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Sławomir Jankiewicz

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Education Inputs Index as the Background of Education Outcomes at Secondary Education Level

Abstract. *Education inputs are often presented as an essential determinant of education quality, usually expressed in the form of students educational performance represented by the results of external exams. Authors concerned with the educational function of production are not unanimous as to the above assumption – some argue that the inputs have a positive impact on the quality of education while others state that they have no such impact. The above-mentioned issues prompted the present author to pursue a research aim which consisted in demonstrating the impact of secondary education inputs on the educational performance of students.The study covered a random group of 100 districts, selected to represent five categories depending on the level of Local Human Development Index (with 20 districts per one category). Data on education inputs were obtained from the Local Data Bank and covered a period between 2012-2014, while exam performance data referred to 2015. All data were analysed using univariate and multivariate analysis of variance. The analysis demonstrates that education input levels were more significant at lower secondary school level. They have been found to be less significant at secondary school level; statistically significant differences have been identified only between extreme categories at secondary education level and for the aggregated index covering lower secondary school and secondary school education levels.*

Keywords: *education inputs, education quality, education quality index*

Introduction

Rational investment in education of the young generation is the responsibility of the state, which is derived from the theory of public goods [Polcyn & Stępień 2016: 266-280]. The rationality of education inputs depends on material factors associated the amount of money spent on school facilities or teachers' salaries. It is very likely that the quality of education can be modified by changing socio-economic variables.

The purpose of the study described in this article was to examine the relationship between the level of inputs in post-primary education and student outcomes. The objective of the analysis is particularly relevant for the assessment of the effectiveness of education, which has a direct influence on the quality of the human capital created in the process of education.

As is often pointed out in the literature, the human capital has a direct effect on GDP growth, which is why it is crucially important to develop an effective and rational approach to how financial resources are invested to improve its quality.

1. Sources of education inputs related to student outcomes

One key element of education inputs are teachers' salaries. The salary expenditure is closely related to the student-teacher ratio. This relationship is regarded as the main determinant of education quality.

Traditionally, smaller class sizes and specialised teaching methods were considered to be sufficient reasons to move students with special needs out of regular classes. In one study [Thurlow et al. 1993] didactic variables for classes with different student-teacher ratios were compared. The study involved primary school students (grades 1-6) and teachers. Different class variables were compared that reflected the key didactic variable expressed as the student-teacher ratio: 1:1, 3:1, 6:1, 9:1 and 12:1. There were significant differences in both quantitative and qualitative didactic variables, most of which favouring a lower student-teacher ratio. In the following years even more advanced research was initiated – Wisconsin's Student Achievement Guarantee in Education (SAGE), which began in the academic year 1996-97 [Molnar et al. 1999]. Under the SAGE programme, participating schools were to reduce the student-teacher ratio to the level of 15:1. The programme was accompanied by a qualitative analysis of the life in participating schools and classes. The results for the years 1996-97 and 1997-98 led to conclusions that were in line with the Tennessee Study of Class Size in the Early School Grades (known as Project STAR) launched in 1985. Individualisation of teaching was found to be the key determinant of education.

Hoxby [2000] measured the influence of class size on scholastic attainment using a longitudinal study (long periods) of each class in selected primary schools. Assignment to classes of different size was independent of parents' incomes or their recommendations as to the preferred class size for a given student. Students themselves were not aware that they were being studied and natural changes in the population generated fluctuations in class sizes under a given policy adopted in the reference period. Two methods were used: the first one involving the isolation of a random factor in the population size, and the second one consisting in tracking changes in the number of classes. Both methods indicate class sizes from 10 to 30. However, even the use of those two methods did not reveal a beneficial effect of reducing class size. Similarly, no evidence was found to support the claim that class size reduction was more effective in school where there was a high concentration of Afro-American students from low-income families.

Observations concerning the individualisation of the learning process and the lack of visible effects of reducing class sizes can be indicative of another phenomenon. There is a theory which states that when one student disrupts class work, learning outcomes for the remaining students deteriorate [Lazear 2001]. Under the disruptive model of educational production, it is assumed that the optimal class size is higher for more disciplined (well-behaved) students, which can explain why it is sometimes hard to find beneficial effects of class size reduction.

In contrast, there is agreement as to the positive effect of reducing class size for disabled people and children with special needs. One substitute for smaller class sizes is class discipline, and perhaps, as Lazear argues, this is why Catholic schools in his study had much better results than the others. According to the studies mentioned above, in most cases student segregation by ability maximises education outcomes.

An extensive article for the European Commission published in 2003 reported results of a study investigating the effect of class size on education quality [Wössman 2003]. The study was an attempt to assess the impact of family background, resources and institutions on scholastic attainment of students in 17 education systems of Western Europe. In Europe, as in the United States, family background has a strong effect on student outcomes. The most sustainable results for students from different family backgrounds have been achieved in France and the Flemish region of Belgium, while the least sustainable results have been observed in Great Britain and Germany. There are studies reporting stronger effects resulting from differences between schools in one country in terms of management autonomy, methods of knowledge testing and homework [Wössmann, Ammermuller & Heijke 2005], which indicates that education quality is more dependent on school resources than on the school itself. The next article, published in the same year [Wössmann, Propper & Duflo 2005] described a study of student performance from the viewpoint of the production process, where inputs from students, teachers and resources were associated with the creation of the key 'output': students' cognitive abilities. The purpose of Wössmann's study was to assess the educational function of production based on a representative sample of lower secondary school students from 15 West European countries. The authors conclude that class size is a particularly important element of the educational element in the production process, since it can be relatively easily changed by decision makers. However, no statistically and economically significant effect of class size was found. The results of the study suggest that at least in the context of resources and the organisational structure of West European education systems at lower secondary school level, investing money to implement a general class size reduction is unlikely to improve educational outcomes.

In the Polish education system teacher salaries are determined by stages of professional advancement, which depend of education level and teaching experience. A study conducted in primary schools, entitled Early Childhood Longitudinal Study (ECLS), analyses the relationship between qualifications of primary school teachers and reading literacy and maths skills of first grade pupils. The authors [Croninger, Rice, Rathbun & Nishio 2007] reported a positive correlation between students' reading skills and their teacher's qualifications and experience. Another finding was a potential link between teachers' qualifications and improved reading and maths performance of first graders in schools where teachers reported more intensive class work in these areas. However, these effects are more visible at school level than between individual teachers.

After 1993 the number of secondary schools in New York had nearly doubled as a result of the appearance of new "small" schools and the reorganisation of many existing schools into smaller "learning communities" [Iatarola, Schwartz, Stiefel & Chellman 2008]. There was a concern about potential differences between students from small and large schools. The study was undertaken to answer the question whether small schools would find it easier than large schools to educate their students given the fact that they received more resources and used them in more diverse ways to produce better educational outcomes. It was found that despite higher expenditure per student, a lower student-teacher ratio and a lower share of students with special needs compared to large schools, there were disproportions between students in terms of English skills. Incoming students had lower test results. There is therefore no unequivocal evidence to suggest that smaller schools facilitate access to education. From the perspective of the whole school system, the actual changes in the distribution of school resources were relatively moderate.

School resources are limited by the funds available to a given school, but there are also other methods of improving education quality. The cost-effectiveness of class size reduction (CSR) can be compared with the cost-effectiveness of rapid formative assessment (RFA), a promising alternative for raising student achievement. Drawing upon existing meta-analyses of the effects of student-teacher ratio, evaluations of CSR in Tennessee, California, and Wisconsin, and RAND cost estimates, CSR was found to be 124 times less cost effective than the implementation of systems that rapidly assess student progress in math and reading two to five times per week [Yeh 2009]. Analysis of the results from California and Wisconsin suggest that the relative effectiveness of rapid formative assessment may be substantially underestimated and that there are other more promising alternatives. The authors also question the results of Project STAR, claiming that of CSR-related effects were actually due to the Hawthorn effect (the impact of the awareness of being observed on the subject's behaviour). When such experimental programmes are implemented across the state, they will be able to benefit from the Hawthorn effect, and consequently, will not lead to better test results, which is compared by Wössmann's study from 2015.

In spite of these results, class size reduction keeps gaining popularity in the USA. It is obvious that supporters of CSR programmes often refer to the positive results of Project STAR, but some researchers remain sceptical. Using Project STAR data, a study was conducted to compare two types of schools depending on educational achievements of students attending small and normal size classes and then analyse distributions of student and teacher characteristics in both types of schools [Sohn 2010]. The distributions differed, which undermines the claims about the degree of randomization in Project STAR and potentially the validity of its results.

Class size reduction has become a very popular method of decreasing differences in student achievements but it remains highly controversial. One study analyses results of implementing the SAGE programme [Burch, Theoharis & Rauscher 2010]. Its authors describe the case of 9 schools whose directors were identified as a critical and often overlooked factor affecting the CSR implementation. Those directors turned out to be the most „influential" in three areas: use of space, meeting the needs of learners and building teacher capacity. By comparing different practices used by schools, the researchers identified "leadership" practices and guidelines for CSR, which are linked to higher student achievements.

One commonly used method of segregating students is the so called tracking. Tracking consists in dividing students depending on ability and achievements. Assigning students to different tracks (classes) depending on academic achievement is a typical practice in the USA and Canada. Alternatively, students are assigned to different schools, with a more practical or more academic orientation, which is a solution mainly adopted in Europe. Advocates of this approach claim that tracking can increase the efficiency of education by focusing on the needs of different groups of students. Its critics tend to emphasise the resulting inequalities. It is not easy to evaluate the effects of tracking, partly because of the different ways in which the system of tracking is implemented, taking into account average academic achievements and the way these achievements are distributed depending on the subject, and the way this system is used in different countries. Some studies indicate that tracking actually exacerbates inequalities in academic achievement. However, current studies in the USA question these results, suggesting that careful assignment of students to different classes and endogenic use of tracking produces radical improvements. Experimental studies involving tracking in the USA have produced different results. One experiment conducted in Kenia suggests that tracking can accelerate academic achievement of low and high achievers alike.

In an attempt to understand the effect of schools and teachers on student outcomes, with special emphasis on potential problems, such as overlooked or incorrectly measured variables as well as problems associated with the selection of students and schools, one can come across new results, which do not confirm the previous ones. Thanks to a unique selection of panel data in the UTD Texas Schools Project, it was possible to identify teacher quality based on student performance and the impact of individual teacher and school characteristics. Results of this project suggest that teachers have an enormous influence on students' reading and maths performance, although few differences in the level of teacher quality can be explained by observable variables, such as teacher qualifications or experience. The results of the study indicate costly effects of CSR are lower than the benefits derived from a positive change of one standard deviation in teacher quality, which shows the role of effectiveness in evaluating the quality of an entire school [Hanushek 2011].

Decisions about class sizes are often motivated by budget constraints and not by best practices in learning (including online learning). One example of a study on this subject is a comparison of experiences of teachers and students in the second semester of two online courses of Spanish, which was published by [Russell & Curtis 2013]. The study involved two courses: one with 125 students and another one with 25 students. Each class had only one teacher without any assistants. It was found that the large number of students had a negative impact on the level of student satisfaction with online learning. In addition, during classes of the large course, the quality and quantity of student-student and student-teacher interactions was limited. The teaching experience was not fully utilised because the large class size affected the teacher's ability to create conditions conducive to learning.

How, then, to maximise student outcomes? There is a possibility of adjusting the class size to suit the teacher's effectiveness. This relationship can be positive or negative. One the one hand, in pursuit of maximum effectiveness, school directors can increase the number of students in classes taught by better teachers. Alternatively, they can reward better teachers by assigning fewer students to their classes. Results of a study investigating the effects of such solutions were published in 2013. The study surveyed schools to find out whether directors rewarded effective teachers by reducing the size of their classes or increased their classes to improve the school's results. The study found that more effective teachers tend to get bigger classes. This finding implies the need to introduce rules concerning class size and regulations for the education policy [Barrett & Toma 2013].

Most analyses of teacher quality end without any assessment of the economic value of teacher quality, the so called altered teacher quality. A paper by Hanushek [1997] combines information about teacher effectiveness with the economic impact of higher achievement (ability to start a job or studies). The demand for teachers results from their impact on economic outcomes. Alternative valuation methods are based on the impact of increased achievement on individual earnings and on the impact of low teacher effectiveness on economic growth through aggregate achievement. A teacher one standard deviation above the mean effectiveness annually generates marginal gains of over $400,000 in present value of student future earnings with a class size of 20 and proportionately higher with larger class sizes. The author argues that by replacing the bottom 5–8 percent of teachers with average teachers, the U.S. could move near the top of international math and science rankings with a present value of $100 trillion [Hanushek 1997].

In recent decades there have been many changes in the distribution of public spending on education in the budgets of many countries. According to Ansell [2008], two forces shape the aggregate pattern of human capital expenditure: the level of democracy and the level of openness of a given state [Ansell 2008].

In another article [Arcalean & Schiopu 2010], the authors claim that an increase in public spending on education crowds out the total level of private contributions and increases the share of resources that households devote to K-12 education. For a given public budget, a higher share of K-12 public funding induces higher private education spending overall, of which a larger share goes towards higher education. The model proposed by the authors broadly matches data on education finance in the OECD countries. The calibrated parameter values indicate that at both stages public and private inputs are good yet imperfect substitutes, with a higher degree of complementarity in basic education. The authors show that the growth maximizing share of public spending devoted to K-12 should be high, irrespective of the size of the public budget. In order to maximise growth, high tax countries should use more of their public resources in tertiary education relative to low tax countries [Arcalean & Schiopu 2010].

There is no agreement in the literature about whether increased education spending improves education outcomes. However, a change in the level of expenditures is one of the main political levers for governments. In England school expenditures were increased by 40% in 2000. Studies conducted in this country suggest that the increase had a significant and positive influence on pupil attainment at primary school level. According to estimates, this expenditure can be relatively cost effective. There was also a certain degree of heterogeneity in the effect of school expenditure depending on economic disadvantage [Holmlund et al. 2010].

Similarly, Dos Santos [2012] argues that higher investments in the education of children from disadvantaged families are much more cost-effective as a crime-prevention policy than expenditures on school resources and police protection.

Winters [2011] conducted a study to examine the determinants of teacher salaries in the United States, including union activity in the teachers' own and in neighbouring districts. Using the 1999-2000 Schools and Staffing Survey and the School District Demographic System and Bureau of Labour Statistics datasets, the author found that union activity (measured by the legal status of collective bargaining and teacher union membership density) increases salaries for experienced teachers by as much as 18% to 28%. Studies that ignore such spatial dependence are likely to be misspecified and may lead to misleading conclusions.

The question of teacher salaries gives rise to various phenomena in the system of teaching. One example of this is described by Dang [2013]. A study carried out in Vietnam showed that low education quality and very large classes stimulate the market of private tutoring, which generates additional costs for households. The same full-time teachers (or contract teachers) have poorer teaching results in the same school and for this reason are employed privately to provide tutoring classes. This results in shifting education costs to households.

The promotion of education equity and improvement of educational quality in China are contextualised in tenets of Confucianism and policy directives, inspiring educational research and practice. Drawing insights from Confucianism, policy, research, and practice, Mu et al. [2013] conclude that the promotion of educational equity through high quality provision of education for disadvantaged groups can help to narrow the gap in educational quality currently existing in China.

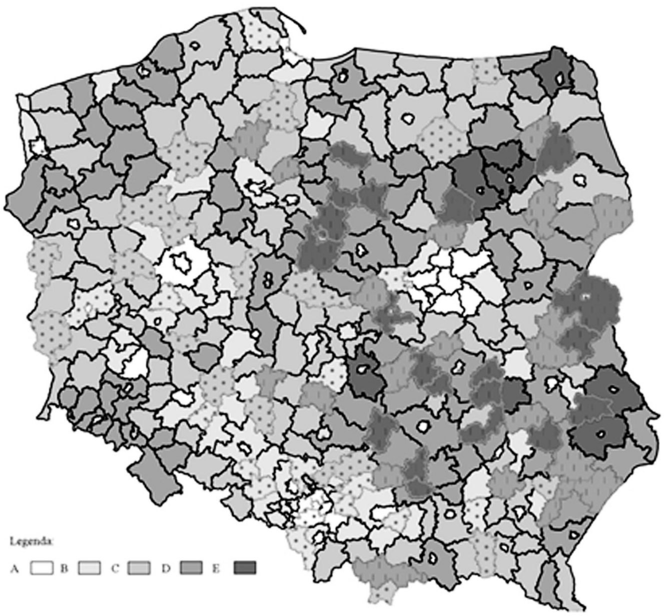
In many places in the world people are asking whether using democratic mechanisms it is possible to prompt a government to alter provision of basic services to its citizens. Harding and Stasavage [2014] argue that in an environment of weak state capacity, in which it is difficult for voters to attribute outcomes to executive actions, we suggest that electoral competition is most likely to lead to changes in policies where executive action is verifiable. The authors show that in Africa, democracies have higher rates of school attendance than non-democracies. Moreover, evidence suggests that this is primarily due to the fact that democracies are more likely to abolish school fees, not to the fact that they provide more school inputs (buildings, teaching staff).

The same issue is approached differently by Edwards and Garcia Marin [2015], who investigate whether the inclusion of social rights in political constitutions can be linked to better education outcomes. Their study was based on data for 61 countries that participated in the 2012 PISA tests. The authors find no evidence that including the right to education in the constitution has been associated with higher test scores. In their opinion, the quality of education depends on socioeconomic, structural, and policy variables, such as expenditure per student, the teacher-pupil ratio, and families' background [Edwards & Garcia Marin 2015].

2. Research methodology

The study described in the this section is based on a group of 100 districts, selected to represent five categories of Local Human Development Index (with 20 districts per one category) described in [Arak et al. 2012: 13]. The spatial distribution of selected districts is shown in Figure 1.

Figure 1. Districts by LHDI level
(dots and lines are used to mark districts selected for the analysis)



Source: own work based on a map from *National Human Development Report*, 2012: 13.

Data about education inputs for 2012-2014 were obtained from the Local Data Bank maintained by the Central Statistical Office. The dataset included information about the share of children in preschool education, per student expenditures of municipalities, including towns with district rights (pre-schools, primary schools, lower secondary schools, secondary schools combined), the number of students for each school type and the number of teachers.

The second group of data concerned final exam performance in middle and secondary schools in 2015. The data with exam results were obtained from The Educational Research Institute of the Ministry of National Education. The difference between the reference periods for the two datasets should help to identify relationships of interests by taking into account the time spent by students at subsequent stages of education.

Analysis of the relationships between education inputs and aggregate scholastic achievement for middle and secondary school students was based on the aggregate measure of inputs and the aggregate education index.

The relationship between the education expenditures index and exam performance in middle, secondary and technical secondary schools was analysed separately.

The aggregate index of education inputs was calculated as the square root of a sum of squared values of (EI_{PI}) for each education level (lower secondary school, technical secondary school and secondary school) and divided by the square root of 3. The resulting index is an aggregate measure ranging from 0 to 100.

The Education Index – Policy Input EI_{PI} (proposed in UNDP Report LHDI 2012) has been modified in the following way:

$$EI_{PIi} = \sqrt[2]{EEI_i \times STRI_i} \tag{1}$$

where i – denotes i-th district.

The Education Expenditures Index EEI_i was calculated according to the formula:

$$EEI_i = 1 + 99 \times \frac{EEI_{ei} - EEI_{min}}{EEI_{max} - EEI_{min}} \tag{2}$$

where:

- i – denotes i-th district,
- EEI_{ei} – denotes expenditures of municipalities including towns with district rights in division 801 (education, NACE Rev.1) in the i-th district (mean for 2012-2014), per student (summed up for preschools, primary schools, lower secondary schools, secondary schools combined),
- EEI_{max} EEI_{min} – the minimum and maximum values of the above mean values for 2012-2014.

$STRI_i$ was calculated according to the formula:

$$STRI_i = 1 + 99 \times \frac{STRI_{ei} - STRI_{min}}{STRI_{max} - STRI_{min}} \tag{3}$$

where:

- i – denotes i-th district,
- $STRI_{ei}$ – the total number of students in schools at each level divided by the number of teachers in the i-th district, the mean for 2012-2014 (in practice there were 3 coefficients, i.e. for lower secondary schools, and all kinds of secondary schools combined),

$STRI_{max}$ – the minimum and maximum values of the above values observed
$STRI_{min}$ in districts in the period 2012-2014 (also 3 coefficients each).

The aggregate education index (AEI) was calculated as the square root of the values of (EI) for each education level (lower secondary school, technical secondary school and secondary school) and divided by the square root of 3. The resulting index is an aggregate measure ranging from 0 to 100. *EI*

The Education Index (EI) (proposed in Arak et al. 2012) is calculated as the geometrical mean:

$$EI_i = \sqrt[2]{PEI_i \times PLSEI_i} \tag{4}$$

where:

- i – denotes i-th district,
- PEI – Pre-school Education Index,
- $PLSEI$ – Performance in Lower Secondary School Education Index.

PEI_i is calculated according to the following formula:

$$PEI_i = 1 + 99 \times \frac{PEI_{ei}}{PEI_{max}} \tag{5}$$

where:

- i – denotes i-th district,
- PEI_{ei} – percentage of children in pre-school education in the i-th district (the mean for 2012-2014),
- PEI_{max} – percentage of children in pre-school education in the i-th district observed (the maximum mean value for 2012-2014, from all districts).

$PLSSEI_i$ is calculated according to the following formula:

$$PLSSEI_i = 1 + 99 \times \frac{PLSSEI_{ei} - PLSSEI_{min}}{PLSSEI_{max} - PLSSEI_{min}} \tag{6}$$

where:

- i – denotes i-th district,
- $PLSSEI_{ei}$ – deviation from the mean for the mean of exam results at different school levels (3 coefficients were calculated, i.e. for lower secondary schools, for secondary schools and secondary technical schools) in i-th district (for 2015),
- $PLSSEI_{max}$ – the minimum and maximum values of the above mentioned ex-
$PLSSEI_{min}$ ams observed in districts in 2015.

Districts selected for analysis were orderd in descending order by the aggregate index of education inputs (EI_{PI}). They were then divided into five categories denoted with letters, from A (denoting districts with the lowest values of the education input index to E (districts with the highest values of the aggregate index of education inputs).

The next stage involved contrast analysis for different categories of the predictor (education inputs), using the simple contrast. The purpose of contrast analysis is to identify which predictor categories significantly determine the variables of interest, i.e. the education index in different school types and the aggregate education index.

3. Analysis of results

The characteristics of the input index in different district categories are shown in Table 1. The values of the LHDI display the same pattern as the indices of education inputs at lower secondary and secondary levels and the aggregate input index.

Table 1. District categories by the level of education inputs

Input level	Input index			
	Lower secondary	Secondary	Secondary technical	Aggregate index
A	28.57	20.27	25.74	25.18
B	31.89	22.94	27.85	27.89
C	34.37	26.18	30.56	30.69
D	38.88	28.18	35.47	34.61
E	42.23	32.03	38.27	37.97
Mean	35.19	25.92	31.58	31.27

Source: own elaboration.

A very interesting relationship can be noticed when one examines the aggregate education index. It shows a growing trend in the aggregate education index accompanied by a similar trend on the level of education inputs (Tables 1 and 2).

Table 2. Distribution of the aggregate education index across district categories depending on the level of education inputs

Input level	Aggregate education index (AEI)			
	Lower secondary	Secondary	Secondary technical	Aggregate index
A	48.08	70.96	66.65	62.25
B	50.58	73.71	65.32	64.11
C	51.51	71.67	67.23	64.26
D	61.45	77.96	69.02	69.98
E	60.97	76.91	67.24	68.91
Mean	54.52	74.24	66.69	65.90

Source: own elaboration.

Multivariate significance tests indicate the need to reject the null hypothesis about the similarity of the vectors of the mean values of the education index (for lower secondary, secondary and secondary technical schools) and the aggregate education index in favour of the alternative hypothesis that these values differ significantly, which confirms the validity of the analysis (Table 3).

Table 3. Multivariate significance tests (variables describing education outputs)

	Test	Value	*F*	*df*	*df* for error	*p*
Levels of inputs	Wilks	0.722	1.982	16	281.70	0.014
	Pillai	0.291	1.861	16	380.00	0.023
	Hotelln.	0.368	2.082	16	362.00	0.009
	Roy	0.317	7.524	4	95.00	0.000

Source: own elaboration.

Univariate results indicate a significant variation in the education index for lower secondary and secondary schools (Tables 4 and 5). There is no evidence of significant variation in the education index for levels of inputs in secondary technical schools (Table 6).

Table 4. Univariate results for dependent variables – lower secondary school

	Degrees of freedom	Education Index (EI)			
		SS	*MS*	*F*	*p*
Levels of inputs	4	3111.7	777.9	6.388	0.000135
Error	95	11569.7	121.8	–	–
Total	99	14681.5	–	–	–

Source: own elaboration.

Table 5. Univariate results for dependent variables – secondary schools

	Degrees of freedom	Education Index (EI)			
		SS	*MS*	*F*	*p*
Levels of inputs	4	771.1	192.8	2.522	0.046072
Error	95	7262.5	76.4	–	–
Total	99	8033.6	–	–	–

Source: own elaboration.

Table 6. Univariate results for dependent variables – lower secondary schools

	Degrees of freedom	Education Index (EI)			
		SS	*MS*	*F*	*p*
Levels of inputs	4	241.4	60.3	0.770	0.547667
Error	95	7448.8	78.4	–	–
Total	99	7690.1	–	–	–

Source: own elaboration.

Univariate test also revealed a statistically significance difference for the aggregate education index (Table 7).

Table 7. Univariate results for dependent variables – aggregate education index

	Degrees of freedom	Aggregate Education Index (AEI)			
		SS	*MS*	*F*	*p*
Input levels	4	898.6	224.6	3.567	0.009350
Error	95	5982.6	63.0	–	–
Total	99	6881.2	–	–	–

Source: own elaboration.

Tukey's HSD test calculated for secondary technical schools shows a significant difference between input level A and levels D and E. Moreover, there are differences between input level B and levels D and E, as well as between level C and level E (Table 8).

Table 8. Tukey's HSD test – variable "Education Index (EI) – lower secondary schools"

No.	Input levels	A	B	C	D	E
1.	A	–	0.952870	0.862579	0.002225	0.003441
2.	B	0.952870	–	0.998907	0.020198	0.029584
3.	C	0.862579	0.998907	–	0.042292	0.059950
4.	D	0.002225	0.020198	0.042292	–	0.999931
5.	E	0.003441	0.029584	0.059950	0.999931	–

Approximate probability for post hoc tests; error: between-group *MS* = 121.79, *df* = 95.000.

Source: own elaboration.

Tukey's HSD tests did not show any significant differences in the Education Index between inputs levels for secondary and secondary technical schools (Tables 9 and 10).

Tukey's HSD test revealed a significant difference only between levels A and D for the aggregate education index (Table 11).

Table 9. Tukey's HSD test – variable "Education Index (EI) – secondary schools"

No.	Input levels	A	B	C	D	E
1.	A		0.857440	0.999111	0.092657	0.208724
2.	B	0.857440		0.946743	0.542076	0.777156
3.	C	0.999111	0.946743		0.162155	0.327960
4.	D	0.092657	0.542076	0.162155		0.995497
5.	E	0.208724	0.777156	0.327960	0.995497	

Approximate probability for post hoc tests; error: between-group *MS* = 76.447, *df* = 95.000.

Source: own elaboration.

Table 10. Tukey's HSD test – variable "Education Index (EI) – secondary technical schools"

No.	Input levels	A	B	C	D	E
1.	A	–	0.999357	0.888896	0.526254	0.887111
2.	B	0.999357	–	0.959920	0.677388	0.958961
3.	C	0.888896	0.959920	–	0.967880	1.000000
4.	D	0.526254	0.677388	0.967880	–	0.968695
5.	E	0.887111	0.958961	1.000000	0.968695	–

Approximate probability for post hoc tests; error: between-group *MS* = 78.408, *df* = 95.000.

Source: own elaboration.

Table 11. Tukey's HSD test – variable „Aggregate Education Index"

No.	Input levels	A	B	C	D	E
1.	A	–	0.946433	0.929346	0.022252	0.068819
2.	B	0.946433	–	0.999997	0.141613	0.317289
3.	C	0.929346	0.999997	–	0.161182	0.350451
4.	D	0.022252	0.141613	0.161182	–	0.993083
5.	E	0.068819	0.317289	0.350451	0.993083	–

Approximate probability for post hoc tests; error: between-group *MS* = 62.975, *df* = 95.000.

Source: own elaboration.

Contrast analysis conducted for the education index calculated for lower secondary schools showed that a change in inputs from level A to E explains about 45% of the growth in the education index for lower secondary schools. A respective change from level B to E explains about 30%, and a change from level C to E – about 25% of the increase in the education index for lower secondary schools (Table 12). The dependence of the education index on the input level indicates the considerable effect of the level of education inputs on student outcomes at this education level.

Table 12. Contrasts for the Education Index (EI) – lower secondary schools

Contrasts	Education Index (EI)				*CI*	*CI*
	Value	*SE*	*T*	*p*	–95.00%	+95.00%
Contrast 1 (A vs. E, i.e. 1;0;0;0;-1)	–12.8866	3.489792	–3.69265	0.000370	–19.8147	–5.95848
*SScontrast/SSeffect	0.53 (45.30%)					
Contrast 2 (B vs. E, i.e. 0;1;0;0;-1)	–10.3947	3.489792	–2.97859	0.003675	–17.3228	–3.46654
*SScontrast/SSeffect	0.35 (29.91%)					
Contrast 3 (C vs. E, i.e. 0;0;1;0;-1)	–9.4576	3.489792	–2.71008	0.007982	–16.3857	–2.52949
*SScontrast/SSeffect	0.29 (24.79%)					

Source: own elaboration.

Results of contrasts between the education index calculated for secondary and secondary technical schools and input levels show a statistically significant difference for extreme levels, i.e. a change from A to E. This kind of change for secondary schools explains about 48% of the increase in the education index (Table 13). A change in the level of inputs from A to E also explains about 49% of the aggregate education index (Table 14). Thus, it can be concluded that the level of education inputs at secondary school level and the level of inputs in education expressed in terms of the aggregate education index for the two levels (with statistically significant differences) are very similar.

Table 13. Contrasts for the Education Index (EI) – secondary schools

Contrast	Education Index (EI)				*CI*	*CI*
	Value	*SE*	*T*	*p*	–95.00%	+95.00%
Contrast 1 (A vs. E, i.e. 1;0;0;0;-1)	–5.94010	2.764913	–2.14839	0.034226	–11.4291	–0.451057
*SScontrast/SSeffect	0.46 (47.92%)					

Source: own elaboration.

Table 14. Contrasts for the Aggregate Education Index

Contrast	Aggregate Education Index				*CI*	*CI*
	Value	*SE*	*t*	*p*	–95.00%	+95.00%
Contrast 1 (A vs. E, i.e. 1;0;0;0;-1)	–6.66130	2.509486	–2.65445	0.009314	–11.6433	–1.67934
*SScontrast/SSeffect	0.49 (48.85%)					

Source: own elaboration.

Summary

The statistical analysis has revealed a greater importance of the level of education inputs for the Education Index at the lower secondary school level. The effect is less prominent in secondary education; statistically significant differences were only found between extreme categories of input levels for secondary schools and in education expressed in terms of the aggregate education index, comprising lower secondary and secondary education.

The results confirm the observation the level of education outputs is not determined solely by the level of financial inputs. This statement is confirmed by observations reported in the literature on the determinants of education quality. It can be assumed that education quality is determined by many socio-economic factors; moreover, the impact these factors have on education quality can vary depending on a particular society.

The identification of determinants of education quality is crucial from the viewpoint of creating human capital, which, in consequence, is instrumental in GDP growth.

The present article is a small contribution to a better understanding of this research problem.

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Wskaźnik nakładów na edukację jako tło efektów kształcenia na poziomie edukacji ponadpodstawowej

Streszczenie. *Nakłady na edukację są często wskazywane jako czynnik decydujący o jakości edukacji, wyrażanej najczęściej osiągnięciami edukacyjnymi uczniów mierzonymi wynikami egzaminów zewnętrznych. Doniesienia zawarte w literaturze na temat badań nad edukacyjną funkcją produkcji nie są zgodne co do wskazanego założenia, spotykane są zarówno doniesienia o pozytywnym wpływie nakładów na jakość edukacji, jak i o braku istotności takiego wpływu. Przedstawione problemy sprawiły, że jako cel badań przyjęto wykazanie wpływu poziomu nakładów na edukację ponadpodstawową na osiągnięcia edukacyjne uczniów. Badania przeprowadzono na losowej grupie 100 powiatów, wytypowanych po 20 z każdej z pięciu klas powiatów zależnie od poziomu rozwoju społecznego. Dane pozyskane z Banku Danych Lokalnych obejmowały lata 2012-2014, a dane o osiągnięciach egzaminacyjnych dotyczyły 2015 r. Analizy przeprowadzono, stosując jednowymiarową i wieloczynnikową analizę ANOVA. Wykazały one większe znaczenie poziomu nakładów dla wskaźnika edukacji na poziomie gimnazjum, a mniejsze znaczenie na poziomie edukacji ponadgimnazjalnej. Stwierdzono statystycznie istotne różnice tylko pomiędzy skrajnymi klasami w edukacji na poziomie liceum oraz edukacji wyrażanej zagregowanym wskaźnikiem edukacji obejmującym edukację gimnazjalną i ponadgimnazjalną.*

Słowa kluczowe: *nakłady na edukację, jakość kształcenia, wskaźnik jakości kształcenia*