure on education across voivodeships and the effects of educational activity at the average level, it was feeble.

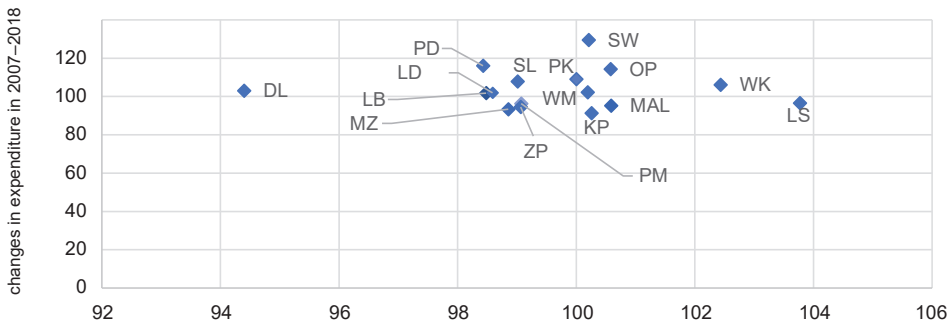

Figure 1. Average change in public expenditure on education and TFP in 2007–2018 by voivodeship (%)

Source: own study.

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4. Discussion

Students' academic achievements are widely accepted as a measure of the quality of education systems to which an increasing amount of both public and private resources are allocated. The analysis of educational public spending effectiveness is also important due to the shortage of public funds and the growing pressure to improve their allocation (Afonso and St. Aubyn, 2010; Aristovnik, 2013).

The regression analysis used in the paper did not show a significant impact of the analysed socio-economic factors on improving the quality of examination results. The signs present by some parameters in the presented regression models are sometimes surprising — e.g. in MZ or WP, the fewer people with higher education, lower public expenditure, lower GDP, and more students per unit, the better the results of lower high school examinations. In particular, we observe that in many voivodeships, both public expenditure, GDPpc, and parents' education negatively affect the improvement of examination results and, consequently, the effectiveness of public educational funds. On the one hand, these results seem to be counter-intuitive, as the literature has consistently shown a positive correlation between, for instance, education and economic development (Hanushek and Kimko, 2000, 1184–1208; Sutherland et al., 2009). On the other hand, there are also studies showing examination results disproportionate to the level of resources involved. Ciro and Garcia (2018) showed that income and education negatively affect examination results. The results of numerous studies suggest that not only the level of public funding allocated, but also the so-called family contributions and school resources are critical factors in improving academic performance. It has been observed that higher investment in education in wealthier countries does not translate into improved examination results. As more prosperous countries have higher GDPpc, the relationship between GDPpc and academic performance is usually negative (Agasisti, 2014, 16). This leads to the conclusion that an increase in resources does not automatically lead to better outcomes. However, it is worth emphasising that Poland is not one of the countries considered "rich."

The average number of students per class is the most critical determinant of the unit cost of teaching. It may express local and regional conditions or the local authorities' educational policy, which deliberately maintains small classes, taking into account higher costs covered from the budget. Such a situation may occur, especially in areas with low population density with a small number of children and adolescents in their area. The decreasing number of students in institutions and growing the distance to transport them to school escalate the costs. Research shows a negative relationship between population density and expenditure per capita on education (Herbst, Herczyński and Levitas, 2009). It should also be added that the educational subsidy, which is the primary source of financing education in Poland, takes into account in its algorithm several weights regarding the location of schools or their various types. Thus, the financing policy of

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first- and second-degree education in Poland should minimise regional disparities. The problem is that the so-called rural weight, used in relation to the location of a given educational institution, raises much controversy. It reaches all rural municipalities and small towns regardless of the fundamental problems of the school network and notwithstanding their wealth. As a result, a significant part of public funds is allocated ineffectively and unfairly (Herczyński and Siwińska-Gorzelak, 2012; Misiąg and Tomalak, 2010).

Based on the results of the DEA method, the ranking of the public spending effectiveness revealed existing differences between the analysed voivodeships. This discrepancy at the regional level is not high, although a slight increase in the coefficient of variation from 3.4% to 4.2% is noticeable. That means the applied public financing of second-level education in Poland does not reduce regional disparities in education but maintains them at a constant level. The multi-period analysis carried out using the Malmquist index shows that there was no increase in overall efficiency in Poland. The results are consistent with our previous research on the impact of government spending on reducing interregional social inequalities in Poland. At the same time, it is difficult to say whether it comes from a well-designed government strategy or from accidental actions of the government. Given the numerous criticisms of the algorithm (Galiński, 2016, 711), which is the basis for distributing public funds within the essential source of financing education in Poland (the educational part of the general subsidy), we rather agree with the latter interpretation.

Conclusion

Based on the conducted research, we conclude that there is no universal set of socio-economic factors for all the surveyed voivodeships. We note that the influence of individual factors included in our model seems to be in line with previous evidence in the literature on determinants of students' performance and outcomes. However, due to the varied results characterising the individual regions we studied, and at the same time the lack of consistency in the literature as to the impact of the analysed factors on the effectiveness of educational systems, further research on this topic is necessary, especially on the national and lower levels. Understanding these relationships requires taking into account the diversity present in the system and other features which may affect educational outcomes at the lowest possible level of aggregation (municipalities and counties). The level of schools is even better for studying this topic in municipalities and counties, but it is difficult to access socioeconomic data. We are aware of the numerous simplifications used in the article, which largely resulted from the lack of data.

At the same time, we reckon that regardless of the factors selected for the models, one should consider the region-specific characteristics. Ultimately, the re-

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search results showed that the spatial approach should not be ignored when assessing the relationship between public education expenditure and the degree (growth) of educational achievement.

Abbreviations

DL — dolnośląskie
KP — kujawsko-pomorskie
LB — lubelskie
LS — lubuskie
LD — łódzkie
MP — małopolskie
MZ — mazowieckie
OP — opolskie
PK — podkarpackie
PD — podlaskie
PM — pomorskie
SL — śląskie
SW — świętokrzyskie
WM — warmińsko-mazurskie
WK — wielkopolskie
ZP — zachodniopomorskie

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