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Study the relationship between creativity and knowledge

Agnieszka Chełmecka

Scientific Circle of Statisticians, University of Economics in Katowice, Poland

E-mail address: agnieszka.chelmecka@op.pl

ABSTRACT

Dependency analysis is based both on planning, implementation and control. However, you can look at this process from the statistical side. Project management lists several methods that differ in priorities, such as time, budget, risk, or commitment. Comparison of several methods used gives a broader perspective on the subject matter. The statistical survey was mainly based on the study of the relationship between knowledge actors and creativity

***Keywords*:** Project management, statistics, statistical survey, independence test χ ^ 2, dependency study, Pearson correlation, creativity, knowledge

1. CHARACTERISTICS OF STATISTICAL MEASURES

The correlation relation between the X and Y characteristics is characterized by the fact that the values of one feature are assigned strictly defined mean values of the second characteristic.

The purpose of the correlation analysis is to determine whether there are any dependencies between the variables studied, what their strength is, what their form and direction are. Interrelation between variables can be of two types: functional or stochastic (probabilistic).

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The essence of functional dependency is that changing one variable value causes a specific change in the value of the second variable. In the case of a functional relationship: one variable (X) corresponds to one and only one value of the second variable (Y) (Z. Rusnak, 2012, pp. 250-280).

Probabilistic dependence occurs when the probability distribution of a second variable changes with the change of one variable value. A particular case is a correlation relationship that is based on the fact that certain values one variable corresponds to strictly defined mean values of the second variable.

We can then determine how the value of the dependent variable Y depends on the value of the independent variable X.

The force of the linear relationship between the two variables is the correlation coefficient from the sample r. It assumes values from the closed interval <-1; 1>.

A value of -1 indicates the existence of a perfect negative correlation (the points lie exactly on the straight line, facing downwards), and the value of 1 denotes the positive positive correlation (the points lie exactly on the straight, facing upward). Value 0 means no linear correlation.

The intervals, which are assumed to be a given level of dependency, are:

- 0-0.3; Means no or weak relationship between variables,
- 0,31-0,69; Means a moderate relationship between variables, that is, in this case one can not say that all changes in one variable are related to changes in the other variable, as the outflows to these changes also have random factors such as weather or natural disasters,
- 0.7-1; Means a strong relationship between variables, that is, most changes in one variable are explained by changes in the other variable, but there may also be a random factor, but already to a lesser extent than with a moderate dependency.

The formula by which the correlation coefficient is calculated is:

$$r_{xy} = \frac{\sum_{i=1}^{k}\sum_{j=1}^{l} f_{ij}(x_i - \bar{x})(y_j - \bar{y})}{\sqrt{\sum_{i=1}^{k} f_i (x_i - \bar{x})^2 \sum_{j=1}^{l} f_j (y_j - \bar{y})^2}}$$

where: xi and yi denote respectively the values of the variables x and y, and x and y mean values of these variables.

However, before proceeding to calculate Pearson's linear correlation coefficient, we need to make an action plan that will allow us to act in accordance with the mathematical sequence we have adopted.

The stages that can be distinguished are:

1. Determine the number of variables and define the scales in which they are expressed,

2. Determining sample size,

3. Draw a sample from the population,

4. Measurement of variables describing the studied objects,
5. Specification of possible coefficients,
6. Choosing the optimum ratio,
7. Calculation of coefficients,
8. Testing factor significance (null hypothesis: no relationship between variables).

When calculating the correlation coefficient, it is always advisable to create a scatter plot. It is recommended to visually determine whether the test compound actually best describes the linear function. It may be that the calculated value of the coefficient is close to 0, but there are dependencies between the variables, but nonlinear.

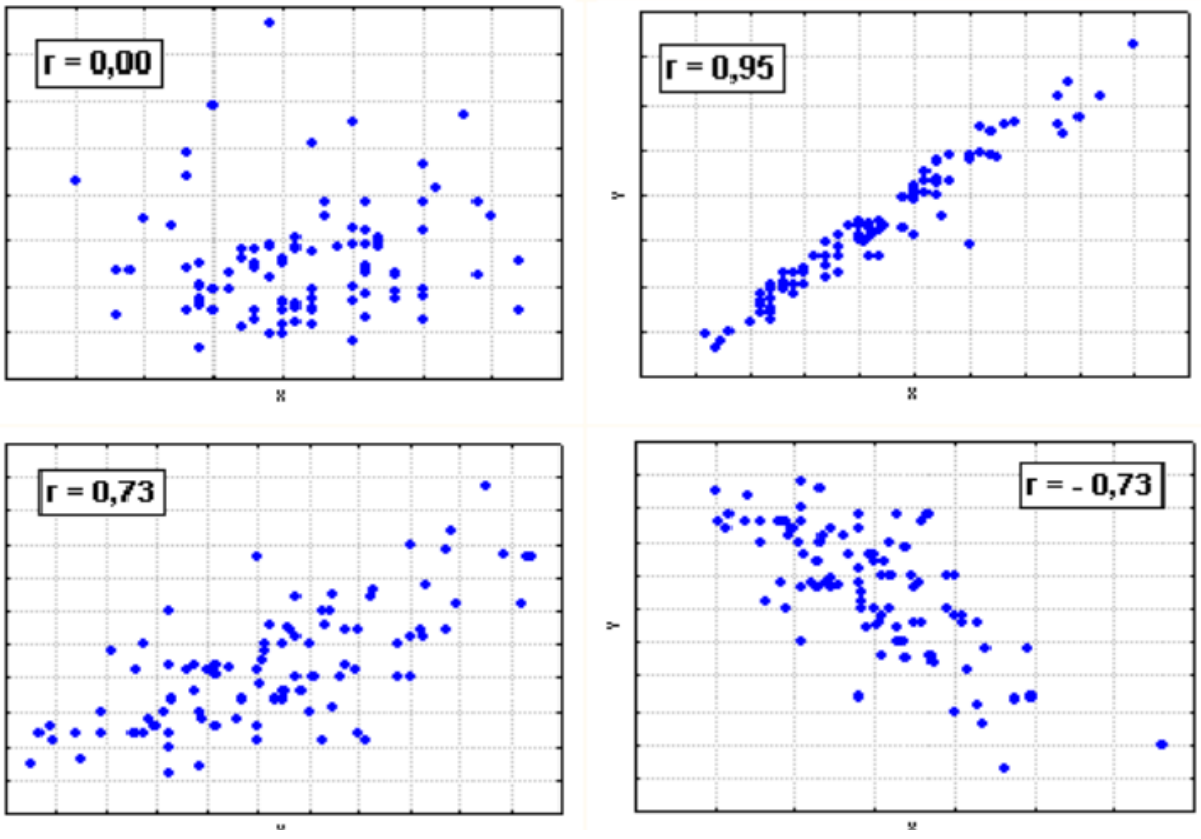

Figure 1. Scatter graphs for different levels of Pearson's correlation coefficient
Source: Own elaboration.

Another important thing in a statistical survey is to determine the significance level of a given variable. Thus the level is the maximum permissible probability of error of type I (usually marked with α). It therefore determines the maximum risk of error that the researcher is willing to accept. The choice of α values depends on the investigator, the nature of the problem and how accurately he wants to verify his hypothesis, the most common is α = 0,05;

Less often 0.1, 0.03, 0.01 or 0.001. The value of assumed significance level is compared with the p-value calculated from the statistical test (sometimes the test statistic value is compared with the value corresponding to the significance level). If p-value is higher, then there is no reason to reject the so-called. The null hypothesis H0, which usually states that the observed effect is the work of the case. The level of significance $\alpha = 0.05$ is taken into account in the statistical study presented.

The basic object considered in econometrics is the econometric model. The econometric model is a formal description of the stochastic relation of the magnitude, phenomena or processes of the economic process (phenomena, processes) to the factors that shape them, expressed in the form of a single equation or set of equations. The structure of each equation is defined by: an explanatory variable, explanatory variables (non-random or random) having fixed economic content, structural parameters, random variable (traditionally referred to as a random component) of unknown content, and a specific type of functional relationship between the explanatory variable and the explanatory variables and the random component.

To illustrate the essence of the meaning of the explanatory and explanatory variable, the following is an example of an econometric model.

The econometric model is given in which Y is the sugar production in Poland (tys.t), X-area of sugar beet growing (thousands of hectares). The variable Y is called the explanatory variable, the X-explanatory variable, the unknown structural parameters of the model. The random component expresses the so- The error in the equation, ie the effect on Y factors not directly included in the model, such as climatic conditions, sugar beet sugar content, sugar factory preparation for sugar campaign, etc. The dependence of sugar production on the area of sugar beet growing is linear (R. Penn D. Berridge, 2010, pp. 15-29).

Therefore, if variable Y is sugar production of thousands. T, and variable X is the area of sugar beet growing from t. Ha, and other explanatory variables are not there that could affect the explanatory variable then the model looks like this:

$$Y = a_1 x_1 + a_0$$

where: a_1 and a_0 can be calculated from the following formulas:

$$a_1 = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}$$

$$a_0 = \frac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n} x_i^2 - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} x_i y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}$$

Classification of variables occurring in the econometric model:
We consider two disjoint subsets of variables occurring in econometric models:

A - endogenous variables: current and delayed (explained by the model),

B - exogenous variables: current and delayed (not explained by the model).

Due to the role played by particular variables in the model, we can still make a division into:

C - explanatory variables

D - explanatory variables.

In the general case, sets C and D are not disjoint sets because the explanatory variable can be simultaneously (in the same model) an explanatory variable. This situation can be encountered in large-scale models.

2. FACTORS THAT EXPRESS THE LEVEL OF CREATIVITY

Everybody happens to come up with something interesting, come up with an original idea. Does this mean we are already creative? Not necessarily, a creative person is one that is relatively easy, lightweight in inventing new and original ideas, can inspire other people, objects or situations, and can inspire others. It is worth emphasizing that our creativity is influenced by many factors - creative people generally care about their intellectual life, read a lot, travel, meet and meet new people, strive for continuous development, visit different places where they can find a wen. Since people for each other are the stimulus to work alongside creativity, they also go: teamwork and communication skills. According to this principle, for example, the famous method of searching for solutions is a brainstorm, where not only people but also their selection are important (B. Jung, 2014, pp. 56-62).

Brainstorming is one of the most effective ways to show creativity. In order to prepare well for its participation, a moderator must first be prepared to prepare and conduct the participants through the entire brainstorming process. Its task is to take care of the good atmosphere of the group and encourage the group to become mentally active. This group should consist of 4-8 persons. By getting people into groups we should avoid combining people who are somehow in conflict with each other. Then, you need to prepare the materials you need for your work, such as self-adhesive stickers, writing boards, writing utensils such as penpoles and chairs for the participants. It is also useful to prepare four basic brainstorming rules that the moderator will present at the beginning of the meeting. These principles can be classified (P. Paulus, T. Nakui, and V. L. Putman, 2005, pp. 69-86):

1. Criticism is forbidden. No proposal can be judged until all are presented.
2. Crazy ideas are desirable. Reason: It is easier to reject ideas than to invent them.
3. Speak as many ideas as you can. It counts quality, not quality.
4. Capture the ideas of others. Develop and rewrite them.

The success of any organization depends to a large extent on creativity and creativity. Creative potential affects social and economic development. Creativity influences the emergence of new, socially accepted solutions and is reinforced by favorable social relationships. According to Michał Kleiber, the Polish society is accompanied by "the irresistible feeling of impending threats to our further stable development and the highly useless use of history given us by the unique opportunity of catching up with civilizational delays" (Kleiber, 2011, p. 64).

Knowledge management in the new economy creates opportunities for the organization to succeed. Organizations should base their activities on knowledge and maximize the available intangible resources. Skillful knowledge management helps to increase the

competitiveness of each organization. It is necessary to appreciate the role and importance of knowledge workers. In a society of knowledge, the success of an organization depends on creativity, creativity and innovation. The creative potential has an impact on social and economic development. There is a need to support the state's creativity and innovation. Creativity is connected with creative thinking and is a feature of every human being. The creative attitude is characterized by openness, independence, originality, sensitivity and ability to reconcile opposites (M. Pańkowska, J. Palonka, H. Sroka, 2013, pp. 125-182). Organizations are looking for employees who can manage knowledge that is becoming a determinant of success in a globalizing, volatile, risk and growing competition environment. The purpose of the article is to point to the essence and growing importance of creativity and knowledge management in organizations functioning in the knowledge society. It presents the essence, types, manifestations and effects of creativity. The relationship between creativity and knowledge management and the direction of improving the management of knowledge-based organizations has been demonstrated (M. A. Runco, 2007, pp. 321-399).

In the context of globalization and the new economy, the importance of knowledge resources increases. In the 21st century, the so-called age of knowledge and information society, the role of intangible assets in the creation of enterprise value is growing (S. Bond, J. Lemasson, 1999, 15-35). The future will belong to smart businesses, strong by the knowledge of their employees and the knowledge of the enterprise itself. Knowledge is the totality of knowledge and skills used by individuals to solve problems (Mikuła, 2003, p. 54). It is also the sum of the assets of the organization not included in its financial statements, including what is in the heads of employees and what remains after they leave. Knowledge is also interpreted as information that is understood, enriched by judgment, and used in action. Knowledge is the accumulated and properly structured information. It is the result of a thought process in which information is combined with an understanding of how to use it. In this sense, knowledge represents human ability to interpret information by giving it meaning (Dziuba, 2000, pp. 24-41).

Creativity with my statistical survey is based on the following characteristics that can express it:

- EU funds -Number of applications for the Innovative Economy Program,
- Number of art exhibitions in the country,
- Number of spectators at the theater,
- P-number of units involved in education,
- Number of books borrowed,
- The share of non-financial corporations that have their own website,
- Expenditures on Research and Development in biotechnology,
- Funds for Research and Development for Higher Education

3. FACTORS THAT EXPRESS KNOWLEDGE

The XXI century is called the age of knowledge, intellectual capital, information, or new economics. Companies operating in volatile and competitive conditions must be innovative, speedy, risk-taking, willing to learn and be able to function in the information society. Information society is characterized by the fact that information is treated as a particular material good, equivalent to or more valuable than other material goods.

This society is the foundation of the knowledge society (A. Skrzypek, 2007, pp. 169-176). Knowledge management can be defined as creating a lasting competitive advantage through ongoing organizational learning. Learning by Ernest Hilgard's definition is more or less a permanent change in behavior that occurs as a result of exercise. Learning is not just a change in behavior, it is also a change in behavior potentiality (M. Pańkowska, J. Palonka, H. Sroka, 2014, pp. 115-196). Learning defines behavioral modifications. If the result of learning is a change in action, it can be assumed that no change is not possible without this process. Every change requires specific knowledge, and this comes as a learning outcome. Consequently, we have to deal with the triad: learning - change - knowledge. Learning depends on the environment, the purpose of learning, the motivation and the obstacles, and the results of learning at work are related to motivation, attitude, willingness, and evaluation of the chances of success. Learning is the process of acquiring knowledge or mastering a given skill.

Martin Grossman emphasizes that, "In the growing wave of activity and interest in knowledge management, it is easy to overlook the fact that it is a developing and developing area that lacks a solid theoretical basis. Much work and research is needed to shape and formalize the structure, taxonomy and procedures necessary for knowledge management practices" (Grossman, 2008, p. 242). One of the key tasks of knowledge management is to allow members of the organization to share knowledge and disseminate knowledge, while motivating them to do so. Knowledge itself does not generate value. Every organization operating in the knowledge society should aim at improving the efficiency of the work that enables it to increase the tendency to share knowledge. It is also necessary to identify the propensity to share knowledge and to identify factors that influence the willingness to share knowledge in the organization. The need to share knowledge in an organization is undisputed. There is diversity in the sharing of open and hidden knowledge. Trends in the development of systems supporting knowledge management and solutions integrating technologies supporting knowledge management are visible in the scope of covering all knowledge-related processes. These technologies are considered in terms of knowledge processes, supported by the latest technology in the field (Saito, Umemoto, 2005, pp. 3-4), they are not yet common (semantic networks, life-support technologies) from a market perspective and commercially available. Solutions and applications supporting knowledge management.

Creativity and knowledge remain in a strong relationship. These relationships are reflected in, inter alia, the creation of creative partnerships that have the potential for inspiration, intellectualism, competence, communication, cognitive and educational potential. These partnerships bring benefits such as openness to new opportunities, stimulating creativity, collaboration with the creativity industry, becoming a platform for collaboration, knowledge exchange and creativity (Knop, 2014). Creativity and knowledge should go hand in hand. Knowledge is valuable when combined with creativity, creating new, inexpensive solutions. Creativity is the art of atypical and effective problem-solving and problem-solving. It is a willingness to create new ideas. Creativity is an important skill that enables you to create reality. The source of creativity in the enterprise are the employees, so you need to manage creativity. The creative enterprise and its employees have the capacity for innovative thinking and action. These abilities are expressed through openness, originality, flexibility. In the new economy, it is necessary to strengthen creativity by combining ways of working and sharing knowledge and ideas. Creativity components are: knowledge, intellectual ability, preferred thinking style, personality traits, motivation, and environment.

Knowledge and creativity are the greatest potential for innovation in an enterprise, so the role of the creative and collaborative chain must grow together with all its links, and it is also necessary to build a network of creative industries. Creativity enables you to gain new, higher quality knowledge. Under knowledge-based economy, knowledge, intelligence, imagination, mental ability, self-initiative, and creativity are all the capital that drives innovation and development. The interaction of creativity and knowledge should translate into the success of any organization, contributing to its effectiveness and maturity.

4. VARIABLES SELECTED FOR MODELS

Table 1. Variables for models

YEAR	P - number of units involved in education	M-number of units engaged in professional, scientific and technical activities	R & D spending on biotechnology	Number of spectators in theaters	R & D funds for universities	Number of exhibitions in the country	EU funds the number of applications for the Innovative Economy Program	He owns% of non-financial corporations that have their own website	Average remuneration	Number of books borrowed	Number of graduates
2009	62916	309565	60444,9	11498720	72193,1	3 377	22000	42	3101,74	21702605	263661
2010	68991	330163	70444,9	11522245	127189,5	3 713	23000	48	3224,13	21702605	278986
2011	71336	334815	76444,9	10935647	174791,5	3 837	24802	50	3403,51	21022432	305513
2012	91020	350256	132733	10681048	208510,3	3 878	32328	57,4	3530,47	20261427	320824
2013	96858	369751	190694,4	11456426	208510,3	3 757	45001	65,5	3659,4	19367751	326599
2014	99272	385105	338490	12262218	127910,5	3 790	47476	64,7	3777,1	18031966	314165
2015	101034	397729	327407,6	12030508	159955,1	3 810	47469	67,6	3907,85	17548076	301826

Source: Own elaboration.

Based on Table 1, two regression models were created. The first model as an explanatory variable shows the number of books borrowed, and the green variables are variables that were originally chosen as explanatory variables for this model. The second model as an explanatory variable presents the number of graduates of public universities in Poland, while the variables explained are all originally highlighted in green. Yellow variables are explanatory variables for the two models. These variables are the level of knowledge, while the green factors chosen for statistical analysis are characterized by creativity. In these two models, Pearson's Linear Correlation Coefficient was analyzed. If the relationship is greater than 0.7, the explanatory variables strongly influence the explanatory variable (I. Roeske-Słomka, 2010, pp. 12-43). Verification of the model is to determine whether the model describes the phenomenon well.

The minimum set of postulates for the econometric model is as follows:

1. The econometric model can not raise substantive objections,
2. The model should be very well matched to the empirical data,
3. All explanatory variables of the model must be relevant.

The total of model verification activities can be divided into:

- substantive verification
- statistical verification.

The substantive verification aims at determining the correctness of the model correctness, and the statistical verification-whether the model satisfies the postulates formulated in econometrics theory and statistics (eg, 2.3). It depends on whether the econometric model is consistent with the economic knowledge of the phenomenon studied, the theory of economics, and common sense.

During the substantive verification we investigate:

- Whether the model parameters are meaningful,
- Whether the scale of parameters is acceptable,
- Can the model be sensibly extrapolated (prognostic consequences)
- Whether the model for variable Y results in sensible models for variables associated with the variable under test (model consequences).

The significance of the explanatory variables is as follows:

The explanatory variable is "significant" when a noticeable (explicit) way influences the explanatory variable. In the case of a linear model, the variable is relevant when the parameter standing at it is significantly different from zero. The necessity to examine the significance of the explanatory variables is based on the observation that the statistical material used to derive model parameters is generally a small fragment of a set of all possible observations of the explanatory variable and explanatory variables. All explanatory variables of the econometric model must be relevant. Substance testing can take place in different ways. The standard way is to use the assumptions of stochastic (probabilistic) probabilistic method of generating observation results of the explained variable. In the case of linear models, many assumptions of the stochastic assumptions are assumed. Classical normal linear regression.

With these assumptions, and when the model is determined by the classical least squares method (mnk), the significance test of the explanatory variable is as follows:

1. Calculate the so-called. Empirical Student statistics, tk, for the explanatory variable under investigation.
2. We determine the critical value of Student statistics, tKR.
3. We compare the student's empirical statistics module with the critical value:

- The explanatory variable is considered significant if the associated empirical statistics are greater than the critical value associated with the module,

$$|tk| > TKR$$

- If it is the opposite, $|tk| \leq tKR$, then we consider the explanatory variable to be irrelevant.

The critical value tKR is read from the tables as the value of the t-distribution of the student at the assumed significance level α (α - usually 5%) and on the model studied the number of degrees of freedom Q:

$$Q = T - K$$

(Where T is the number of observations and K is the number of estimated parameters).

5. FIRST MODEL

- The explanatory variable representing the level of knowledge is education (number of graduates)
- The explanatory variables are:
- P-number of units involved in education
- Expenditures on R & D in biotechnology
- R & D funding for higher education institutions
- EU funds the number of applications for the Innovative Economy Program
- Average salary
- The number of books borrowed

In the first place it is advisable to see if there are relationships between the explanatory variable and the explanatory variables. For this purpose, a graph will be helpful.

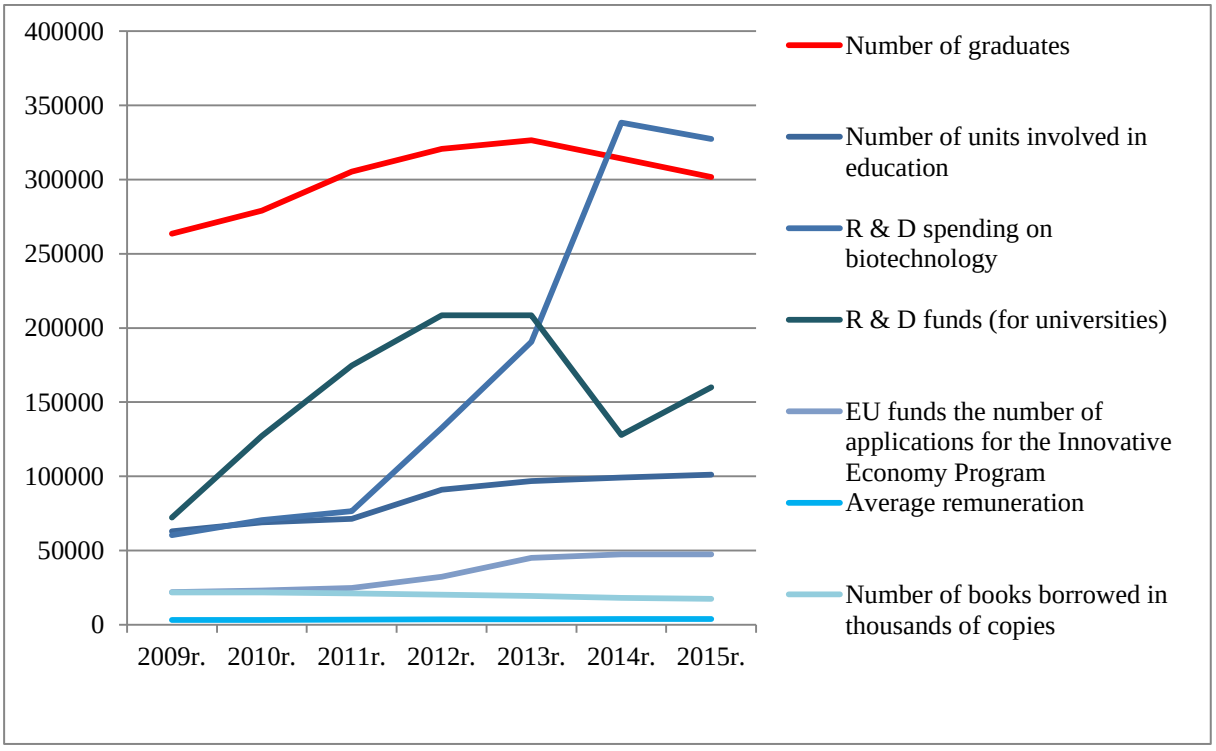

Figure 2. Variables for the first model.

In Chart 1, it can be seen that when the explanatory variable (number of graduates) is increasing, the remaining variables will also grow, at least until 2013. Thus, there is a potential relationship between variables. In order to verify the direction and force of dependency, an analysis of data from Excel will be used to verify the relevance of the data and to match the data to the model.

Table 2. First model

Regression statistics				
Multiplication R	0,930196			
R square	0,915264			
Fit R square	0,860082			
Standard error	9325,52			
Observations	28			
VARIETY ANALYSIS				
	df	*SS*	*MS*	*F*
Regression	7	1,68E+10	2,40E+09	3,68E+30
residual	20	1,30E-20	6,52E-22	
sum	27	1,68E+10		
	coefficients	Standard error	T Stat	P-value
Cut	26624	1,60E-11	7,272567	4,92105E-07
P-number of units dealing with education x1	-1,26	9,23E-15	-1,40E+14	0,0000060
R & D spending on biotechnology x2	0,72	2,36E-15	3,03E+14	0,0024500
R & D funds (for universities) x3	0,79	2,06E-15	3,84E+14	0,0002000
EU funds the number of applications for the Innovat	1,77	9,17E-15	1,93E+14	0,0001000
Average salary x5	58,8	5,54E-13	1,06E+14	0,0021450
Number of books borrowed x6	0,03	6,51E-17	4,05E+14	0,0007000

Source: Own elaboration.

All significance values "p" were less than 0.05, which means all of the above variables were selected for the model.

Model 1: Y = 26624 -1.26×1 + 0.72×2 + 0.79×3 + 1.77×4 + 58.8×5 + 0.03×6

For example: With the increase in variable x1, the number of educational units by 1,000, the number of graduates will decrease by 1260. This is because these units are mainly post-secondary schools, after which people do not go to higher education. On the other hand, the growth of the remaining explanatory variables has a positive effect on the number of graduates, ie it increases the level of knowledge in society.

6. SECOND MODEL

The variable is explained the number of books borrowed
The explanatory variables are:

- P-number of units involved in education
- The number of spectators in theaters
- R & D funding for higher education institutions
- Number of exhibitions in the country

In the first place it is advisable to see if there are relationships between the explanatory variable and the explanatory variables. For this purpose, a graph will be helpful.

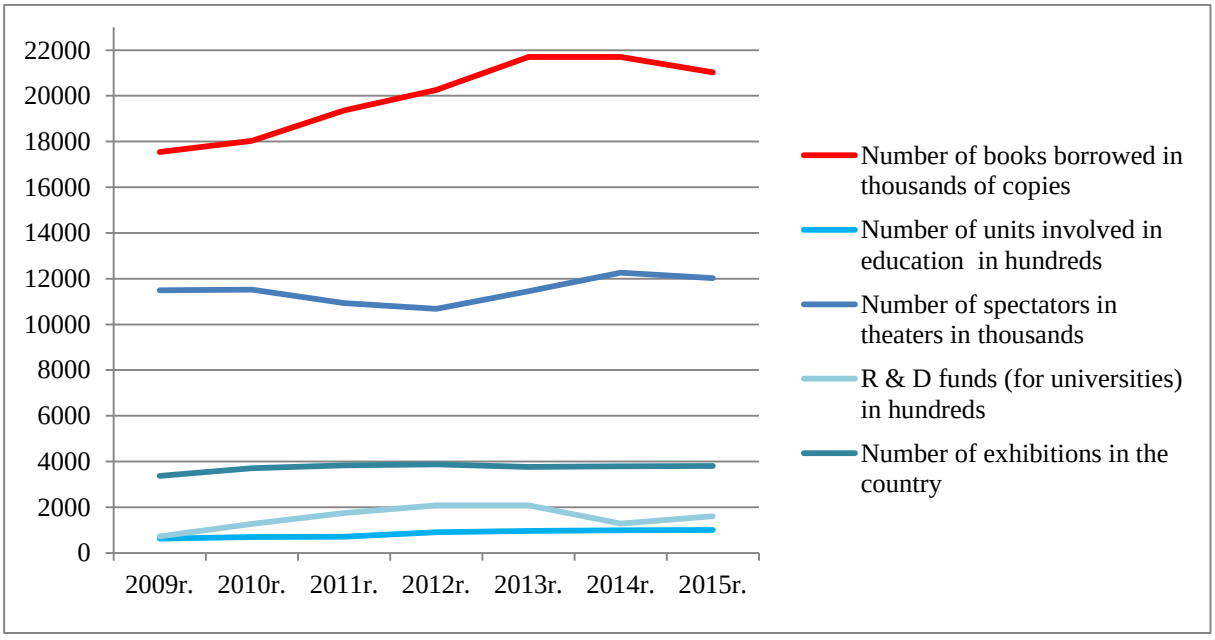

Figure 3. Variables for the second model.

In Chart 2, it can be seen that when the explanatory variable (number of borrowed books) is growing, the remaining variables will also grow, albeit slightly, until at least 2013. Thus, there is a potential relationship between variables. In order to verify the direction and force of dependency, an analysis of data from Excel will be used to verify the relevance of the data and to match the data to the model.

Table 3. The second model

Regression statistics				
Multiplication R	0,9997276			
R square	0,9994552			
Fit R square	0,9992996			
Standard error	43920,265			
Observations	28			
VARIETY ANALYSIS				
	df	*SS*	*MS*	*F*
Regression	6	7,43206E+13	1,23868E+13	6421,376703
residual	21	40508783617	1928989696	
sum	27	7,43611E+13		
	coefficients	Standard error	T Stat	P-value
Cut	3853,86	27515,63428	0,140060878	0,890
P-number of units dealing with education x1	102,73	12,43421107	8,262030423	0,000000049
Number of spectators in theaters x2	2,71	0,327451897	8,267775351	0,000000048
R & D funds (for universities) x3	15,75	5,397813576	2,918359087	0,008215602
Number of exhibitions in country x4	41,65	13,50870704	-3,083045817	0,005638889

Source: Own study based on data from: https://bdl.stat.gov.pl/BDL/dane/podgrup/template

Model 2: Y = 3853,86 + 102,73×1 + 2,71×2 + 15,75×3 + 41,65×4

All significance values "p" were less than 0.05, which means all of the above variables were selected for the model.

For example: With the increase of x4 - the number of exhibitions in the country by 1000, the number of books borrowed is growing by 4165. The remaining explanatory variables also show an increase, which also causes upward tendencies in the number of books borrowed, which contributes to the level of knowledge.

7. CONCLUSIONS

Enterprise innovation gives the organization a chance to succeed. It remains strong in relation to people's creativity. Creativity is related to knowledge management in an organization, including employee knowledge management. Creativity, innovation and entrepreneurship create conditions for increasing the competitiveness of enterprises. Organizational learning is at the core of competitiveness. Investing in human capital fosters creativity. Skillful knowledge management creates conditions for developing the creativity of all employees, including knowledge workers. Knowledge management brings organizations specific benefits in terms of increased decision effectiveness, loyalty, confidence, quality culture and knowledge. The experience of many companies confirms the relationship between learning, competence, creativity, innovation and organizational competitiveness

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