Barometr Regionalny
Tom 16 nr 2

Ratio Analysis of Infrastructure Investments: a Case Study of the Municipalities and Communes of the Olsztyn County

Waldemar Kozłowski
University of Warmia and Mazury in Olsztyn, Poland

Abstract

A fundamental aspect of infrastructure investments made by local authorities is the evaluation of their effectiveness. Considering their public character, infrastructural investments require more methodological sophistication to allow an assessment of a number of areas which have been ignored in previous analyses. This paper introduces a model for evaluating infrastructural investments based on select socio-economic ratios. The results of the research can be used by local authorities during investment planning and evaluation.

Keywords: infrastructure investments, ratio analysis, municipality

JEL: O18, P43, R53, R58

Introduction

Local development is closely connected with the development of technical and social infrastructure as a key potential for creating an economically and socially active locality, which has been discussed in numerous publications (Brzozowska 2005, 5; Dziembowski 1985, 725; Karst 1986, 7; Ratajczak 1999, 10). Definitions of infrastructure consistently describe it as a system of facilities and institutions which are subsidiary to other spatial systems, both in their technical and social aspects (Kowalski 2013, 5). The importance of infrastructure in local development has been acknowledged as a "bottom-up" approach which evolved in regional development theory. It stressed the necessity to rely on local resources, such as infrastructure, for regional development (Adamska 2008; Kołodziejczyk 2014, 198–199).

In Poland, local infrastructure has developed dynamically in recent years with the use of European funds. Sound investments are credited with a significant positive influence on the quality of life in local communities, as well as an increase in consumer demand (Kryk 2012, 150). Most infrastructural investments are local, which is mostly due to statutory competences of the municipal authorities. Value-wise, global investments prevail. Primary municipal investments are those in the road infrastructure, water and sewage networks, housing infrastructure, waste management, as well as heating and renewable energy supply. Structural investment requires significant funding and compliance with rigorous legal requirements, mainly concerning public financing, environmental protection, and land management.[1] The basic characteristics of infrastructural investments are outlined in figure 1.

1. The most important laws and regulations include: Ustawa z dnia 8 marca 1990 r. o samorządzie terytorialnym [Local Self-Government Act]. DzU z 1990 r. nr 16 poz. 95; Ustawa z dnia 27 sierpnia 2009 r. o finansach publicznych [Public Finance Act]. DzU z 2009 r. nr 157 poz. 1240); and Ustawa z dnia 27 marca 2003 r. o planowaniu i zagospodarowaniu przestrzennym [Spatial Planning and Development Act]. DzU z 2003 r. nr 80 poz. 717.

E-mail addresses of the authors
Waldemar Kozłowski: wkozlowski@xl.wp.pl

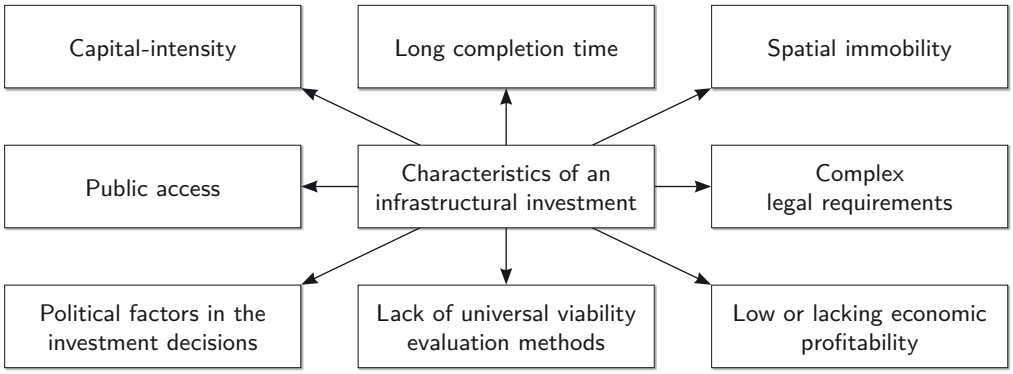

Fig. 1. Characteristics of infrastructural investments

Source: Kozłowski (2012, 11)

Infrastructural and commercial investments differ mainly in their goals, and consequently in the methods used for viability evaluation. Infrastructural investments are typically very capital-intensive and pose a high technological risk. The viability of local infrastructural investments, expressed mainly in their economic and social aspects, is difficult to evaluate (Kasiewicz and Rogowski 2009, 109). Evaluation is done both ex ante and ex post. Ex ante evaluation of infrastructural investments focuses mainly on the planning stage, concerning project preparation and selection of options that best fulfil the local development strategy, as well as meeting investment goals. Ex post evaluation is based on effect verification vis-à-vis the investment plan. The final evaluation consists in a comparison of the effects and the plan.

The purpose of this paper is an evaluation of infrastructural investments based on selected socio-economic ratios as a case study of the municipalities and communes of the Olsztyn County.

1 Methodology

The subject of this paper is the evaluation of infrastructure investments. According to the research hypothesis, there is a stochastic relationship between structural investment expenses and their socio-economic effects, as expressed by selected socio-economic ratios. The basic research methods used in the study are:

- ratio analysis based on 12 socio-economic ratios, describing their effects related directly or indirectly to the infrastructure investment expenditure (tab. 1),
- Ward's minimum variance method applied in hierarchical cluster analysis, describing similarities between municipalities and communes in regard to the ratios analyzed, and
- Pearson correlation coefficient, which measures correlations between the socio-economic ratios.

The subject of the research are infrastructure investments completed in the municipalities and communes of the Olsztyn County. The county area is 2 840,3 km^2, which constitutes 11,7% of the Warmińsko-Mazurskie Voivodship.[2] It is the largest county in the voivodship, and third largest in the country (fig. 2). The county is divided into 12 municipalities, including:

- 5 urban-rural municipalities — Barczewo, Biskupiec, Dobre Miasto, Jeziorany, Olsztynek, and
- 7 communes — Dywity, Gietrzwałd, Jonkowo, Kolno, Purda, Stawiguda, Świątki.

The time scope of the study are years 2005–2016.

2 Methods for evaluating infrastructure investments

Infrastructure investment expenditures made by local authorities can be analyzed with functional, asset or financial criteria (fig. 3, see page 98). The functional criterion consists in separating investments by their functions (e.g., transport, water supply, housing, etc.). In total, 25 functions

2. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

Tab. 1. Socio-economic ratios of infrastructural investments (yearly)

No.	Basic ratio	Formula
E1	Amount of investment expenditure	invested amount
E2	Amount of investment expenditure per capita	$\frac{\text{invested amount}}{\text{population}}$
E3	Dynamics of the share amount of investment expenditure to expenditure total	$\frac{\text{amount of investment expenditure in the expenditure total in the year } t}{\text{amount of investment expenditure in the expenditure total in the year } t-1}$
E4	Dynamics investment autonomy	$\frac{\text{invested amount in income total in the year } t}{\text{invested amount in income total in the year } t-1}$
E5	Dynamics amount own income in income total	$\frac{\text{own income in income total in the year } t}{\text{income in income total in the year } t-1}$
E6	Dynamics share of EU financing in invested amount	$\frac{\text{EU financing in invested amount in the year } t}{\text{EU financing in invested amount in the year } t-1}$
E7	Dynamics of the number of economic operators in the years in question	$\frac{\text{number of operators in the year } t}{\text{number of operators in the year } t-1}$
S1	Dynamics of the population in the years in question	$\frac{\text{population in the year } t}{\text{population in the year } t-1}$
S2	Dynamics of the working age population ratio	$\frac{\text{working age population ratio in the year } t}{\text{working age population ratio in the year } t-1}$
S3	Dynamics of the unemployment rate	$\frac{\text{working age population ratio in the year } t}{\text{working age population ratio in the year } t-1}$
S4	Dynamics of the employment to 1000 inhabitants rate	$\frac{\text{number of employees to 1000 inhabitants in the year } t}{\text{number of employees to 1000 inhabitants in the year } t-1}$
S5	Dynamics of the migration balance	$\frac{\text{number of migrants in the year } t}{\text{number of migrants in the year } t-1}$

Note: E1 is measured in PLN, E2—in PLN per capita, ratios from E3 to S5 are measured in percentages

Fig. 2. The Olsztyn County and its municipalities and communes

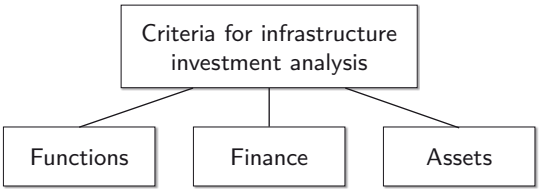

Fig. 3. Criteria for infrastructure investment analysis

are discerned. The asset criterion involves an analysis of investments based on their division into investment expenditures and maintenance of the infrastructure. The first group includes purchasing and installing fixed assets, their restoration, construction work, etc., as well as overhaul. The second group — maintenance expenditure — includes routine repairs. Finally, the financial criterion allows for an analysis of infrastructure investments within the scope of fees for facility use (e.g., fees for water, waste disposal, energy, administrative procedures) and other costs of public facilities, like roads, and socio-cultural, environmental, educational, and healthcare services.

The methodology of infrastructure investment evaluation continues to develop, as confirmed by the inclusion of a number of areas (social, strategic, environmental) which cannot always be translated into the financial dimension (Kozłowski 2012, 13). As noted by Drobniak (2005, 41), due to their public character, infrastructural investments should undergo a multi-criterion evaluation in their economic, social, strategic, political, environmental and technical dimensions. In practice, a socio-economic evaluation known as the cost-benefit analysis is commonly employed (Drobniak 2002, 108). For the purposes of this paper, a model of ratio analysis for infrastructure investments has been developed (fig. 4).

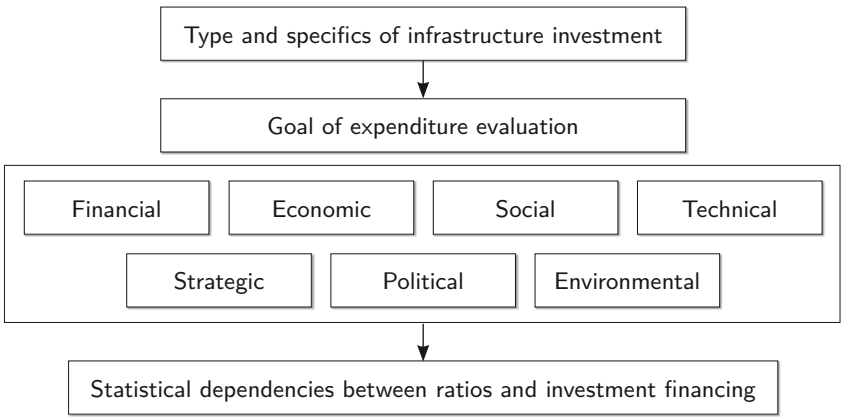

Fig. 4. Model of ratio analysis for infrastructure investments

Depending on the type of infrastructure and the purpose of the evaluation, several ratios from different analytical areas can be selected in any groups of ratios. Socio-economic ratios are employed in most evaluations (Ray 1984, 90). The main goal of the research is to find causal relationships between investment expenditure and its effects.

3 Analysis of infrastructural investment expenses by the municipalities and communes of the Olsztyn County

The analysis of infrastructural investment expenses includes their amount and structure. Cluster analysis has also been performed within sets of observations that were deemed to be related. Table 2 shows infrastructural investment expenses from 2005 to 2016. In the years 2005–2016, the greatest nominal amounts were expended for infrastructure investments in the municipalities and communes of Biskupiec (PLN 110,2 million), Stawiguda (PLN 84,8 million), Olsztynek (PLN 82,1 million), and Barczewo (PLN 81,5 million). The least expenses were made in the communes of Świątki (PLN 13,0 million) and Kolno (PLN 18,8 million). The greatest total infrastructural investments were completed by the municipalities and communes in 2010, amounting to about PLN 100,9 million.

Tab. 2. Amounts of infrastructural investment expenses (E1) (in PLN thousand)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total	Mean
Barczewo	2 548	7 351	6 452	5 244	6 891	9 468	15 320	6 507	5 887	6 826	4 560	4 462	81 518	*6 793*
Biskupiec	13 248	3 489	9 313	7 144	5 623	24 833	15 201	4 635	3 145	11 387	5 155	7 012	11 0184	*9 182*
Dobre M.	4 220	4 206	19 651	5 612	3 476	6 490	5 316	3 271	4 262	12 800	1 771	2 238	73 314	*6 110*
Dywity	7 321	4 624	5 139	3 344	8 659	9 068	7 327	5 994	6 084	7 931	7 354	4 279	77 124	*6 427*
Gietrzwałd	5 253	7 378	6 294	3 046	9 779	2 614	2 221	7 763	8 407	7 211	3 360	2 850	66 175	*5 515*
Jeziorany	1 283	4 662	6 275	6 452	6 035	3 963	3 048	6 507	3 856	4 334	2 286	1 692	50 392	*4 199*
Jonkowo	853	837	3 261	2 041	1 995	13 229	3 577	6 759	2 567	5 065	2 949	2 668	45 800	*3 817*
Kolno	646	904	953	815	1 331	3 658	2 165	276	271	1 277	4 742	1 801	18 839	*1 570*
Olsztynek	3 094	3 131	4 955	5 778	8 545	10 983	11 929	6 651	6 238	9 427	6 150	5 274	82 155	*6 846*
Purda	1 881	896	2 097	3 074	2 838	5 650	3 545	3 002	2 803	4 123	2 284	2 055	34 247	*2 854*
Stawiguda	3 496	4 601	3 470	8 094	5 162	9 808	10 601	8 036	7 056	9 477	9 219	5 807	84 827	*7 069*
Świątki	151	709	690	314	569	1 214	2 151	1 736	2 425	1 721	574	915	13v168	*1 097*
Total	43 994	42 786	68 549	50 959	60 901	100 976	82 402	61 136	53 001	81 579	50 405	41 054	–	–

Tab. 3. Amount of investment expenditure per capita (E2) (in PLN)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean
Barczewo	156	446	390	316	411	561	898	379	340	393	261	254	*400*
Biskupiec	696	183	490	377	297	1317	784	239	163	593	269	367	*481*
Dobre M.	264	264	1236	354	220	411	328	202	263	791	110	139	*382*
Dywity	843	510	550	348	878	898	705	563	564	720	663	380	*635*
Gietrzwałd	1 000	1 393	1 176	559	1 740	456	371	1 280	1 358	1 136	518	437	*952*
Jeziorany	157	569	773	794	745	496	377	809	481	542	287	213	*520*
Jonkowo	159	148	565	341	323	2 083	538	994	373	722	416	375	*587*
Kolno	187	262	278	241	395	1 096	632	81	80	383	1 440	546	*468*
Olsztynek	226	229	363	423	622	801	855	477	447	674	439	380	*495*
Purda	263	123	285	411	373	732	437	364	336	487	269	240	*360*
Stawiguda	701	906	670	1503	899	1604	1 667	1 186	993	1 281	1 204	728	*1 112*
Świątki	35	167	164	76	138	291	509	412	576	409	137	219	*261*

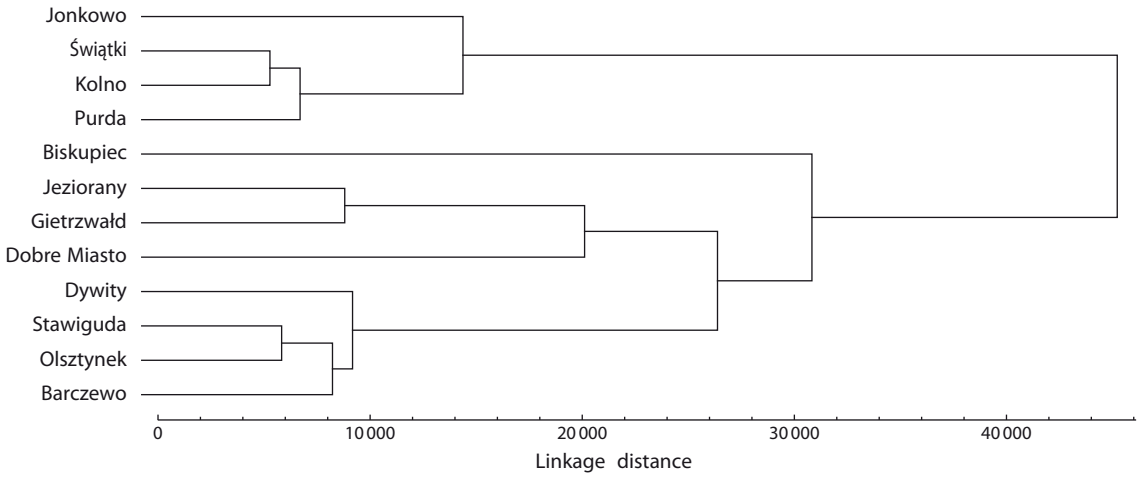

Fig. 5. Cluster analysis — Ward's method

Another analytical ratio was the amount of investment expenditure per capita (tab. 3). The analysis of investment expenditure per capita reveals that the highest ratios were recorded in the communes of Stawiguda (PLN 1 112 per capita) and Gietrzwałd (PLN 952 per capita). The lowest ratios were those of Świątki (PLN 261 per capita), Purda (PLN 360 per capita) and Dobre Miasto

(PLN 382 per capita). On the basis of those two ratios, municipalities and communes were classified by their investment expenditure. A cluster analysis was performed using Ward's method (fig. 5).

The analysis allowed further classification of the municipalities and communes by similarities in investment expenditure. The process rendered 6 clusters of similar municipalities and communes:

- 1st cluster — Barczewo, Dywity, Stawiguda, Olsztynek
- 2nd cluster — Dobre Miasto
- 3rd cluster — Gietrzwałd, Jeziorany
- 4th cluster — Biskupiec
- 5th cluster — Jonkowo
- 6th cluster — Kolno, Świątki, Purda

4 Analysis and evaluation of the socio-economic effects

For the purposes of socio-economic evaluation of investment expenditure, 10 ratios were employed. Their dynamics were analyzed within the period from 2006 to 2016, where the base is the year 2005 (tab. 4). The analysis of the dynamics of the indices presented in table 2 and reported by the individual communes for 2005–2016 indicates that:

- the highest dynamics of the E3 index describing the capital expenditures in the total expenditures were recorded in Gietrzawałd and Stawiguda communes — 28% and 27%, respectively;
- the highest dynamics of the E4 index describing the level of self-financing of infrastructure investments were recorded in Jonkowo and Gietrzwałd communes — 60% and 59%, respectively;
- the highest dynamics of the E5 index describing the level of commune's revenues in the total income structure were recorded in Stawiguda and Dywity communes — 71% and 62%, respectively;
- the highest dynamics of the E6 index describing the level of investment financing with the EU funds were recorded in Olsztynek and Gietrzwałd communes — 7,5%/year and 5,4%/year, resp.;
- the highest dynamics of the E7 index describing the growth rate of the number of business entities were recorded in Stawiguda and Dywity communes — 45% and 38%, respectively;
- the highest dynamics of the S1 index describing the population growth was recorded in the Stawiguda commune at 60%;
- the highest dynamics of the S2 index describing the working age population growth were recorded in the Olsztynek and Jeziorany communes — 12% and 10%, respectively;
- the highest dynamics reduction of unemployment of the S3 index of 74% was recorded in Gietrzwałd, Purda, and Stawiguda communes;
- the highest dynamics of the number of employed people per 1 000 residents (S4 index) were recorded in Świątki and Kolno communes — 27% and 23%, respectively; and
- the highest dynamics of the S5 index describing migration levels were recorded in Purda and Barczewo communes — 132% and 155%, respectively.

Tab. 4. Dynamics of economic and social indices in 2006–2016 (in %, the reference year: 2005)

	E3	E4	E5	E6	E7	S1	S2	S3	S4	S5
Barczewo	16	36	47	4,0	35	8	6	−66	19	155
Biskupiec	17	45	40	5,2	6	0	4	−61	4	26
Dobre M.	14	40	44	3,0	23	1	4	−61	4	−19
Dywity	21	37	62	2,9	38	30	4	−70	−1	32
Gietrzwałd	28	59	54	5,4	33	24	3	−74	−10	−85
Jeziorany	18	60	33	5,4	20	−3	5	−49	2	−52
Jonkowo	17	31	57	1,2	29	33	10	−73	−4	59
Kolno	15	41	32	5,0	33	−5	9	−63	23	8
Olsztynek	18	38	48	7,5	9	1	12	−72	−11	−125
Purda	12	29	43	4,1	23	20	8	−74	−2	132
Stawiguda	27	41	71	3,4	45	60	6	−74	−15	−19
Świątki	8	27	33	3,3	16	−2	2	−65	27	15

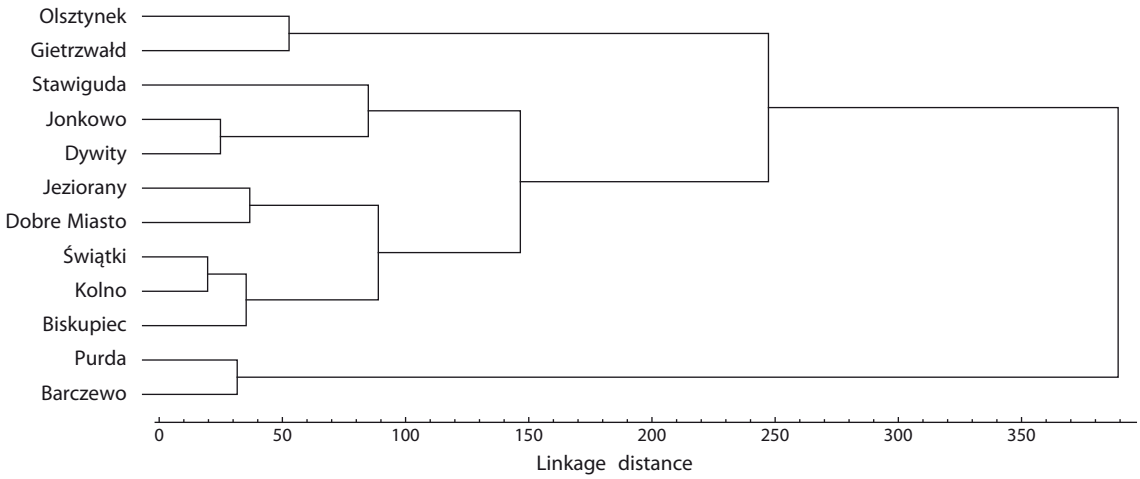

Fig. 6. Cluster analysis — Ward's method

In an analysis of the dynamics of socio-economic ratios, the municipalities and communes have been classified into similarity clusters using Ward's method (fig. 6). The analysis rendered the following clusters of municipalities and communes, characterized by similarities with respect to the selected ratios: the first cluster (with the lowest aggregation level) contains the communes of Kolno and Świątki. The municipalities of Dywity and Jonkowo form the second cluster, while the third one includes Barczewo and Purda. The fourth cluster is the stand-alone municipality of Biskupiec. The fifth cluster contains Dobre Miasto and Jeziorany. The sixth cluster contains the commune of Gietrzwałd and the municipality of Olsztynek. The commune of Stawiguda forms the seventh cluster, characterized by the highest aggregation level.

On the basis of the investment analysis (fig. 5) and the level of growth of defined indicators (fig. 6), it can be stated that there have been changes in clusters between individual municipalities, which proves the varied effectiveness of infrastructural investments implemented by municipalities.

5 Relationship analysis

This research has also investigated the relationships between infrastructure investment expenditures in the municipalities and communes in question and the ratios characterizing their socio-economic effects. The correlations confirmed the existence of causal relationships which, in turn, may become a driving force behind growth, creating a synergistic feedback loop. The correlations between ratios under investigation show dependencies existing between them, which can aid in planning infrastructure investments with specific socio-economic goals in mind (tab. 5).

The analysis suggests a number of significant correlations between the ratios under investigation between the studied years:

- there is a positive significant correlation between investment amount per capita (E2) and
  - the ratio of investment expenditure to total expenditure (E3) at $r = 0{,}948$
  - the ratio of own income to total income (E5) at $r = 0{,}763$
  - the increase in the number of economic operators (E7) at $r = 0{,}782$
  - population growth (S1) at $r = 0{,}782$
  - employment increase (S4) at $r = 0{,}691$
- there is a positive significant correlation between the ratio of investment expenditure to total expendit (E3) and
  - infrastructural investment autonomy (E4) at $r = 0{,}611$
  - the dynamics of own income–to–total income ratio (E5) at $r = 0{,}719$
  - population growth (S1) at $r = 0{,}645$
- there is a positive signif. correlation between the ratio of own income-to-total income (E5) and
  - the growth of the number of economic operators (E7) at $r = 0{,}616$
  - population growth (S1) at $r = 0{,}918$

Tab. 5. Matrix of Pearson' correlation coefficients between analyzed ratios in the years 2005–2016

	E1	E2	E3	E4	E5	E6	E7	S1	S2	S3	S4	S5
E1	1	0,368	0,524	0,297	0,482	0,213	−0,061	0,228	−0,084	−0,060	−0,507	−0,146
E2		1	0,948*	0,465	0,763*	−0,007	0,597*	0,782*	−0,064	−0,419	0,691*	−0,382
E3			1	0,611*	0,719*	0,151	0,520	0,645*	−0,055	−0,331	−0,345	−0,427
E4				1	−0,060	0,483	0,028	−0,097	−0,276	0,431	−0,309	−0,566
E5					1	−0,349	0,616*	0,918*	0,078	−0,685*	−0,703*	−0,033
E6						1	−0,464	−0,463	0,216	0,184	−0,128	−0,542
E7							1	0,693*	−0,070	−0,364	−0,126	0,238
S1								1	0,039	−0,671*	−0,633*	0,101
S2									1	−0,310	−0,250	−0,025
S3										1	0,455	−0,107
S4											1	0,420
S5												1

* $p < 0{,}05$

Conclusions

Following the analysis, it may be concluded that the research hypothesis has been partly confirmed and that stochastic relationships do exist between the levels of expenditure and the selected socio-economic ratios. The municipalities and communes under investigation were characterized by different infrastructure investment amounts. In the years 2005–2016, the greatest absolute amounts were spent by the municipalities and communes of Biskupiec (PLN 110,2 million), Stawiguda (PLN 84,8 million), Olsztynek (PLN 82,1 million) and Barczewo (PLN 81,5 million). The smallest amounts were expended by the communes of Świątki (PLN 13,0 million) and Kolno (PLN 18,8 million). There was a positive correlation between the level of investment per capita (ratio E2) and the share amount of investment expenditure (E3), amount of own income in income total (E5), Dynamics of the number of economic operators (E7), its population (S1) and the level of employment (S6). This testifies to the existence of a causal relationship between the ratios under investigation.

Evaluating investments through the lens of socio-economic ratios allows for a broader look at both municipal investment expenditures and their effects. The diagnosed dependencies enable decision-makers to plan expenses more effectively and to expect more realistic outcomes. Ratio analysis may become one of the tools which will ensure an optimal and realistic evaluation of the expenses by local authorities. It is therefore advisable for municipalities and communes to analyses economic ratios pertinent to their development strategies and translate them into investment procedures. Furthermore, ratio analysis facilitates a realistic evaluation of the effects yielded by investments in different types of infrastructure, which significantly expedites the decision-making and evaluation process.

References

Adamska, H. 2008. "Rozwój na szczeblu lokalnym a konkurencyjność." *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu* 10 (2): 14–17.

Brzozowska, K. 2005. *Finansowanie inwestycji infrastrukturalnych przez kapitał prywatny na zasadach project finance*. Warszawa: CeDeWu.

Drobniak, A. 2002. *Zastosowanie analizy kosztów i korzyści w ocenie projektów publicznych*. Prace Naukowe / Akademia Ekonomiczna w Katowicach. Katowice: Wydawnictwo Akademii Ekonomicznej im. Karola Adamieckiego w Katowicach.

———. 2005. *Ocena projektów publicznych*. Prace Naukowe / Akademia Ekonomiczna im. Karola Adamieckiego. Katowice: Wydawnictwo Uczelniane Akademii Ekonomicznej im. Karola Adamieckiego.

Dziembowski, Z. 1985. "Infrastruktura jako kategoria ekonomiczna." *Ekonomista* (4): 725–739.

Karst, Z. 1986. *Techniczno-ekonomiczna infrastruktura gospodarki narodowej*. Warszawa-Wrocław: Państwowe Wydawnictwo Naukowe.

Kasiewicz, S., and W. Rogowski. 2009. *Inwestycje hybrydowe. Nowe ujęcie oceny efektywności*. Warszawa: Szkoła Główna Handlowa – Oficyna Wydawnicza.

Kołodziejczyk, D. 2014. "Infrastruktura w rozwoju społeczno-gospodarczym gmin w Polsce." In *Agrobiznes 2014. Problemy ekonomiczne i społeczne*, edited by A. Olszańska and J. Szymańska, 198–207. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Kowalski, A. 2013. *Inwestycje lokalne i źródła ich finansowania*. Warszawa: Dział Wydawnictw IERiGŻ-PIB.

Kozłowski, W. 2012. *Zarządzanie gminnymi inwestycjami infrastrukturalnymi*. Warszawa: Difin.

Kryk, B. 2012. "Jakość życia w kontekście zrównoważonego rozwoju." *Handel Wewnętrzny. Marketing, Rynek, Przedsiębiorstwo* 58 (1): 145–155.

Ratajczak, M. 1999. *Infrastruktura w gospodarce rynkowej*. Poznań: Wydaw. AE.

Ray, A. 1984. *Cost-Benefit Analysis. Issues and Methodologies*. Baltimore: Published for the World Bank by Johns Hopkins University Press.