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Thermodynamic relationships between time, capital, and labour[3]

Introduction

The first purpose of the paper is to theoretically illuminate and rigorously define the categories of capital, labour, and time. Thus, at the outset, we will present the achievements that have already occurred, and considerations based on thermodynamic fundamentals. We will present empirical calculations that confirm the theoretical findings. An important starting point is the argument about the nature of capital and its identity with the concept of energy in physics. This is not an analogy, but an identity, and this fundamentally changes the thinking about economics.

An important scientific source for considering capital is the work of L. Pacioli of 1494 called *Summa*[4] for short. In this guide to mathematics, the author presented a theory of dual accounting in the last section, the foundation of which is the principle of dualism, that is, the distinction between assets and capital in the form of basic identity. This work, not often overlooked by economists, contains profound statements without which economic thought will always be lame.

The identity is represented by the formula $A_0 = C_0$, where A and C represent the value of assets and capital, respectively, and the index marks a common

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[3] The article presents the results of the Project ADN/WOFP/2023/000072 financed from the subsidy granted to the Krakow University of Economics.
[4] Pacioli L. (1494). *Summa de Arithmetica, Geometria, Proportioni et Proportionalita*. Wenecja.

moment in time. The formula therefore requires an understanding of the terms assets, capital, value and time. We treat assets as tangible and heterogeneous, while capital, understood by Pacioli as economic power, is an abstract and homogeneous category. It is embodied in assets. Thus, if assets are material, then according to the nature of philosophical dualism, capital is abstract energy, it represents the specific potential of the energy embodied in the assets.

The indisputable statement that capital is energy significantly enriches economic thought. Previously thought of as an analogy between capital and energy, we now have an identity, so a strong theoretical basis is emerging. These are the principles of thermodynamics that actually constitute the theory of energy, and therefore capital. The first principle of thermodynamics, indicating that capital cannot be created, undermines the foundations of the current financial system. Much is known about the second principle (usually capital letters are used out of respect for it). Albert Einstein said that it is a principle that no one will ever disprove.

Understanding capital and the role of thermodynamic knowledge provides a broader framework and avenues for the development of economic thought. A clear division is drawn; physics studies the world mainly at the micro and macro scales, while economic knowledge describes the earth's living system using physics, but as the history of capital shows, economic research leads to independent results. This is mainly evidenced by the discovery of the economic constant regarding capital and the passage of time.

R. Wright (2000, p. 11) states that the driving force of socioeconomic life is the pursuit of the benefits of playing with nature's positive, non-zero sum, i.e., everyone can win. The fact that many lose does not change this opinion. But let us consider the fact that this non-zero sum, as Wright calls it, must have some fixed measure. The rationale for this is the observation of the natural cyclic constant in the Solar System, as well as the constant of gravity, the electromagnetic field, solar and cosmic radiation, etc. The Earth's living system is stable, so the measure of potential capital growth should be constant. And this is, in fact, the case. Studies recognise the existence of the constant $a = 0.08$ [1/year]. This constant also determines the rate of passage of time.

There is a clear answer to the question: Why is capital, this abstract quantity, this important medium in non-zero summability? After all, what happens when an enterprise is unable to multiply capital or the capital embodied in a manufactured device disappears? The enterprise, after a failed restructuring attempt, becomes a bankrupt entity, while the device is scrap metal. So capital is the energy of existence; without it, an object loses its properties and name. For humans, it is the energy of life, the absence of which means the end of life. It is difficult to find something more important.

On the principles of thermodynamics as tools of cognition

Thermodynamics is fundamental knowledge, which means that without it, it is difficult to explain correctly the most important scientific questions. This opinion applies equally to economics and other scientific disciplines, which is now widely recognised. Organisations are emerging, such as IAISAE[5], whose statutory objectives are to create a platform for cooperation mainly in the field of thermodynamic knowledge[6]. Three fundamental principles are indeed manifested in the economic sciences: the principle of minimum action and the first and second principles of thermodynamics.

The first principle of thermodynamics expresses the idea that the sum of all types of energy in an isolated system is fixed, that is, energy cannot arise from nothing. This principle lies at the heart of accounting theory and is realised via the principle of duality and double entry (Dobija, Renkas, 2020). Thus, in accounting systems, it is possible to periodically measure profit, i.e. capital (energy) growth.

The second law of thermodynamics accumulates extraordinary explanatory power. Each equivalent formulation of it reveals further areas of knowledge about reality. For example, Benjamin Thomson's (Sir Kelvin) natural formulation of this principle specifies that a heat engine cannot operate without a radiator, the latter not necessarily being a real object built for the purpose. There have been working cars without a radiator, and its role was fulfilled by the environment. The same is true of the organisms of living beings. Understanding that the human body can be seen as a heat engine and combining it with the necessary loss of energy has become a source of fruitfulness for human capital theory. Another example is related to the entropic formulation. The human body is not a closed and isolated system and, therefore, entropy does not need to increase. However, the buildup of disorder in the body is a fact, so the question becomes whether it can be counteracted. The positive answer is balanced nutrition, with food providing order and completeness to the elements. The principles of balanced nutrition are part of the knowledge from ancient, still prehistoric China regarding the division of energy into elements. Note that preventing the growth of entropy is a common preoccupation of mankind. Entropy is associated with an increase in disorder, but it is actually a phenomenon of spontaneous and random dissipation of the potential of concentrated energy, as consistently pointed out by F.L. Lambert (2002).

The second law of thermodynamics has at least three equivalent formulations:

- (Kelvin) No such process is possible, the only result of which would be to do work equivalent to the heat received from the source;

[5] International Association for the Integration of Science and Engineering. Retrieved from: https://www.youtube.thermodynamics.nature.of.Time.Dobija.Renkas.2022 (2022.02.21).

[6] Thermodynamics 2.0 is a platform where the natural sciences meet the social sciences. This biennial international conference aims to identify and connect dots of scientific revolutions in the natural and social sciences.

- (Clausius) No such process is possible, the only result of which would be the transfer of heat from a cold body to a hot one;
- (Entropic) The entropy of an isolated system cannot decrease (Greene, 2020, pp. 35–63).

The three versions of the SLT are equivalent. Version one, as mentioned, helped develop the theory of human capital measurement and the theory of fair compensation (Dobija, Renkas, 2021a,b). Understanding time and determining the tempo of its passage is related to the third version of the SLT, but somewhat clarified. As (Bejan, Tsatsaronis, 2021) write, thermodynamics originated as the science of firepower. It developed in the 19th century, about a century after the introduction of the first steam propulsion systems and is a pillar of physics, life sciences and engineering sciences. J. Barbour (2021, pp. 359–399) describes the emergence of structure in the universe, pointing to the inalienable role of thermodynamics. The SLT is also fully applicable and inalienable in explaining biological processes on Earth.

Living entities are particularly subject to the SLT. Using the example of man, it is known that an organism acting like a heat engine must, in order to exist, lose some of the energy dissipated through heat. This is adjudicated by the second law of thermodynamics in Sir Kelvin's formulation. In addition, disorder, dysfunctionality of various organs and chronic diseases increase over time in the human body, and in general the ability to generate the necessary energy decreases. This state of affairs also follows from the SLT, but in Boltzmann's formulation, i.e., increasing entropy as a measure of disorder. This undoubtedly impinges on human behaviour and character.

One can get closer to answering the questions posed by focusing on the etymology of the word entropy, the essence of which is transformation. The rapid development of human beings in the first years of life indicates the existence of potential energy that transforms into energy of a different kind, namely personal human capital. We see this transformation all around; not only in human offspring but also in the animal and plant world. Human capital, in turn, is naturally subject to the SLT and its potential also undergoes spontaneous, random dissipation.

Thus, reasoning leads to the conclusion of the existence of a resource (potential) of primary life energy. This potential of human life energy is transformed into personal human capital, which we know increases according to the constant a = 0.08 [1/year]. Therefore, it can be assumed that the potential of primary human life energy also decreases according to this constant. This thermodynamic process is common in the system of earthly life, but 8% as a dimension of the constant applies only to humans.

Another conclusion suggests that this transformation determines the nature of time and indicates that it is the constant a = 0.08 [1/year] that determines the pace of the course of time in human civilisation. This is the discovery of an extremely important role for the constant, hitherto known as the constant of potential capital growth in economics (Dobija, Renkas, 2021c).

The difficulties of precisely defining time and its passage, capital, profit and its sources are well known. The reason for this is that at the time that these three key scientific categories were passionately discussed, there was inadequate knowledge of thermodynamics. Moreover, as we shall see, time is closely related to man, so physicists had natural difficulties in recognising this category based on physics paradigms alone, as noted by D. Park, (1972, p. 111) and R. Feynman (1963).

The authors of this article present the current definition of time and its passage. However, we have previously developed a theory for measuring human capital while stating the existence of a constant quantity, necessary in numerical calculations. This is the quantity $a = 0.08$ [1/year], which has various interpretations. In particular, it determines the rate at which the primary energy of human life decreases, and therefore determines the direction of the course of time. It is, however, a thermodynamic transformation that results in the accumulation of human capital at this rate.

Independently, the thermodynamic track in the study of human capital was indicated by viewing the human body as a heat engine. The second law of thermodynamics (SLT) in Kelvin's formulation, indicating that a heat engine cannot run without a cooler, directly relates to the human body. In the applications of this principle to the determination of fair wages, that is, not allowing the depreciation of the human capital of the worker, the original said constant quantity was revealed. In fact, the application of the SLT revealed the random variable (s) of human capital dissipation and empirical studies show that its mean value $E(s) \approx a = 0.08$ [1/year].

The currently achieved state of knowledge regarding the constant 'a' and random variable 's' is synthetically summarised in Table 1. The contents of Table 1 are the subject of explanation of the presented study.

Table 1. Natural constant '*a*' and random variable '*s*' shaping the economic environment

Natural constant 'a'	Random variable 's'
Rate of the passage of time and the metabolism of modern man	Human capital dissipation rate according to the second law of thermodynamics
Constant needed to calculate the value of personal human capital	Percentage of human capital value that determines fair salaries
Positive factor affecting capital growth in economics	Destructive factor affecting capital growth in the economy
Bottom line of growth rates in the plant kingdom	Magnitude underlying the 'uncertainty' category
Constant quantifying the impact of natural forces on economic development and growth	Basis of the 'risk premium' in finance and economics

Source: own elaboration.

Research indicates that the relationship between the constant and the random variable is as follows:

$$E(s) \leq a = 0.08 \text{ [1/year]} \tag{1}$$

The average magnitude of destruction *E(s)* is minimally smaller than the constant of potential capital growth in farming, which guarantees the possibility of farming and generating profits.

Update the definition of time and the constant that determines the rate of its passage

Many scholars are deeply convinced of the existence of the phenomenon of the passage of time. According to Holt (2018, p. 19), A. Eddington declared that our intuitive sense of time's passage is so powerful that it must correspond to something in the objective world. If science cannot get purchase on it, one might say, well, so much the worse for science. In turn, J.T. Fraser (1979), the founder of the International Society for Study of Time, expressed the belief that the sensation of the passage of time is perhaps more poignant, profound, and direct than any aspect of our existence. Moreover, time is profoundly related to the functions of the mind and is the only dimension of our inner life. This is an extension of the opinion of Immanuel Kant, who recognised time and its passage as an inalienable tool of the human mind. Accepting these premises, it is justified that the human perception of time has its real basis, and for a human being, time flows evenly, regardless of other events, so Newton's concept is essentially correct, only the feature of absoluteness can be disputed.

The original definition of time formulated by Isaac Newton and included in his work "Principia" is as follows (Newton, 1999, p. 54):

> Absolute, true, and mathematical time, in and of itself and of its own nature, without reference to anything external, flows uniformly and by another name is called duration. Relative, apparent, and common time is any sensible and external measure (precise or imprecise) of duration by means of motion; such a measure – for example, an hour, a day, a month, a year – is commonly used instead of true time.

Immanuel Kant (1724–1804), guided by well-known aphorisms such as (2021, pp. 59–60): 'Without sensuality no object would be given to us, without intellect none would be conceived, concepts without sensory perceptions are empty, and perceptions without concepts are blind', formulated an opinion about time and space. Time is a form of our sensuality; it is a form of the inner sense. He also recognised that time is empirically real. This opinion is largely confirmed by our definition of time. At that time, thermodynamics had not yet been developed, and yet Kant's understanding of the nature of time is extremely accurate, and also points to the inseparable connection between time and humanity.

The modified formulation of time takes into account the constant thermodynamic transformation taking place in the human body; that is, the ongoing transformation of the primal energy of life into personal human capital. The application of the SLT

version of transformation requires the identification of objects; in this case, these objects are primary life energy and personal human capital.

In the proposed formulation, an explanation of time emerges that inalienably relates to thermodynamics, while also following the direction given by Newton. In this approach to the category of time, objects subject to the process of thermodynamic transformation are identified along with their quantitative characteristics. As a result, the category of time and the process that causes the passage of time are included in the following definition (Dobija, Renkas, 2021a, 2022).

Time is the process of transformation of the stock of primary life energy of modern man into the ability to perform work, i.e. personal human capital. The rate of passage of time is constant and independent of anything. This rate is determined by the natural constant a = 0.08 [1/year].

In this term, concrete real elements appear, such as: the primary life energy (*E*) of modern man, personal human capital (*H*), the process of energy transformation and the uniformity of this process, the rate of which is determined by a natural constant. This term, being in accordance with the idea of the even flow of time, reveals the real objects mentioned by A. Eddington: the raw energy of life transforms into the energy of action. Thus, time passes evenly, reflecting the decrease of the original stock of life forces and the increase of human capital. The course of these processes is controlled by a constant whose apriority value is 0.08 [1/year], and its unit of measurement refers to the astronomical calendar.

A formalised description of the transformation (T) that determines the course of time is as follows:

$$\text{T: } E_0 \times e^{-at} \text{ transforms into } H \times e^{+at} \tag{2}$$

where: constant $a = 0.08$ [1/year], t – number of years of the process.

Taking the maximum $E_0 = 1.0000$, we get that after one year, $E_1 = 0.9231$, after the second year, $E_2 = 0.8521$, after the third year, $E_3 = 0.7866$, …, while $E_{65} = 0.0055$, and so on. This transformation makes the infant look like a grown-up one-year-old child after one year, and the following years also show the rapid growth of a person's capital *H*, however slowing down. At the retirement age of 65, *E* is already very small, which is associated with certain effects in the physical body, as medic Ki Bo informed the Yellow Emperor (Maoshing, 2012, pp. 22–23). However, with this residual E, some people even reach an age close to 120 years, when $E_{120} = 0.000068$. This is because people still have at least two available sources of life energy; air and food. Thus, the indicated value of E with four zeros after the decimal point represents the biological end of life, so this is the biological zero for the function $E(t) = e^{-0.08t}$ at $t = 120$ years.

The definition of time presented is a significant generalisation of the definition given by Isaac Newton. One can clearly see a barrier that could not be overcome in the 17th century. This was the lack of knowledge called thermodynamics, which

also enabled the development of human capital theory. In addition, there was a lack of current results from gerontologists confirming that the end of a person's life is 120 years, which makes it possible to numerically estimate the rate at which time passes. Newton tied time to the calendar. In the updated definition, this knowledge is complemented by a constant that has the astronomical year as the unit of measurement.

The given definition also meets all the characteristics of time described by I. Kant. It is the time of man, the representative of earthly civilisation, for whom time and its passage is an immanent intellectual tool for learning about the reality in which he lives and acts. It also confirms the validity of beliefs about the uniform passage of time expressed by many prominent thinkers, with A. Eddington and J.T. Fraser in the lead. It also explains why physicists such as D. Park and R. Feynman doubted the possibility of defining time on the grounds of narrow physics paradigms. Time is integrally related to humans, so the life sciences, including the economic sciences, should make a significant contribution to the recognition of this abstract category.

The understanding of time was formulated not as a result of the study of time, but of the categories of capital, labour and value and especially human capital, and thus in the minds of economists rather than physicists, leads to the view that physicists actually use the category of duration, a certain fragment of time that is fully present in economics. What is referred to by the letter '*t*' in the formulas of mechanics is the number of astronomical durations of an object or process. Of course, physicists, astronomers and other representatives of the natural sciences defined the arrows of time and introduced the principles of thermodynamics, so their orientation regarding the nature of reality prevails over others. Nevertheless, duration is present in their theories, not time, if the content of these concepts is taken into account. The connotation of time is associated with change, while permanence implies existence in an almost unchanging state. As we see it, the above statements are the reasons for constant discussions about time, but with no positive result or agreement on a common position.

Capital is a category that is closely related to time, and therefore, understanding capital is the first step in illuminating the nature of time and providing an appropriate definition; in particular, the need to come to an understanding of how to measure human capital, where the natural constant that turns out to be the constant of the passage of time is revealed. Thus, the category of profit, that is, the periodic growth of capital in economics, also naturally depends on the constant of the passage of time. Eventually it will become clear that there are two variables in the category of time: (i) t – which determines the number of unit periods (hours, months, years), and (ii) the natural constant that determines the rate of the passage of time. In physics formulas, time is represented only by the letter t; in economic formulas and calculations, time is represented by the pair (a, t), where $a = 0.08$ [1/year] and is the time lapse constant.

An important feature of the consideration of time presented here is that it is limited to the Earth System of Life (ESL), actually to the area of the solar system, treated as a virtually isolated part of the universe. Consideration of current socio-economic relations does not extend beyond the solar system and, moreover, we are not competent to share knowledge of the universe. This arrangement makes it easier to consider time in the ESL while relieving us from unfeasible studies of, for example, the metabolic rate of some extraterrestrial civilisation. As a result, there is no strong contradiction between our determination of time and J. Barbour's (2018) statements about the non-existence of time. Time in the ESL is inherently thermodynamic and related to the specific arrow of time of modern humans. The quoted author does not deny the existence of arrows of time. On the contrary, he emphasises and illuminates their importance.

Interpretation of the time lapse constant in terms of human capital measurement theory

According to the determination of time, the disappearance of *E* is accompanied by an increase in personal human capital. As is already known, the constant was discovered within the framework of the emergence of the theory of human capital measurement in the 1990s (Dobija, 1998, 2007). The idea of measuring H was to calculate the value of the stream of annual cost of living (*k*) from birth to employment after reaching at least 17 or 18 years of age. To calculate this value, a capitalisation rate (r) equal to the real rate of return on the NYSE was used, which, according to Ibbotson's research, was estimated at 0.08 [1/year].

The second idea considered the thermodynamic nature of the calculated quantity referred to as *H*. This quantity undergoes spontaneous and random dissipation, so the minimum wage should be no less than $s \times H$, where (s) denotes the random dissipation of *H*.

The minimum wage formula emerged:

$$W = s \times H = s \times \mathrm{k} \times [(1 + \mathrm{r})^n - 1]/r \tag{3}$$

where: *W* – annual fair minimum wage, *k* – annual cost of living, *r* – capitalisation rate of annual cost of living.

Taking into account the availability of data from the U.S. and the fact that the minimum wage could be considered fair in that country, calculations were carried out, obtaining an estimate: $r = a = 0.08$ [1/year]. Then it turned out that at a minimum, $s < r$. Thus, the constant $a = r$ was originally revealed in research on the value of human capital. Now we see the symmetry; the disappearance of *E* results in an increase in *H* according to the *T* – transformation. The formula for the disappearance of $E - Z(a,t) = exp[-at]$ – explains why human beings grow very quickly in the first years of life and why the changes are clearly visible. The

growth of human capital is also explained: it is a composite of the cost of living and *E*, the proportion of which changes over time. Since the inflow of *E* is greatest in the first years of life, the growth of the child and all his or her abilities are very pronounced.

The natural development of theories for measuring personal human capital has led to the development of models suitable for employees with varying degrees of professional education and experience (Dobija, 2011; Koziol, 2011; Renkas, 2022) and others. In order to provide independent evidence that the estimated wages are fair and to give scientific weight to this category, Table 2 is presented, which contains an accounting on average cost of living and minimum wages in the United States. For the calculations, it is assumed that two parents receive earnings at the theoretical minimum wage. Also, those working contribute 6.2% of their income to Social Security Tax and 1.45% Medicare Tax, which is the basis for the respective funds. The remaining income is compared with the cost of living. The average cost of living in the United States is estimated to be $585.00 monthly[7].

According to formula (4), the theoretical minimum wage W(a) for a teenager (t = 17 years old) can be calculated: $W(a,t) = W(0.08, 17) = 0.08 \times (12 \times 585) \times [e^{0.08\times17} - 1] / 0.08 = \$1{,}694.00$/month. On the other hand, the statutory monthly minimum wage is: $9.00 (average minimum wage per hour in all states) × 176 hours (number of hours worked per month) × 1.0765 (6.2% Social Security Tax and 1.45% Medicare Tax paid by the employer) = 1,705 USD/month.

The key role of the constant a = 0.08 [1/year] in determining wages that preserve workers' personal capital (are fair) is shown by the calculations in Table 3. Assumptions are made that: (i) the contribution to the pension fund is 20% of the salary, (ii) the contribution to health care coverage is 10% of the salary, (iii) the retirement age is 65, (iv) the family consists of 2 adults and 2 descendants, (v) the average number of life years is 85, (vi) the percentage of capitalisation of the pension contribution is 3%. Under these natural assumptions and a given constant value, the theoretical wage *W(a,t)* ensures that the worker's personal capital does not depreciate, that is, it is a fair wage.

Table 2. Proof that the theoretically calculated wage *W(a)* is fair

1	Country	USA (USD)
2	Theoretical monthly minimum wage W(a) = a × H(a,t)	1,694.0
3	Statutory monthly minimum wage	1,705.0
4	Percentage of compliance (3) : (2)	100.7%
5	Total earning (2 persons × $1,694)	3,388.0

[7] Cost of living in the USA. Retrieved from: https://www.expatistan.com/cost-of-living (2022.02.21).

6	Pension fund contribution including Social Security Tax paid by the employee (20%)	677.6
7	Health care contribution including Medicare Tax paid by the employee (10%)	338.8
8	Amount remaining for cost-of-living disbursement	2,371.6
9	Amount per person (2 adults + 2 children)	592.9
10	Average cost of living	585.0
11	Pension funds per one 333.8 x 12 x [(1 + 0.03)48 – 1)/0.03] =	418,218.0
12	Monthly pension after 65 years of work	1,742.0

Source: own elaboration.

As the calculations in Table 3 show, the amount remaining to cover the living costs per person in the family ($592.9) exceeds the value of the average cost of living of $585. This means that the standard of living is preserved and the earnings of two working parents in the U.S. make it possible to bring up two descendants to the level of human capital they have achieved, i.e., this wage guarantees the preservation of human capital. In addition, after 48 years of work, the pension fund calculated at a capitalisation rate of 3% is $418,218. Hence, the monthly pension amount can reach 1,742. The personal capital of the worker is preserved over a lifetime of 85 years, so the wage under study can be considered fair. The condition for this is the value of the constant 0.08 [1/year].

Note that the remuneration adopted in the calculation represents the minimum. However, in reality, earnings increase over time due to the increase in capital from experience, so the amount left in the family per person will also be higher. It should also be added that empirical studies show that the earnings of employees are at the level of 10% of the value of personal capital (Koziol, 2011). This allows for a slow, steady progress in the welfare of the employed.

The considerations show the contribution of the constant to the solved cognitive problems of human capital measurement and the appropriate labour compensation that preserves this capital. The constant – 0.08 [1/year] – is clearly a steady invariable theoretical and computational factor that leads to original economic knowledge. The formulas and calculations confirm the known fact that minimum wages are at a fair level in the countries studied, especially in the U.S. This has been confirmed by calculations with repeated use of a constant that unambiguously indicates that the minimum wage at the level of 8% of the value of the personal capital of the employed person makes it possible for a family to bring up 2 descendants, to work out pension funds for the next 25 years of life. Unfortunately, this positive theoretical picture is disrupted by various factors occurring in social and economic reality. People have their own characters and are not always industrious, thrifty and reasonable, there are serious illnesses. Economic crises happen because people do not respect the correct theories, as well as all kinds of negative political influences, which threaten pension funds.

Sources of income as a play between constant, dissipation and labour. The relationship $E(s) < a$

Albert Einstein reportedly said that the compound interest formula is the greatest mathematical achievement of mankind[8]. Whether a joke or not, the formula $C_t = C_0 e^{rt}$ is the nucleus of the general model of capital. Ch. Bliss (1975, p VII) expressed that we do not know what capital is and are unlikely to find out. We certainly will not find out without knowledge of thermodynamics. Thermodynamics is already manifested in the simple model of compound interest through the variable of initial capital C_0, its necessity for existence, since nothing will arise from nothing. Einstein introduced the 'rule of 72', indicating after how many years the initial capital will double, at a given interest rate r, which shows that he was toying with it. It is a fact that the compound interest formula is important. After all, it is the main mathematical tool in this study.

To create a general model of capital, it is necessary to recognise the structure of the rate determining the changes in initial capital C_0, that is, the structure of the variable r. The discovery of the constant in economic research made it possible to determine the structure of the rate r as a function of the constant a, as presented in the work (Dobija, Kurek, 2013). Theoretical analysis led to the model $r = a - s + m$, where: s – rate of disappearance of capital, and m – capital inflow by labour. Thus, the general model of capital after the period $\Delta t = 1$ is presented:

$$C_t = C_0 \times e^{-st} \times e^{mt} \times e^{at} = C_0 \times e^{(a-s+m)t},\ a \geq E(s) = 0.08[1/\text{year}] \qquad (4)$$

An example interpretation of model (5) with respect to human capital is as follows. An infant is born (variable C_0). This infant, subject only to the influences of the forces of nature (the second principle), could die (variable e^{-st}). The work of the parents and society offsets the negative influences of the forces of nature (variable e^{mt}), so the infant develops and grows due to changes of PLE, which is quantified by the constant (variable e^{at}). It should be emphasised that the inflow of capital through the work of the parents can only level the destructive influences; it is not possible to create a stock of life energy, or to accelerate its transformation into human capital, that is, to accelerate the course of time. The child will develop at a natural rate regardless of the surplus efforts of the parents. Labour does not increase capital; labour is merely a transfer of capital, but competent labour counteracts entropy.

The economic processes in which capital gains, or income, are sought are interpreted similarly. By definition, income = $\Delta C = C_1 - C_0 = C_0 \times e^{(a-s+m)t} - C_0$

[8] Albert Einstein is credited with discovering the compound interest rule of 72. Referring to compound interest, Albert Einstein is quoted as saying: 'It is the greatest mathematical discovery of all time'. Retrieved from: http://www.ruleof72.net/rule-of-72-einstein.asp (2022.02.21).

$\approx C_0(a - s + m)\ \Delta t$, where $\Delta t = 1$. A company must have initial capital C_0 (the first principle), which is affected by forces that dissipate equity capital (-*s*), the work of the staff tries to offset the impacts of the second principle (*m*), and if successful, return on assets ROA ≈ *a*. In some cases, it is possible that ROA > a, which happens at the expense of other firms, or this is the result of the emergence of creative intellectual capital.

Concluding this topic, let us note that the economy is powered by nature. We are not talking about raw material resources, which in economics are not valued in monetary terms, they are measured in natural units. The size of GDP is mainly created by labour and management; this can be seen as the sum of wages and salaries, annual depreciation amounts of fixed assets, and profits and some taxes. The value of fixed assets is determined by the work done in previous periods, i.e., the labour that has coagulated. The source of labour is human capital, which, as the definition of time reveals, arises after the conversion of E. Thus, there are two sources of power to the economy: (i) the sun, which provides biomass growth at a rate typically exceeding 0.08 [1/year], (ii) the universe as the provider of *E* life energy. Economic processes generating GDP take place with the help of the constant *a*, which also determines the rate of passage of time. One can say that this constant imbues the saying '*time is money*' with content.

Is the mean value of the random variable s representing the forces that dissipate energy and increase entropy smaller or equal to the constant *a*? Common sense indicates that the relation $E(s) < a$ is true, with the difference being very small. After all, economic units generate periodic profits while paying decent wages to employees, so they overcome the destruction from DZT. On the other hand, there are accepted opinions that the actions determined by the SLT are overwhelming and lead to the 'heat death of the universe', which was recently challenged by J. Barbour (2021, pp. 394–399). There is also a well-known opinion (Atkins, 2007), which states that 'where something is built up, something elsewhere falls into ruin, but at an even faster rate'. These are opinions concerning the universe or large-scale structures of, for example, the entire solar system. However, they are not subjects of economic considerations. The question posed is about the Earth's living system and the question of whether the beneficial impact of nature, as defined by a constant, outweighs the somewhat destructive impact of the SLT. Research in human capital seems to confirm expectations.

Table 3 presents the results of estimating the random variable '*s*' from the actual minimum wage in the indicated European countries and selected U.S. states (workers were assumed to be 17 years old to standardise the results). For example, in the UK, the statutory minimum wage is set at 8.91 GBP/hour. Adding the 13.8% Employer Social Security Tax to this amount results in the total cost of employing a worker. On a monthly basis, this is: 176 hours × 10.14 GBP/hour = 1,784.64 GBP. The monthly cost of living in the UK is estimated to be 568 GBP.

Therefore, s = 21,415.78/246,756 = 0.0867. In other selected European countries and the U.S. states, the estimation leads to similar results.

Table 3. Calculation of 's' values for selected European countries and U.S. states

Country or State of U.S.	Monthly cost of living per person (k/12)	The value of human capital $K(a,t)$	Statutory annual minimum wage (W_r)* [9]	$s = W_r/K(a,t)$
1	*2*	*3*	*4*	*5*
Belgium, [EUR]	898	390,117	24,879	0.0638
France, [EUR]	932	404,888	27,900	0.0689
Germany, [EUR]	954	414,445	32,567	0.0786
Great Britain, [GBP]	568	246,756	21,416	0.0868
Switzerland, [CHF]	1.617	702,472	47,182	0.0672
Sweden, [SEK]	9.696	4,212,224	283,874	0.0674
Alaska (USA), [USD]	696	302,363	22,493	0.0744
California (USA), [USD]	790	343,199	29,547	0.0861
Colorado (USA), [USD]	725	314,961	27,287	0.0866
Florida (USA), [USD]	638	277,166	19,452	0.0702
Hawaii (USA), [USD]	770	334,510	22,957	0.0686
Idaho (USA), [USD]	531	230,682	16,474	0.0714
Indiana (USA), [USD]	572	248,493	16,474	0.0663
Kentucky (USA), [USD]	527	228,944	16,474	0.0720
Louisiana (USA), [USD]	585	254,141	16,474	0.0648
Maryland (USA), [USD]	630	273,690	25,006	0.0914
Massachusetts (USA), [USD]	807	350,584	28,998	0.0827
Michigan (USA), [USD]	560	243,280	21,944	0.0902
Minnesota (USA), [USD]	638	277,166	22,746	0.0821
Nebraska (USA), [USD]	577	250,666	20,465	0.0816
New Jersey (USA), [USD]	885	384,470	25,006	0.0650
New Mexico (USA), [USD]	498	216,346	20,465	0.0946
North Carolina (USA), [USD]	572	248,493	16,474	0.0663
Ohio (USA), [USD]	523	227,206	19,789	0.0871
Oklahoma (USA), [USD]	506	219,821	16,474	0.0749
Oregon (USA), [USD]	725	314,961	25,576	0.0812

[9] Eurostat, Monthly minimum wages, https://ec.europa.eu/eurostat/databrowser/view/earn_mw_cur/default/table?lang=en (2022.02.21).

1	*2*	*3*	*4*	*5*
Rhode Island (USA), [USD]	613	266,305	23,866	0.0896
Tennessee (USA), [USD]	490	212,870	16,474	0.0774
Texas (USA), [USD]	543	235,895	16,474	0.0698
Vermont (USA), [USD]	626	271,953	24,922	0.0916
Washington (USA), [USD]	770	334,510	30,687	0.0917
Wisconsin (USA), [USD]	556	241,543	16,474	0.0682
			Mean value E(s)	**0.0775**
			Minimum value	**0.0638**
			Maximum value	**0.0946**
			Median value	**0.0762**
			Standard deviation	**0.0099**

* The statutory hourly wage was increased by the percentage of Employer Social Security Tax[10] (UK – 13.8%, France – 45%, Germany – 19.98%, Belgium – 25%, Switzerland – 6.4%, Sweden – 31.42%).

Source: cost of living data was taken from (Cost of living, 2022).

The important relation suggested by Table 3 is the weak inequality $E(s) \leq a$. What does this mean? Using the definition of time, the constant can be looked at as the rate at which human labour resources are supplied from external sources: from nature. In turn, labour transfers human capital to labour objects, which then become products and assets, subject to entropy growth. Thus, if the random variable s, which determines the rate of dissipation of human capital, satisfies the indicated relationship, it can be expected that destruction does not necessarily prevail over construction. It should be emphasised that this opinion can be made under the natural assumption of openness of the system called a human.

Another general observation resulting from the calculations in Table 2 is the conclusion that the constant determines the growth rate of human capital, which leads to the formulation of the theory of remuneration as a function of this capital. Moreover, the results of calculations confirm that the minimum wages in the highly developed countries of Europe and the states of the U.S. are determined by the constant $a = 0.08$ [1/year]. This fact is associated with correspondingly high labour productivity, as highlighted in (Dobija, 2011).

In contrast, the pure influence of nature quantified by a constant is presented in the following empirical study. It can be shown further that the constant also reveals itself in the study of business profit rates and stock returns. This is because profits are created by human labour; that is, transfers of human capital to products.

[10] *Employer Social Security Tax Rates*, https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/social-security-employer-tax-rates-table.html (2022.02.21).

Research in this field has long been conducted on the assessment of the 'risk premium'. This quantity, defined as the difference between the real rate of return and the return on Treasury Bills in the U.S., is a component of the CAMP model (Goetzmann, Ibbotson, 2006), which has strongly lost its values in current times. Our approach to the study of the 'risk premium' is marked by an awareness of the economic constant with which this 'risk premium' is associated. We recognise that in an efficient market, periodic profits are partly the result of natural forces. After all, employees receive fair wages, depreciation of fixed assets increases costs, so it is also the forces of nature that are the source of the periodic increase in invested capital. Therefore, the magnitude of the constant, under the hypothesis $a = 0.08$ [1/year], is estimated as the real rate of return earned in an efficient market (Table 4).

Table 4. Summary statistics for returns on U.S. stocks, bonds, and Treasury Bills (1926–2004)

Specification	Stocks	Long-term government bonds	Treasury Bills	Inflation	Real rate of return
Arithmetic mean	12.39%	5.82%	3.76%	3.12%	9.27%
Geometric mean	10.43%	5.44%	3.72%	3.04%	7.39%
Standard deviation	20.31%	9.30%	3.14%	4.32%	8.33%

Source: own elaboration based on (Goetzmann, Ibbotson, 2006, p. 35).

To calculate the rate of return based on the data in Table 5, the percentage of inflation was subtracted from the stock return, resulting in the value: 12.39% – 3.12% = 9.27%, calculated according to the arithmetic mean. However, according to the geometric mean, it is 10.43% – 3.04% = 7.39%. Within this range (7.39–9.27%) is the average multi-year return achieved in the U.S. equity market. To arrive at a point estimate, the arithmetic average of these two numbers was calculated and a value of 8.285% was obtained. In the case of stock market information and corporate earnings reporting, the data determines the value at the end of the calculation year. Thus, if capital multiplies at a rate of 8% (*ex ante*), then at the end of the year (*ex post*) it reaches a multiplication of $e^{0.08} - 1$, or about 8.33%. Thus, the estimation determines that a priori: $a = 0.08$ [1/year].

Rates of return on invested capital in economic entities were examined, among others, by B. Kurek (2012). The research was conducted on a sample of financial statements of companies belonging to the Standard & Poor's 1,500 index over a period of 20 years. The components of the index were taken into account, i.e. companies grouped in the Standard & Poor's 1,000, Standard & Poor's 900, Standard & Poor's 600, Standard & Poor's 500, and Standard & Poor's 400 indices. The total number of observations in the sample reached 22,952 financial reports. The results of B. Kurek's statistical tests confirmed the hypothesis of a mean *ex post* risk premium of 8.33%, which corresponds to an 8% *ex ante*

risk premium. The test was performed at a confidence level of 0.999, yielding a confidence interval of 8.25–8.89%, with a mean of 8.57%. Statistical inference was considered completely safe due to the low relative random error (3.75%). The research of B. Kurek concerned the rate of capital multiplication in real economic entities.

The constant under consideration is also found in the interest rates set by the loan agreements of the old days. This was especially true for farms. Indeed, A. Pikulska-Robaszkiewicz (1999) indicates that in Republican Rome, the law specified an interest rate on loans not exceeding 8%.

Capital and labour – complementary notion

The economic sciences are known to have difficulties in understanding capital, even though it is a major scientific concept. It is a strange one. The measurement of the periodic growth of capital, or income (profit), is dealt with in the theory and practice of accounting. And this measurement largely forms the basis for budgeting and steering the state economy. Understanding and defining capital stems from a basic principle of accounting theory, the principle of dualism. According to this principle, a distinction is made between heterogeneous tangible assets and homogeneous abstract capital embodied in these assets. In doing so, it is worth noting that the natural sciences and economics share at least one common paradigm, that is, the *matter-energy* dualism in physics and the *asset-capital* dualism in economics.

This dualism found in the economic sciences is aptly characterised by Y. Ijiri (1995, p. 55). According to that author, capital is abstract, aggregate and homogeneous, while resources are concrete and heterogeneous. The double-entry accounting system, which has been the foundation of accounting for more than five centuries, has been based on a dual view of resources and capital since its inception. Let us add that the category of resources differs from assets, in that assets have an explicitly measured capital value, while resources do not. Therefore, resources are estimated in natural units. For example: coal resources in a given layer are estimated at 10 million tons.

What, then, is this abstract medium called capital, and why is its periodic growth viewed so positively? How can this be explained using the example of cars, which is a vivid example of tangible assets? Well, the car has the ability to drive, to do work. This abstract property of the car is known to fade over time, the car loses its ability to drive. When it fades completely, the car is gone, only scrap remains. Similarly, the disappearance of the energy of life causes a person to cease to exist. It is also clear why a company with initial capital seeks to achieve periodic increments of capital; this is a condition for survival.

These are two fundamental scientific concepts and from them arise derived categories. Capital is the ability to do work and, from this term, it follows that work is a complementary category. At the same time, capital is a potential category. A dynamic category, on the other hand, is labour, which can be performed as long as there is the potential to perform it, i.e. capital. Labour is defined as the transfer of capital to the object of labour. A given object, such as a car, may have a greater or lesser concentration of capital obtained from transfers called labour. Those modern, perfectly constructed and equipped cars having a high concentration of capital are characterised by high value. Thus, we have a natural sequence of major economic concepts: capital, labour, value.

Work is done by machines but also by people with adequate human capital, the concentration of which may be higher or lower. It is natural that a worker with a higher value of capital receives a higher proportional salary. When dealing with the issues of measuring human capital and adequate compensation for labour, a natural constant analogous to known quantities of this kind was revealed (Dobija, Renkas, 2021b). As is known, there is this constant $a = 0.08$ [1/year], which is also related to the category of time.

Capital is thermodynamic in nature; it does not arise from nothing and is subject to natural spontaneous dissipation. It cannot be created out of nothing; it appears with the birth of a human being, grows as human capital and is further transferred through labour processes. Similarly, capital grows through other living organisms. In these processes, the sun plays an inalienable role by providing energy for the processes of life. The measurement of the periodic growth of capital in economics, which is provided by accounting systems, has as its basis the double entry of economic operations resulting from the principle of dualism, which precludes that capital can arise from nothing (the first principle of thermodynamics).

In addition, the capital embodied in an object disperses spontaneously and its potential is reduced; entropy increases in an isolated object. In the case of a car, knowing its value at the end of its useful life (the level of concentration of capital), it is possible to determine the theoretically reasonable rate of capital dispersion, i.e. depreciation of the car. The general formula for determining the annual rate of depreciation (entropy increase) of the object under consideration is as follows: $Vp \times e^{-d \times t} = Vk$, where: Vp – initial value of the object, Vk –value at the end of the useful life, t – number of years of operation, and d – annual rate of depreciation of the asset.

In a consistent thermodynamic approach, the issue of capital is presented clearly and simply. The discernment of capital in economic thought, in which there was no lack of reference to physics, but there is still a lack of distinction between abstract capital with material resources or assets, is presented differently. A recent work by T. Piketty (2015) is an example of an economic work in

which the author defines capital as he sees fit, with no connection to scientific achievements or accounting theory.

R.M. Solow (1963, p. 8) expressed his opinion on capital: "…It seems that certain issues that were debated in the 19th century, for example, how capital should be measured, remain contentious to this day…". R.M. Solow (1963, p. 10) goes on to emphasise that these debates were inconsistent and still are, although he himself participates in them. He states that it is highly significant that if a theoretical issue remains debatable and unresolved after 80 years, the suspicion arises that it is either misplaced or very deep indeed.

Recall also that Ch. Bliss, A.J. Cohen and G.C. Harcourt (2005), in a three-volume work entitled: 'Capital Theory', collected 71 scientific articles, chapters of monographs, and letters from the 19th, 20th and 21st centuries, the authors of which presented their own views on capital theory. The differences in views were so great that they justified the authors formulating the opinion that capital theory is an infamous subject precisely because of the notoriously recurring controversies surrounding it. This controversy is the result of the continuing tension between the two concepts of capital: physical and value. This is because economists view capital both as a collection of heterogeneous resources used in the process of producing goods and as a homogeneous fund of value that flows between alternative uses to establish a uniform rate of return.

Current economic theory suffers many failures when confronted with practice, which many authors have written about. N. Roubini and S. Mihm (2011, p. 59) describe the prevailing discrepancies that exist among economists on almost every important issue. As they write:

'Such divergence of views may embarrass non-economists. After all, economics aspires to be a science that obeys laws, performs equations, creates mathematical models and uses other tools used in objective research. But beyond the façade of a single scientific truth lies a huge variety of mutually contradictory opinions, especially on the contentious issue of financial crises. This was the case in the 19th and 20th centuries, and it is still the case today.'

To be fair, many economists associated capital as an abstract category. Physical theories, the epistemological views of physical theorists, were the model to which scientists working in the field of economic sciences referred. As (Mirowski, 1989, pp. 224–225) writes, many scholars viewed value and utility through the prism of the physical understanding of energy and considered mechanics as a model for economic science. (The latter opinion ultimately proved wrong.) W.S. Jevons (1905, p. 219), for example, wrote explicitly that the concept of value is to our science what energy is to mechanics. In 1926, I. Fisher presented a table containing analogies of physical and economic categories (Mirowski, 1989, pp. 224–225); energy in his understanding was the equivalent of utility.

However, the aforementioned economists could not sufficiently clarify this issue. By associating value with energy, they did not clearly state that it is capital,

as the ability to do work, that has all the characteristics of energy, and that value should be understood as the concentration of capital in an object. They also failed to find the right analogies between the laws governing energy in physics and capital in economics and correctly interpret the laws of thermodynamics in relation to economics. We should add that the issue of capital creation from nothing, related to the actions of the current banking system, negatively weighs on the theory of political economy and its possibilities for development.

Ending words

The role of the knowledge of thermodynamics is, as can be seen from the presented research, very helpful in explaining the issues of time and the effects of economic processes taking place in time. An extremely constructive feature of the second principle is that it forces living organisms to act to contain entropy in order to prolong duration. In the case of humans, it compels logical thinking and productive, purposeful work. Through the synthesis of the principles of thermodynamics, knowledge of the primordial energy of life, human consciousness, including the knowledge of the astronomical calendar, emerges an understanding of time on the planet Earth. Periodic economic profit is revealed as a result of the existence of initial capital and the result of the game between the inflow of capital with the stream of labour, which nullifies entropy and allows the inflow of energy offered by nature.

Modifying the definition of time to include the thermodynamic transformation of life energy into human capital has naturally enriched the understanding of the potential constant of capital growth, which opens up avenues for further scientific research. A deeper understanding of the structure of the discount factor naturally emerges. In this quantity, time appears fully as a pair (*t, a*). At the same time, it is an example of an important economic theory (capital budgeting), in which there are scientific categories of present and future value (PV and FV), rather than mere divagations about the past and future.

It can be expected that economists who do not respect the principle of dualism in their writings and consider capital as a type of asset will find that they oppose the theory based on the foundation of the unassailable capital-labour-time triad. The chutzpah called the 'Cambridge controversy' will stop poisoning the clarity of economic thought. And without this ethically dubious achievement, it is astonishing to ignore the theory of double-entry accounting, the theoretical and practical importance of which is indisputable in terms of creating information for maintaining the financial balance of an organisation. And maintaining balance is a condition of existence. It can also be expected that it will be established that the texts of creative economic works will take into account the languages of

mathematics and physics necessary to describe abstract but real categories, as well as the natural language in which the author conducts a clear narrative presenting achievements.

Bibliography

Atkins, P. (2007). *Four Laws that Drive the Universe*. New York: Oxford University Press.

Barbour, J. (2018). *The End of Time: The Next Revolution in Our Understanding of the Universe*. Cracow: Copernicus Center Press.

Barbour, J. (2021). *The Janus Point: A New Theory of Time* (Polish language: Nowa teoria czasu. Punkt Janusa). Cracow: Copernicus Center Press.

Bejan, A., Tsatsaronis, G. (2021). Purpose in Thermodynamics. *Energies, 14*, 408. DOI: 10.3390/en14020408.

Bliss, C., Cohen, A. J., Harcourt, G. C. (2005). *Capital Theory*, Vol. I–III. Massachusetts: Edward Elgar Publishing Limited, Northampton.

Bliss, J. Ch. (1975). *Capital Theory and the Distribution of Income*. Oxford: North-Holland, California Institute of Technology, Michael A. Gottlieb and Rudolf Pfeiffer.

Cost of living in USA. Retrieved from: https://www.expatistan.com/cost-of-living (2022.02.24).

Cost of living, 2022. Retrieved from: https://www.numbeo.com/cost-of-living/rankings_by_country.jsp (2022.02.21).

Cost of living in USA. Retrieved from: https://www.expatistan.com/cost-of-living (2022.02.24).

Dobija, M. (2007). Abstract Nature of Capital and Money. In: M. Linda Cornwall (eds.), *New Developments in Banking and Finance* (pp. 89–114). New York, Inc.: Nova Science Publishers.

Dobija, M. (1998). How to place human resources into the balance sheet. *Journal of Human Resource Costing & Accounting*, *3*(1), 83–92. 2. DOI: 10.1108/eb029044.

Dobija, M. (2011). Labor Productivity vs. Minimum Wage Level. *Modern Economy*, *2*(5), 780–787. DOI: 10.4236/me.2011.25086.

Dobija, M., Kurek, B. (2013). Towards Scientific Economics. *Modern Economy*, *4*(4), 293–304. DOI: 10.4236/me.2013.44033.

Dobija, M., Renkas, J. (2020). Accounting among the Natural Sciences. *Modern Economy*,*11*(12), 2081–2100. DOI: 10.4236/me.2020.1112138.

Dobija, M., Renkas, J. (2021a). How the inclusion of thermodynamic principles recovers economic sciences. *International Journal of Accounting and Economics Studies*, *9*(2), 21–31. DOI: 10.14419/ijaes.v9i2.31608.

Dobija, M., Renkas, J. (2021b). The thermodynamic principles as the theoretical basis of fair remuneration. *International Journal of Physical Research*, *9*(1), 1–6. DOI: 10.14419/ijpr.v9i1.31247.

Dobija, M., Renkas, J. (2021c). Thermodynamic constant of time passage. *International Journal of Physical Research*, *9*(2), 92–97. DOI: 10.14419/ijpr.v9i2.31823.

Dobija, M., Renkas, J. (2022). Study on Thermodynamic Constant of Time Passage. *Research Trends and Challenges in Physical Science, 6*, 57–68. DOI: 10.9734/bpi/rtcps/v6/15220D.

Employer Social Security Tax Rates. Retrieved from: https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/social-security-employer-tax-rates-table.html (2022.02.21).

Eurostat, Monthly minimum wages. Retrieved from: https://ec.europa.eu/eurostat/databrowser/view/earn_mw_cur/default/table?lang=en (2022.02.21).

Feynman, R. (1963). Time and Distance, The Feynman Lectures on Physics, Vol. I, Ch. 5. Retrieved from: https://www.feynmanlectures.caltech.edu/I_toc.html (2022.02.21).

Fraser, I. T. (1979). Wyjście z jaskini Platona: naturalna historia czasu. *Zagadnienia filozoficzne w nauce*, II/1979/80, 18–39.

Goetzmann, W. N., Ibbotson, R. G. (2006). History and the Equity Risk Premium. In: W. N. Goetzmann, R. G. Ibbotson (eds.), *The Equity Risk Premium: Essays and Explorations*. Oxford: Yale School of Management, Oxford University Press.

Greene, B. (2020). *Until the end of time. Polish edition*. Warszawa: Prószyński Media Sp. z o.o.

Holt, J. (2018). *When Einstein Walked with Gödel: Excursions to the Edge of Thought*. New York: Farrar, Straus and Giroux.

Ijiri, Y. (1995). Segment Statements and Informativeness of Measures: Managing Capital vs. Managing Resources. *Accounting Horizons, 9*(3), 55–67.

International Association for the Integration of Science and Engineering. Retrieved from: https://www.youtube.thermodynamics.nature.of.Time.Dobija.Renkas.2022 (2022.02.21).

Jevons, W. S. (1905). *Principles of Economics*. London: Macmillan.

Kant, I. (2021). *The Critique Of Pure Reason*, Translation and Comments by Philip McPherson Rudisill, Completed on October 17, 2019, with editing on-going as of, November 5, 2021, 59–60. Retrieved from: https://chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://kantwesley.com/Kant/CritiqueOfPureReason.pdf (2022.02.21).

Koziol, W. (2011). Constant of potential growth in the calculation of human capital (Polish language: Stała potencjalnego wzrostu w rachunku kapitału ludzkiego). *Nierówności Społeczne w Wzrost Gospodarczy*, *19*, 252–260.

Kurek, B. (2012). An estimation of the capital growth rate in business activities. *Modern Economy, 3*(4), 364–372. DOI: 10.4236/me.2012.34047.

Lambert, F. L. (2002). Disorder – A Cracked Crutch for Supporting Entropy Discussions. *The Journal of Chemical Education*, *79*(2), 79–187. DOI: 10.1021/ed079p187.

Maoshing, Ni. (2012). *The Yellow Emperor's Classic of Medicine* (Polish edition), Łódź: Wydawnictwo Galaktyka.

Mirowski, P. (1989). *More Heat than Light, Economics as social physics: Physics as nature's economics*. Cambrodge: Cambridge University Press.

Newton, I. (1999). *The Principia. Mathematical Principles of Natural Philosophy.* The Authoritative Translation by I. B. Cohen and A. Whitman assisted by J. Budenz. California: University of California Press.

Park, D. (1972). The myth of the passage of time. In: J. T. Fraser, F. Haber, G. Muller (eds.), *The Study of Time* (pp. 110–121). Berlin: Springer Verlag.
Piketty, T. (2015). *Kapitał w XXI wieku*. Warszawa: Wydawnictwo Krytyki Politycznej.
Pikulska-Robaszkiewicz, A. (1999). *Usury in the State and Law of Republican Rome* (Polish language: Lichwa w państwie i prawie republikańskiego Rzymu). Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
Renkas, J. (2022). *Thermodynamic model of human capital measurement in applications to employee compensation formation* (Polish language: Termodynamiczny model pomiaru kapitału ludzkiego w zastosowaniach do kształtowania wynagrodzeń za pracę). Warszawa: Wydawnictwo Difin.
Roubini, N., Mihm, S. (2011). *Ekonomia kryzysu*. Warszawa: OficynaWolter Kluwers.
Solow, R. (1963). *Capital Theory and the Rate of Return*. Amsterdam: North-Holland Publishing Company.
Wright, R. (2000). *Nonzero. The Logic of Human Destiny*. New York: Pantheon Books (Polish edition).

Summary

In the theoretical achievements of economics, the past has left many insinuations, not always accurate terms and also controversies. This does not burden the scholars whose diligent efforts fell on the immature ground of general knowledge, in particular the lack of thermodynamics. The categories of capital, profit, labour are basic examples. There was also a lack of understanding of the nature of time. This issue was as if left to physicists, despite the fact that the use of present and future value was and is a significant achievement in economics and accounting. On the other hand, among those engaged in physics, there are divergences about time travel. The great idea of the economy as a game with nature with a non-zero positive sum has also not spread in economic theory, reinforcing the aspiration to belong to the natural sciences. Therefore, we take up the consideration of the *capital-labour-time* triad as an important basic element of economic knowledge. In our view, this correctly understood triad will correctly illuminate many economic issues and can form the hard core of a scientific program for improving economic and accounting theory. Thus, the epistemology of I. Lakatos defines the methodology of ongoing research, in which positive heuristics and empirical verification are the engine of scientific action.

Keywords: time, capital, labour, thermodynamics, economic constant.

Termodynamiczne relacje między czasem, kapitałem i pracą

Streszczenie

W teoretycznych dokonaniach ekonomii przeszłość pozostawiła wiele niedomówień, nie zawsze trafnych określeń, a także kontrowersji. Nie obciąża to uczonych, których rzetelne wysiłki padały na niedojrzały grunt wiedzy ogólnej, w szczególności na brak termodynamiki. Kategorie kapitału, zysku, pracy to podstawowe przykłady. Brakowało też zrozumienia natury czasu, ta kwestia została jakby zostawiona fizykom, mimo że posługiwanie się wartością teraźniejszą i przyszłą było i jest znaczącym osiągnięciem ekonomii i rachunkowości. Natomiast wśród zajmujących się

fizyką mają miejsce dywagacje o podróżach w czasie. Wielka idea gospodarki jako gry z naturą o sumie niezerowej dodatniej także nie upowszechniła się w teorii ekonomii wzmacniając dążenia do przynależności do nauk naturalnych. Dlatego podejmujemy rozważania o triadzie *kapitał-praca-czas* jako istotnym podstawowym elemencie wiedzy ekonomicznej. W naszym przekonaniu ta poprawnie rozumiana triada poprawnie naświetli wiele kwestii ekonomicznych i może stanowić twarde jądro naukowego programu doskonalenia teorii ekonomii i rachunkowości. Zatem epistemologia I. Lakatosa określa metodologię prowadzonych badań, w których pozytywna heurystyka i empiryczna weryfikacja stanowią motor naukowych działań.

Słowa kluczowe: czas, kapitał, praca, termodynamika, stała ekonomiczna.

JEL: A12, E24, J24, O15.

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The significance of the absorption of EU funds in the socio-economic development of the subregions of Poland, the Czech Republic, and Slovakia

Introduction

The most important financial instruments of the EU cohesion policy are the Structural Funds as well as the Cohesion Fund, which in the economic practice and in the subject literature are often termed as "EU funds". The main principle of spending the EU funds is achieving social, economic and territorial cohesion, mainly through supporting growth and creating new workplaces in the weakest developed states and regions (Matsuura, 2015; Albulescu, Goyeau, 2014). In relation to the abovementioned, regions subcategorised as NUTS II level whose GDP per capita in the case of Structural Funds is lower than 75% of the whole EU average, and in the case of the Cohesion Fund – states of GDP per capita amounting to less than 90% of the average for the whole EU that were implementing the program directed at meeting the economic convergence criteria are all eligible to obtain financial support (Beugelsdijk et al., 2018).

The means originating from the general EU budget were to contribute to the increase in the regional dynamics due to which high hopes were linked with them, ascribing them the role of *capo di tutti capi*[2] of the socio-economic changes of the EU regions, especially in its poorer part, i.e. Central Eastern Europe. The first empirical examination suggested that the impact of those means on the economy will be extremely important[3] (Dreyer et al., 2006; Florida, 2002). The subsequent

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[2] From Italian: a person highest in the ranking, the most significant factor.

[3] For example, the first analyses using the HERMIN and MaMoR3 models conducted by the Institute of Research on the Market Economy, and the Wrocław Agency of the Regional Development indicated that the EU funds should impact the GDP level to as high an extent as 11.2%.

compilations demonstrated, however, that the impact of the EU funds on GDP growth is significantly lower than was originally expected[4] (Shikverdiev et al., 2019; Jašková, Havierniková, 2020).

In light of the abovementioned, the presentation of the significance of the EU absorptions in socio-economic development has become the basis for taking up the research area mentioned above. The goal of the article is to attempt to specify the correlations between the variation in the Structural Funds and the Cohesion Fund absorption in Poland, the Czech Republic, and Slovakia[5] and the changes in the level of socio-economic development in the regional dimension. The level of regional development was specified within the dimension of factors (subcomponents) of the development, subcategorising: the society, the economy, and the natural environment. In the compilation, the "absorption" notion is understood as the amount of means actually spent in projects co-financed from the EU funds, realised within the EU cohesion policy in the subregions researched, and used interchangeably with the notions: "commitment" as well as "the use". In the research, projects co-financed from EU funds were realised between 2007–2019. The change in the level of development was established for the years 2010–2021. A certain time delaying the impact of the results of the EU projects on economic development was taken into consideration. The authors of other research most often specify a two- or three-year delay in the impact of the EU funds on the economy (Baklanov, 2020; Goryachikh, Kravchenko, 2020).

The article undertakes to verify the hypothesis according to which the absorption of EU funds has impacted the development of "the economy" subcomponent to the largest extent.

The research procedure was conducted in three stages. In the first one, the level of socio-economic development in Poland, the Czech Republic, and Slovakia was established in the subregional dimension – at the level of the NUTS-3 units. For that purpose, an original synthetic gauge of the level of socio-economic development based on Eurostat data as well as the national statistical offices was created. The research was conducted on the level of the subregions, on one hand, in order to obtain the highest level of detail, and on the other – with respect to the accessibility of empirical data. In the second stage, spatial differentiation of EU fund absorption in the NUTS-3 units in Poland, the Czech Republic, and Slovakia was presented using data extracted from teleinformatics systems of the Ministries responsible for spending the EU funds and/or the realisation of the EU cohesion policy in Poland, the Czech Republic, and Slovakia. In the third stage, the correlations between the extent of the absorption and the changes in the level of development within the arrangement of the factors of development were based on regression analysis.

[4] Most often, it was indicated that the EU funds impacted the GDP level at around 2.5%.

[5] The spatial scope of the study results from the subject of the research grant carried out by the author.

Methodology

The variation in the level of regional development is a natural phenomenon that results from imbalanced access to the means of production, such as: labour, capital, or natural resources (Feldman, 1999; Khasanova et al., 2020). The differences in the potential of the regions converge with most theories of regional development (Naydenov, 2019; Yun et al., 2017). However, the theories originating from different scientific orientations explain the variation in the socio-economic processes in a different manner. The first group of theories originating from the neoliberal trend assumes the minimisation of state interventionism, and the free market treats the regulatory mechanisms irreplaceable (Krugman 1998). The second group of theories representing neo-Keynesian economic thought acknowledges state interventionism as necessary and the most important regulatory mechanism of socio-economic development (Diebolt, Hippe, 2019; De Castro et al., 2018).

In order to specify the variation in the level of the socio-economic development of the NUTS-3 units in Poland, the Czech Republic, and Slovakia, a synthetic gauge of distance from the established pattern was used. The research procedure consisted of four subsequent stages (Spychała, 2020): the selection of variables being the basis for creating the indicators, a reduction of multi-feature space, the specification of the level of socio-economic development of the subregions as well as the classification of all 95 NUTS-3 units on the scale of the regional development.

Table 1. Indicators considered in the analysis specifying the level of development

Factor of the development	Indicators
1	*2*
Society (11 variables)	The birth rate per 1,000 inhabitants; the migration balance per 1,000 inhabitants; the feminisation coefficient in total; the percentage of people at the production age in the total number of people; the share of people at the pre-production age in the total number of people; the share of people at the post-production age in the total number of people; the number of people at the post-production age per 100 people at the pre-production age; the number of people at the non-production age per 100 at the production age; median age of the population; the average age of women giving birth; birth rate in total.
The natural environment (10 variables)	The share of farmland as well as natural green areas in the total space; the share of farmers-farm owners in farms below the age of 35 in the total number of farm owners; the share of farms below 5 ha in the total number of farms; road transport of products measured in tonnes per 1,000 inhabitants; registered offences and crimes connected with the natural environment per 1,000 inhabitants; the use of the electrical energy for the purpose of cooling inhabitable areas (as the EU average); the use of the electrical energy for the purpose of heating inhabitable areas (as the EU average); urban waste per 1 inhabitant; number of accommodation places per 1,000 inhabitants; detoxifying urban waste per 1 inhabitant.

1	*2*
The economy (10 variables)	The share of microenterprises in the total number of economic entities; the coefficient of new enterprise creation; the share of the employed in the financial sector in the total number of the employed; the share of the employed in farming in the total number of the employed; the share of the employed in the sector of professional services in the total number of the employed; the share of the employed in the sector of information and communication in the total number of the employed; the quantity of consumer goods per 1 million inhabitants; Gross GDP per 1 million inhabitants (as the EU average).

Source: own compilation based on research conducted.

In the first stage of the research procedure, a matrix of geographical information was created based on 31 indicators (Table 1), which specified the changes in the socio-economic development of the NUTS-3 units in the years 2010-2021 in relation to the following factors of development: "the society" (comprising, among others, the changes in the size and quality of human and social capital), "the economy" (comprising, among others, the structure of employment, the level of entrepreneurship as well as the level of innovativeness), as well as "the natural environment" (comprising, among others, spatial planning, the energy consumption of the economy as well as activities harmful to the environment). The abovementioned factors (components) of the development have been identified based on the literature review conducted (Naydenov, 2019; Yun et al., 2017; Feldman, 1999; Khasanova et al., 2020; Spychała, 2020; Diebolt, Hippe, 2019; De Castro et al., 2018; Krugman, 1998; Baklanov, 2020; Goryachikh, Kravchenko, 2020). Subsequently, Pearson's linear correlation coefficients were calculated between the researched departure indicators for their change in the years 2010–2021. Variables selected for the synthetic gauge should thus be weakly correlated with one another in order for their information capacity to be different (Balcerzak, 2016). The correlation coefficient matrices constructed were the basis for conducting departure variable reduction using Z. Hellwig's method (i.e. for the separation of those indicators that shall be taken into account in further procedures). The variable reduction procedure was conducted four times: separately for the general socio-economic level and separately for the level of development of each of the three subcomponents, which were the factors of that development.

At the next stage of the research procedure, the pattern and the antipattern of the regional development were established, and subsequently, a taxonomic distance of each subregion was researched from the established pattern of development. In the last part of the research conducted for each NUTS-3 unit, a synthetic gauge was established as an indicator of socio-economic development.

Results – variation in the level of the development of the NUTS-3 units in Poland, the Czech Republic, and Slovakia in the years 2010–2021

A synthetic gauge of the level of development assumes values from 0 to 1. The higher the value, the higher the level of development of the phenomenon considered. Based on the indicators calculated for 95 NUTS-3 units in Poland, the Czech Republic, and Slovakia, 5 groups were subcategorised: a very high, high, average, low and very low change in the level of socio-economic development in the years 2010–2021.

Table 2. Extreme values of the synthetic gauge within the respective factors of the socio-economic development in 2010–2021

The highest values of the synthetic gauge (the period between 2010–2021)			The lowest values of the synthetic gauge (the period between 2010–2021)		
Item	The NUTS-3 subregion	Value	Item	The NUTS-3 subregion	Value
1	*2*	*3*	*4*	*5*	*6*
Society					
1	Miasto Warszawa (PL)	0.571	95	Szczecinecko-pyrzycki (PL)	0.226
2	Warszawski wschodni (PL)	0.542	94	Legnicko-Glogowski (PL)	0.243
3	Miasto Kraków (PL)	0.540	93	Jeleniogórski (PL)	0.261
4	Warszawski zachodni (PL)	0.530	92	Włocławski (PL)	0.261
5	Bialostocki (PL)	0.526	91	Koszaliński (PL)	0.279
The natural environment					
1	Bytomski (PL)	0.672	95	Nowosądecki (PL)	0.346
2	Miasto Warszawa (PL)	0.666	94	Słupski (PL)	0.383
3	Trójmiejski (PL)	0.638	93	Leszczyński (PL)	0.416
4	Katowicki (PL)	0.631	92	Jeleniogórski (PL)	0.430
5	Gliwicki (PL)	0.627	91	Nowotarski (PL)	0.464
The economy					
1	Miasto Warszawa (PL)	0.552	95	Gorzowski (PL)	0.274
2	Trójmiejski (PL)	0.537	94	Koszalinski (PL)	0.279
3	Miasto Kraków (PL)	0.490	93	Ústecký kraj (CZ)	0.286
4	Jihomoravský kraj (CZ)	0.489	92	Wałbrzyski (PL)	0.289
5	Póocki (PL)	0.488	91	Legnicko-Głogowski (PL)	0.293

1	*2*	*3*	*4*	*5*	*6*
The general level of economic development					
1	Miasto Warszawa (PL)	0.590	95	Jeleniogórski (PL)	0.329
2	Trójmiejski (PL)	0.550	94	Legnicko-Głogowski (PL)	0.329
3	Warszawski zachodni (PL)	0.534	93	Koszaliński (PL)	0.340
4	Białostocki (PL)	0.513	92	Szczecinecko-pyrzycki (PL)	0.347
5	Miasto Kraków (PL)	0.497	91	Słupski (PL)	0.354
6	Warszawski wschodni (PL)	0.493	90	Wałbrzyski (PL)	0.359
7	Rzeszowski (PL)	0.492	89	Gorzowski (PL)	0.367
8	Jihomoravský kraj (CZ)	0.483	88	Szczeciński (PL)	0.368
9	Łódzki (PL)	0.483	87	Karlovarský kraj (CZ)	0.374
10	Miasto Łódz (PL)	0.482	86	Nowosądecki (PL)	0.376

Source: own research conducted on the basis of Eurostat data "General and regional statistics".

THE CHANGE IN THE LEVEL OF DEVELOPMENT BETWEEN 2010–2021

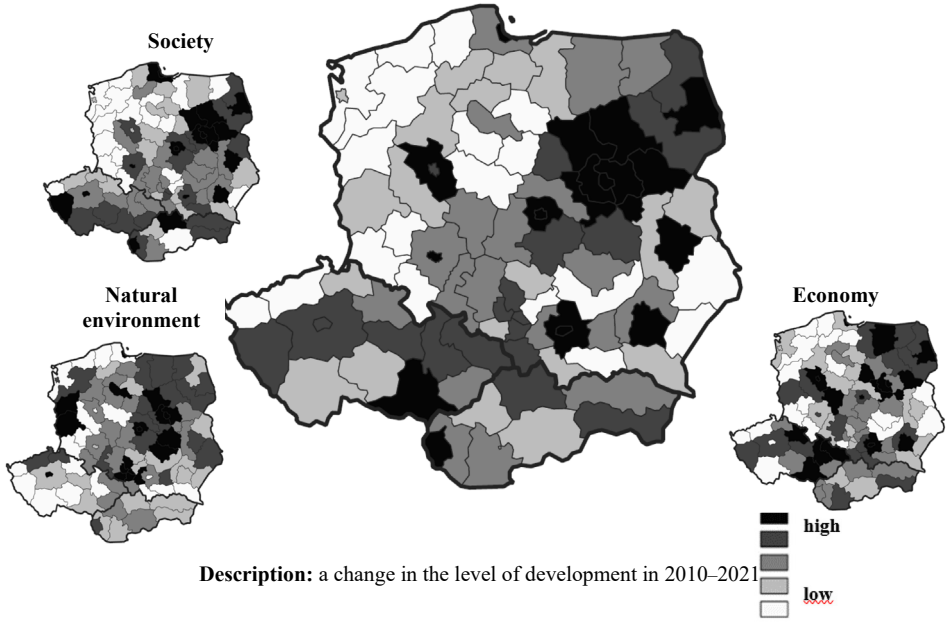

Figure 1. Spatial variation in the level of the socio-economic development and its aspects in Poland, the Czech Republic, and Slovakia within the arrangement of the NUTS-3 units

Source: own research conducted on the basis of Eurostat data "General and regional statistics".

In Figure 1, as well as in Table 2, the results of the research conducted were presented. Table 2 presents subregions of the highest and the lowest values of the synthetic gauge within the respective subcomponents of socio-economic development. Figure 1 contains choropleths representing the spatial variation of the changes in the socio-economic development of 95 NUTS-3 units in Poland, the Czech Republic, and Slovakia in the period of 2010–2021. The biggest change in the level of the society subcomponent has been observed in the subregions located near Warszawa, Prague and Bratislava, the economy subcomponent – around large cities such as Poznań, Warszawa, Kraków, Łódź, Gdańsk and the eastern subregions of the Czech Republic, and the natural environment subcomponent – in the śląskie, lubuskie and świętokrzyskie subregions. A high variation was also observed within the changes of the socio-economic level in total, and its highest changes were registered in big regional centres, such as: Warszawa, Trójmiasto, Kraków, Białystok, Rzeszów, Łódź, Wrocław, Poznań, Bratislava and Brno.

The use of EU funds in Polish, Czech and Slovakian subregions

At the second stage of the research procedure, the extent and structure of the absorption of the EU funds in Poland, the Czech Republic, and Slovakia were specified at the level of the NUTS-3 units. The basis for implementing the EU cohesion policy in the respective member states were: National Strategic Frameworks for the financial perspective as of 2007–2013, as well as a Partnership Agreement for the operational period as of 2014–2020 concluded between the member state government authorities and the representatives of the EU institutions. The strategic documents presented specified the priorities and activities for the state regional policies. In the abovementioned documents, an assumption was made that the Structural Funds (among which there are to be found: the European Fund of Regional Development as well as the European Social Fund) as well as the Cohesion Fund formed the main source of funding the regional policy in the EU member states.

In the years 2007–2019, within the EU cohesion policy, over 180,000 projects co-funded from the EU funds were realised, and the total value of the co-funding obtained by the beneficiaries for the purpose of the realisation of those projects amounted to around EUR 69 billion. In the Czech Republic, in the researched period, over 120,000 EU projects were realised, for a total amount of around EUR 32 billion of the EU co-funding. In Slovakia, however, in the years 2007–2019, over 53,000 projects were co-funded from EU funds, for the realisation of which around EUR 15 billion were obtained. In each of the 95 researched subregions in Poland, the Czech Republic, and Slovakia, projects co-financed from the EU

funds were realised. On average, in one NUTS-3 unit, 4,776 of such undertakings were realised, with a proviso that large discrepancies in the respective states were observed: in Poland for one subregion, 3,816 projects were relevant for one subregion, in Slovakia – 6,662, and in the Czech Republic as many as 8,704. The fewest projects were realised in Szczecin (1,065), and the most in the Stredoceský kraj subregion (15,038), Moravskoslezský kraj (14,977) and Jihomoravský kraj (14,704). The highest amount of the EU funds were involved in the realisation of projects in the capital city of Warsaw (EUR 7.1 billion) and the lubelski subregion (EUR 3.3 billion), and the lowest value of the total co-funding paid out in one NUTS-3 subregion was registered in the świecki and chojnicki subregions (EUR 0.4 billion each).

Table 3. Subregions of the highest and the lowest values of the EU fund absorption *per capita* calculated for the respective factors of the development

The highest values of the EU fund absorption (in EUR per capita)			The lowest values of the EU fund absorption per capita (in EUR per capita)		
No.	Subregion NUTS-3	Value	No.	Subregion NUTS-3	Value
1	*2*	*3*	*4*	*5*	*6*
Society					
1	Karlovarský kraj (CZ)	3257.19	95	Bratislavský kraj (SK)	262.84
2	Liberecký kraj (CZ)	2259.12	94	Miasto Warszawa (PL)	280.46
3	Pardubický kraj (CZ)	1959.43	93	Trenciansky kraj (SK)	320.10
4	Kraj Vysocina (CZ)	1945.80	92	Trnavský kraj (SK)	346.46
5	Královéhradecký kraj (CZ)	1864.92	91	Warszawski wschodni (PL)	351.53
The natural environment					
1	Trenciansky kraj (SK)	3699.38	95	Koniński (PL)	270.58
2	Zilinský kraj (SK)	2030.73	94	Hlavní mesto Praha (CZ)	294.47
3	Presovský kraj (SK)	1888.73	93	Płocki (PL)	306.31
4	Banskobystrický kraj (SK)	1305.36	92	Pilski (PL)	308.01
5	Olsztyński (PL)	1198.26	91	Nowotarski (PL)	310.65
The economy					
1	Elbląski (PL)	3098.74	95	Trenciansky kraj (SK)	432.67
2	Miasto Wrocław (PL)	3059.83	94	Hlavní mesto Praha (CZ)	578.18
3	Miasto Warszawa (PL)	3058.77	93	Pilski (PL)	639.88
4	Trójmiejski (PL)	3047.42	92	Nowotarski (PL)	646.25
5	Rzeszowski (PL)	2892.18	91	Presovský kraj (SK)	685.81

1	*2*	*3*	*4*	*5*	*6*
Total absorption					
1	Karlovarský kraj (CZ)	5349.33	95	Nowotarski (PL)	1456.75
2	Olsztyński (PL)	5209.35	94	Koniński (PL)	1457.45
3	Elbląski (PL)	5085.49	93	Pilski (PL)	1510.93
4	Rzeszowski (PL)	5052.22	92	Plocki (PL)	1664.52
5	Lubelski (PL)	4718.96	91	Nowosądecki (PL)	1670.89
6	Trenciansky kraj (SK)	4452.15	90	Jeleniogórski (PL)	1676.13
7	Kraj Vysocina (CZ)	4367.84	89	Hlavní mesto Praha (CZ)	1685.15
8	Miasto Wrocław (PL)	4269.74	88	Kaliski (PL)	1689.78
9	Trójmiejski (PL)	4209.22	87	Włocławski (PL)	1705.52
10	Miasto Warszawa (PL)	4038.84	86	Tyski (PL)	1709.75

Source: own research conducted on the basis of Eurostat data "General and regional statistics".

The comparison of the size and structure of the absorption of the EU funds within the interregional arrangement required the introduction of data relativisation. For that purpose, the number of people was used, and the respective data was calculated in the per capita dimension. The most EU projects per 10,000 inhabitants were realised in the subregions of warmińsko-mazurski: olsztyński (247) as well as elbląski (204), and the fewest – in Szczecin (26) and in Warsaw (29). It is well worth noting the fact that most subregions with the highest number of projects per 10,000 inhabitants are located in North-Eastern Poland – within the area of the warmińsko-mazurskie province. The abovementioned situation is an offshoot of several factors: first – the regional authority has assumed the principle of preferring a larger number of projects of relatively lower values; second – within the area of the province in the researched years, relatively high unemployment was registered; therefore, more projects concerning human capital and the job market were realised within the area; third – beneficiaries from the warmińsko-mazurskie province were entitled to also apply for the co-funding from the operational programs concerning the development of Eastern Poland; fourth – the province is one of the few regions which were allowed the access to the means from the so-called initiative to the benefit of employing young people. All the abovementioned factors impacted the relatively high number of EU projects per 10,000 inhabitants.

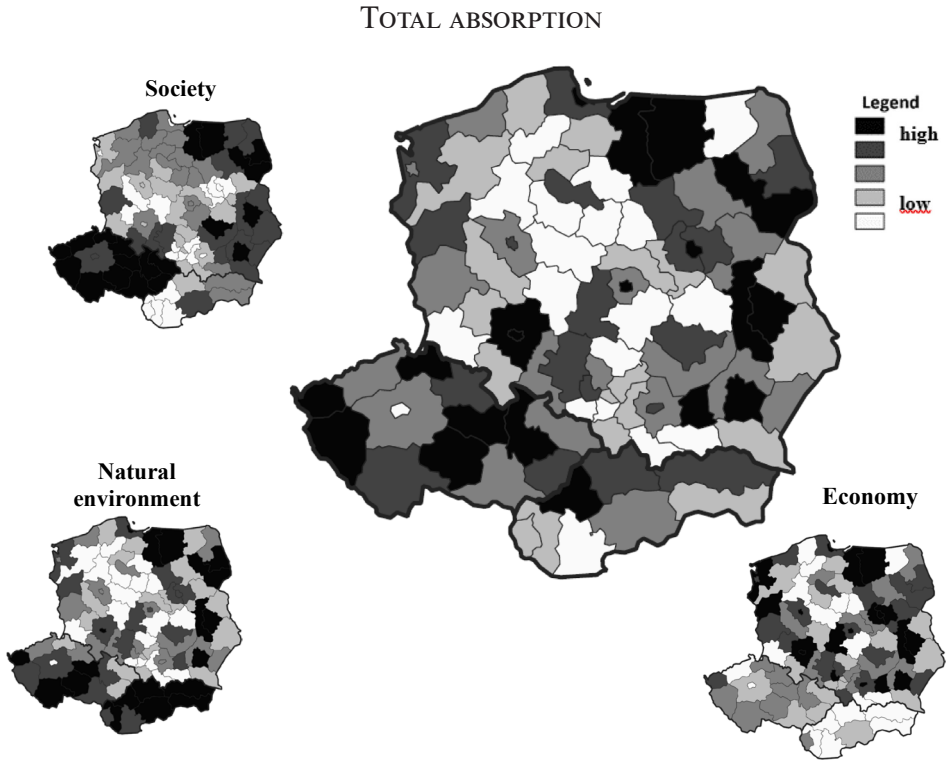

Figure 2. EU fund absorption per capita in Poland, the Czech Republic, and Slovakia within the arrangement of the NUTS-3 units

Source: own research conducted on the basis of Eurostat data "General and regional statistics".

The next scope of the analysis of the stage was the specification of the spatial variation of the EU fund absorption in relation to the factors – the components of socio-economic development: the society, the economy and the natural environment. The results of the research conducted formed the basis for specifying the correlations between the EU fund absorption and the change in the level of socio-economic development. Means from the European Social Fund were used for the development of the society subcomponent, the development of the economy was funded above all from the funds of the European Regional Fund, and the development of the natural environment factor was allowed thanks to financing mainly from the Cohesion Fund. Based on the research conducted, it was established that in the states researched in the years 2007–2019, the most means – 43.0% – were directed to the benefit of the economy. The following 36.9% of the value of the EU funds were used for the benefit of society, and 20.1% of the funds made accessible were devised for the benefit of the protection of the natural environment.

The results of the research conducted are presented in Figure 2 as well as in Table 3. Table 3 presents the NUTS-3 units of the highest and the lowest values of EU fund absorption per capita. Figure 2 contains choropleths representing the spatial variation of the absorption in Poland, the Czech Republic, and Slovakia in the subregional dimension. It is well worth noting the fact that the respective states specialised in spending the EU funds for the respective components of growth. The EU funds devised towards the development of the society, as calculated for 10,000 inhabitants, were used to the largest extent in the Czech subregions. Slovakian subregions, however, specialised above all in obtaining EU funds for the benefit of environmental protection. In the case of the Polish subregions, the EU funds devoted towards the support of the economy were the most significant.

The size of the absorption and the level of the development within the arrangement of the NUTS-3 units

At the last stage of the research conducted, a correlation between the size of the EU fund absorption and the level of socio-economic development was established in 95 NUTS-3 units in Poland, the Czech Republic, and Slovakia. The abovementioned relations were researched separately for each subcategorised unit (a subcomponent) of the development as well as for the socio-economic development in total. Based on the average value of the synthetic gauge specifying the change in the development as well as the average value of the particular EU factor of the development support fund absorption per capita, the subregions researched were subdivided into four groups (Figure 3 and Figure 4):

- Group 1: NUTS-3 units were subcategorised in which an above-average change in the level of a particular factor was registered as well as an above-average EU fund absorption;
- Group 2: Subregions were calculated in which an above-average change in the level of the development was observed, but the EU fund absorption was below average;
- Group 3: NUTS-3 units were calculated in which a change in the level of the development of a particular factor was below average, along with below-average EU fund absorption;
- Group 4: NUTS-3unit subregions were classified in which a below-average change in the level of the development of a particular factor was observed, as well as high EU fund absorption devoted to the development of a researched factor.

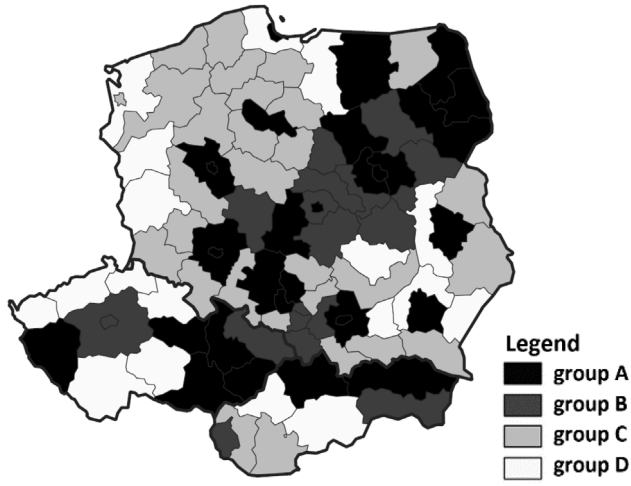

Figure 3. Charts of the EU fund absorption as well as the changes in the level of the socio-economic development of the NUTS-3 units in Poland, the Czech Republic, and Slovakia

Source: own research conducted on the basis of Eurostat data "General and regional statistics".

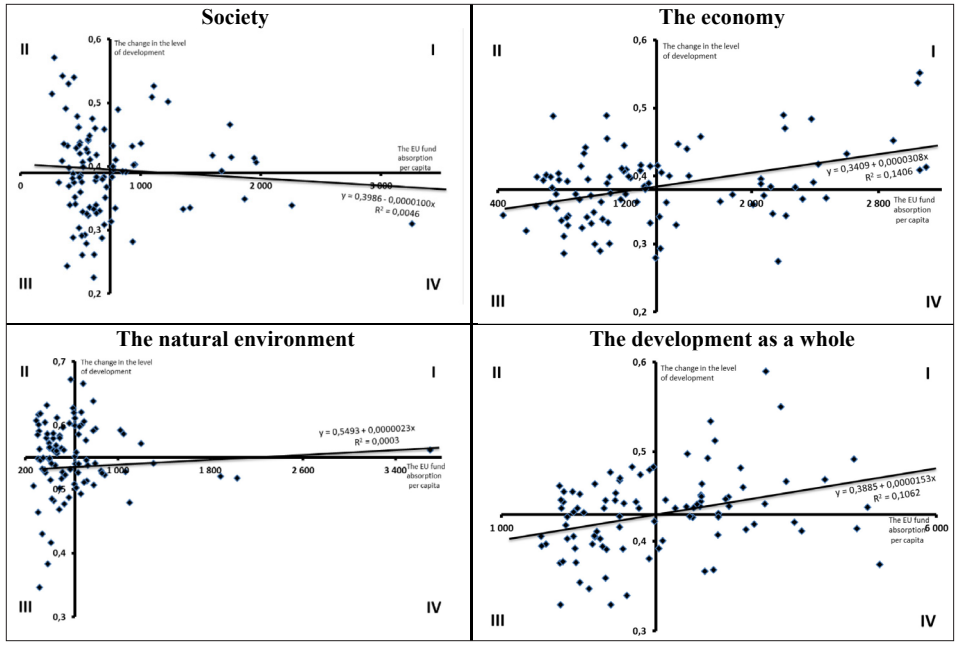

Figure 4. Charts of the EU fund absorption dispersion, as well as the changes in the level of the socio-economic development of the NUTS-3 units in Poland, the Czech Republic, and Slovakia

Source: own research.

Group 1 thus contains those subregions in which the biggest change in the level of the development of a particular factor was observed in the years 2010–2021 and, at the same time, high absorption of the EU funds devoted to the development of a particular factor. Group 2 includes those NUTS-3 units in which a significant change in the development of the researched capital occurred despite a relatively low EU fund absorption towards the development of the factor. Group 3 was composed of the NUTS-3 subregions with a relatively low EU fund absorption supporting the development of a researched factor as well as a relatively low synthetic gauge. Group 4 included units of the lowest efficiency of the Community means used – despite the above average EU fund absorption, the development of a particular factor within the years 2010–2021 was completed to a low degree.

At the next step of the research, simple linear regression models between the variables were researched within the respective factors of the development (Table 4). A positive direction correlation was observed between the extent of the EU fund absorption supporting the development and the changes in the level of development as of 2010–2021 in the case of the natural environment, the economy, as well as the development as a whole (Table 5). In the case of the "society" subcomponent, a negative correlation was registered.

Table 4. Linear regression models between the researched variables

Factor of development	The pattern of the regression model
Society	y = 0.3986 – 0.0000100*x
The natural environment	y = 0.5493 + 0.0000023*x
The material capital	y = 0.3409 + 0.0000308*x
Total socio-economic development	y = 0.3885 + 0.0000153*x

Source: own research.

Based on the selected statistics of the models obtained based on the classical method of the smallest squares, the explanatory value of the regression functions received was assessed as relatively low (alternatively average). The highest value of the R^2 determination coefficient was obtained in the case of the model specified for the economy (0.14). In the case of this factor of development, the changeability of the dependent variable has thus been explained through the independent variable in 14%. One may thus conclude that the direction of EU fund intervention supporting the development of the economy was correct, and the proper direction of the EU fund intervention in the development of the economy has been confirmed by means of a high EU fund absorption devised for that purpose, a large number of the innovative enterprises established as well as the modern solutions implemented in the economy. The best quality of the regression model calculated for the "economy" factor is also confirmed by the fact

that the explanatory value turned out to be significant already at a very low level of significance of 0.02% (the *p*-value for the parameter and the F-Snedecor statistics (Nowak, 2018) – the likelihood of making a mistake). One may thus conclude that in the case of the "economy" development subcomponent, a regression model states the correct–positive correlation between the EU fund absorption and the change in the development of that factor.

Table 5. Parameters stating the quality of regression models within the arrangement of the respective factors of the socio-economic development

Description	Society	The natural environment	Material capital	The development as a whole
The correlation: absorption vs development	negative	positive	positive	positive
The R^2 determination coefficient	0.46%	0.03%	**14.06%**	10.62%
Value p for the F test	51.2%	86.38%	**0.02%**	0.13%
The standard error of a statistic	7.15%	5.56%	4.96%	**4.24%**
The sum total of residual squares	47.58%	28.71%	22.88%	**16.76%**
The residual variability coefficient	18.29%	10.09%	12.92%	**9.85%**
Akaike'a information criteria	**-229.58**	-277.57	-299.13	-328.72

Source: own research.

A synthetic gauge of the empirical value dispersion around the theoretical values is the standard variation of the residual component. It informs about the average variable of the empirical values of the explanatory value from the theoretical values received from the regression functions. The higher the values of the standard variation of the residual component, the statistical "goodness" of the matching of a particular regression function to empirical data decreases (Nowak, 2018). In the research conducted, positive residuals and negative residuals were identified. Positive residuals indicate that the observed size of the explanatory variable is higher than the expected one, resulting from the model; the negative residual, however, proves the reverse situation. The lowest value of the standard error of the residual is registered in the case of the model assessed for the level of socio-economic development in total (4.24%). Relatively short distances of the trend line observation, and through that, quite a good matching of the model is proved by the fact that the sum of residual squares constitutes only 16.76% of the average for the change in the level of development in total. Moreover, the model may be considered to be relatively well-matching as the value of its coefficient was 9.85%[6] (such a part of the average value of the explanatory variable constitutes

[6] In the subject literature, the regression model is considered to be admissible when the residual variability coefficient assumes a value lower than 20%.

its standard residual variability). The real change in the level of socio-economic development in total in the NUTS-3 units in Poland, the Czech Republic, and Slovakia – apart from a few cases – is that the value obtained is not much different from the value obtained from the regression model.

Conclusions

Summarising the research conducted in this article concerning the impact of the spatial variation of the EU fund absorption on the changes in the level of socio-economic development as well as the respective factors of the development in the subregional dimension, i.e. within the arrangement of the NUTS-3 units in Poland, the Czech Republic, and Slovakia, one may thus conclude that a positive correlation between the extent of the EU fund absorption per capita and the change in the level of development was identified in the case of the natural environment, the economy as well as the development in total. In the case of the society, a negative correlation is registered. One may thus note that the absorption of the EU funds has positively impacted the development of those factors (the subcomponents of the development), within which the most EU fund allocations were made accessible, which is related to at least the economies of scale. A negative impact was registered in the case of those factors in which the intervention turned out to be relatively low, and the means have been wasted to a large extent.

Among all the regression functions, the best quality is the model built within the framework of the analysis of the level of development of the economy, which was characterised as the best match, and the explanatory variable turned out to be significant already at a very low level of significance of 0.02%. A satisfactory quality of the model may also result from a liberal approach to the manner of characterising the factor of the development as well as its broad indirect indexing. Based on the analysis of the residuals, a model built within the analysis of the socio-economic development in total was considered to be the one best matching reality, in the case of which the respective coefficients assumed the lowest values. Summarising the research conducted, one should thus conclude the absorption of the EU funds to the largest extent impacted the changes in the level of the development of the economy in the researched subregions of the NUTS-3 level. It attests to the correct direction of the EU fund intervention, the funds which were devised for the purpose of the development of the economy. For the specific factor of the development, most funds from the general EU budget were directed (43% of the funds accessible), and the results of the EU economy support fund absorption are visible in a relatively short period of time, a phenomenon that is not experienced in the case of the society factor, within which the results of EU fund implementation are visible only in the long-term perspective.

In relation to the abovementioned, it is well worth concluding that in the context of the research conducted, one may not single-handedly point to the correlation between the EU fund absorption and the change in the level of the socio-economic development, and the results of the research procedure conducted are based solely on a statistical dependency, thus their interpretation must be approached with care.

It is beyond doubt that EU funds made a positive impact on the socio-economic development of the subregions in Poland, the Czech Republic, and Slovakia. It is very difficult to specify in a definite manner the scale of the impact as the development registered in research resulted from the interplay of different kinds of stimuli and many other factors (such as, for example, the COVID-19 pandemic). Moreover, it is well worth noting that in the case of the society, within which a negative correlation was observed, the results of projects co-funded from the EU funds shall be visible in a longer time period; therefore, they have not been fully considered in the research conducted. Furthermore, measuring the state of the natural environment is difficult, at least with respect to a lack of widely accessible objective indicators that would relate to the indicated factor of the development directly.

With respect to the specificity of spending the means from the EU general budget, it is well worth considering the extension of the research period in order to take into consideration the long-term impact of the EU support funds. Moreover, the authors of the further stages of the research project intend to expand their scope, first to Hungary to analyse the entire Visegrad Group, and then to include additional countries of Central and Eastern Europe: Romania, Bulgaria, Lithuania, Latvia and Estonia. The results of the conducted research procedure could, for example, be used by European Union institutions in planning the next programming period in terms of allocating EU funds between European regions.

BIBLIOGRAPHY

Albulescu, C., Goyeau, D. (2014). EU Funds Absorption Rate and the Economic Growth. *Timisoara Journal of Economics and Business, 6*(20), 25–26.

Baklanov, P. Y. (2020). Geopolitical Factors in Regional Development. *Customs Policy of Russia in the Far East, 93*(4), 75–83. DOI: 10.24866/1815-0683/2020-4/75-83.

Balcerzak, A. P. (2016). Multiple-criteria evaluation of quality of human capital in the European union countries. *Economics and Sociology, 9*(2), 11–26. DOI: 10.14254/2071-789X.2016/9-2/1.

Beugelsdijk, S., Klasing, M. J., Milionis, P. (2018). Regional economic development in Europe: the role of total factor productivity. *Regional Studies, 52*(4), 461–476. DOI: 10.1080/00343404.2017.1334118.

De Castro, E. A., Marques, J., Viegas, M. (2018). The Schumpeter creative destruction hypothesis: A spatial assessment on Portuguese regions. *Global Business and Economics Review*, *20*(2), 198–212. DOI: 10.1504/GBER.2018.090069.

Diebolt, C., Hippe, R. (2019). The long-run impact of human capital on innovation and economic development in the regions of Europe. *Applied Economics, 51*(5), 542–563. DOI: 10.1080/00036846.2018.1495820.

Dreyer, L. C., Hauschild, M. Z., Schierbeck, J. (2006). A framework for social life cycle impact assessment. *International Journal of Life Cycle Assessment, 11*(2), 88–97. DOI: 10.1065/lca2005.08.223.

Feldman, M. P. (1999). The new economics of innovation, spillovers and agglomeration: Areview of empirical studies. *Economics of Innovation and New Technology, 8*(1–2), 5–25. DOI: 10.1080/10438599900000002.

Florida, R. (2002). The economic geography of talent. *Annals of the Association of American Geographers, 92*(4), 743–755. DOI: 10.1111/1467-8306.00314.

Goryachikh, M. V., Kravchenko, L. A. (2020). Free economic zone as a factor of regional economic development. *Scientific Bulletin: Finance, Banking, Investment, 2*(51), 213–222. DOI: 10.37279/2312-5330-2020-2-213-222.

Jašková, D., Havierniková, K. (2020). The human resources as an important factor of regional development. *International Journal of Business and Society, 21*(3), 1464–1478. DOI: 10.33736/ijbs.3364.2020.

Khasanova, A., Amirova, N., Sargina, L. (2020). Natural resource potential as a factor of regional development. *CITISE, 24*(2), 234–245. DOI: 10.15350/2409-7616.2020.2.22.

Krugman, P. (1998). What's new about the new economic geography? *Oxford Review of Economic Policy, 14*(2), 7–17. DOI: 10.1093/oxrep/14.2.7.

Matsuura, M. (2015). Contribution of EU Funds to Economic Growth in Poland. *Russian and East European Studies, 44*, 87–98. DOI: 10.5823/jarees.2015.87.

Naydenov, K. (2019). Human resources development as a factor for regional development. *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 19*(5.4), 475–481. DOI: 10.5593/sgem2019/5.4/S23.063.

Nowak, P. (2018). Regional variety in quality of life in Poland. *Oeconomia Copernicana, 9*(3), 381–401. DOI: 10.24136/oc.2018.019.

Shikverdiev, A. P., Oganezova, N. A., Mazur, V. V., Obrezkov, N. I., Ichetkina, M. A. (2019). Development of regional competitiveness as a factor in creating a favorable business environment. *Espacios, 40*(28), 1–6.

Spychała, M. (2020). The absorption of EU funds and the socio-economic development in the subregional dimension in Poland. *Prace Naukowe Uniwersytetu Ekonomicznego We Wrocławiu, 64*(3), 78–91. DOI: 10.15611/pn.2020.3.07.

Yun, J. H. J., Won, D. K., Park, K. B., Yang, J. H., Zhao, X. (2017). Growth of a platform business model as an entrepreneurial ecosystem and its effects on regional development. *European Planning Studies, 25*(5), 805–826. DOI: 10.1080/09654313.2017.1282082.

Summary

Within the EU cohesion policy, higher and lower developed regions, taking into account only GDP *per capita*, are subcategorised. Based on that, areas qualifying for obtaining support from aid programs of the general EU budget are established. The aim of the article is to attempt to specify the co-dependency between the absorption of EU funds and the changes in the level of

socio-economic development in the regional dimension. The research was conducted at the level of 95 NUTS-3 units in Poland, the Czech Republic, and Slovakia in three stages. In the first stage, the level of the development of the subregions in Poland, the Czech Republic, and Slovakia is exhibited, subcategorising three factors of that growth based on 31 indicators: "the society", "the economy", or "the natural environment". In the second stage, the variation in the absorption of EU funds in the researched units is demonstrated. In the third stage, the co-dependencies between the extent of the absorption and the changes in the development within the arrangement of the factors of that development are specified. In the article, a hypothesis is verified according to which the absorption of the EU funds impacted, above all, the development of "the economy" component. As a result of the examination conducted, it has been concluded that the absorption of EU funds impacted the changes in the level of the development of the "economy" sector to the largest extent. It confirms the proper direction of the EU fund intervention, which was made accessible above all to the benefit of the development of that factor.

Keywords: EU funds, socio-economic development, synthetic gauge.

Znaczenie absorpcji funduszy Unii Europejskiej w rozwoju społeczno-gospodarczym podregionów Polski, Czech i Słowacji

Streszczenie

W ramach polityki spójności UE wyodrębnia się regiony lepiej i gorzej rozwinięte biorąc pod uwagę jedynie wartość PKB *per capita*. Na tej podstawie ustala się m.in. obszary kwalifikujące się do uzyskania wsparcia z programów pomocowych budżetu ogólnego UE. Celem artykułu jest próba określenia zależności pomiędzy absorpcją funduszy unijnych a zmianami poziomu rozwoju społeczno-gospodarczego w ujęciu regionalnym. Badania przeprowadzono na poziomie 95 jednostek NUTS-3 w Polsce, Czechach i Słowacji w trzech etapach. W pierwszym etapie określono poziom rozwoju podregionów w Polsce, Czechach i Słowacji, wyodrębniając na podstawie 31 wskaźników trzy czynniki tego rozwoju: „społeczeństwo", „gospodarkę" oraz „środowisko naturalne". W drugim etapie przedstawiono zróżnicowanie absorpcji funduszy unijnych w badanych jednostkach. W trzecim etapie określono zależności pomiędzy wielkością absorpcji a zmianami poziomu rozwoju w układzie czynników tego rozwoju. W artykule postanowiono zweryfikować hipotezę, według której absorpcja funduszy unijnych wpłynęła przede wszystkim na rozwój składowej „gospodarka". W rezultacie przeprowadzonego badania stwierdzono, że absorpcja funduszy unijnych w największym stopniu wpłynęła na zmiany poziomu rozwoju „gospodarki". Potwierdza to właściwy kierunek interwencji środków UE, które były udostępniane przede wszystkim na rozwój tego czynnika rozwoju.

Słowa kluczowe: fundusze unijne, rozwój społeczno-gospodarczy, miernik syntetyczny.

JEL: O11, O20, O47.

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The conditions and change tendencies of the innovativeness of the Polish economy against the background of selected European countries

Introduction

Scientific and technological progress has a special importance in the contemporary economy. Knowledge in its strategic dimension is regarded as a key production factor. Changes in knowledge resources and their implementation decide the role of a given economy in the world. The competitive potential and strategic positions of national economies largely depend on their ability to create, implement and domesticate advanced scientific-technological solutions. They must also effectively utilise human (including intellectual) capital and secure funding that matches their needs in both external and internal markets (Dzhukha et al., 2017). In these circumstances, a special role is played by innovativeness or the ability of a firm or an economy to create, implement and absorb innovation. States characterised by low innovativeness experience slower socio-economic development. Innovation is the only way for the most developed countries to secure sustainable long-run productivity growth (Bloom et al., 2019, pp. 5–31). It is a major part of international economic competitiveness and continuing and sustainable development.

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In this connection, special attention must be paid to countries ranking low in the annual European Innovation Scoreboard (EIS). Its methodology helps to compare innovation systems of particular economies by means of an index based on some appropriately selected partial indicators. The SII (Summary Innovation Index) is the weighted arithmetic mean of a number of innovative characteristics (Wich, 2017, p. 102). Through an examination of the specific metrics included in SII, it is possible to determine which ones primarily represent advantages and disadvantages for the development of innovativeness. This will serve as the foundation for the government's policies to restrict and lessen them.

Poland has a low ranking, so the goal of this study is to compare the innovativeness of the Polish economy to that of a few chosen European nations, as well as to ascertain the factors that influence and alter these trends. Indicating which components of the SII are important to determining the level of innovativeness and which are the most serious barriers in this respect is of particular importance. In this way, it will become possible to define the causes of the distance between the Polish economy and the innovation leaders.

Based on the specialist literature and the authors' observations, the following research hypothesis is put forward – H: The causes of low innovativeness in Poland are varied and multidimensional, and more spending on research and development should be the starting point for its improvement.

THEORETICAL BACKGROUND

The literature lacks a universal, homogeneous and standard definition of innovation due to the latter's weight and role in economic development and the research perspectives adopted.

The concept was introduced to the specialist literature by J. Schumpeter, who defined it as "a new combination" of production factors leading to the emergence of new products, new production methods, new organisational links, new sale markets, new sources of raw materials or intermediate products, a new organisation of an enterprise in the market (Schumpeter, 1960, pp. 104, 118). He referred to the correlation between innovation and development as "creative destruction". Therefore, the greater the innovation's revolutionary nature, the more conspicuous and simultaneously both destructive and constructive is its influence on the advancement of progress and development (Sieradzka, 2021, p. 218).

J. Schumpeter's ideas were taken up by P. F. Drucker, who identified innovations with tools for entrepreneurs and the sources of wealth through new economic activities or supply of new services (on their first application). He also stressed that innovation and entrepreneurship had become integral parts of economic activities, an impulse to the development of enterprises and the whole economy (Drucker, 1992, p. 29). The approach to innovation has expanded to include improvements

to existing products and services. M.E. Porter (2001, p. 202) points out that even a minor change to the existing processes, methods or products generates economic benefits, technological improvements and broadly defined progress. M.E. Porter's concept is reflected in how innovation is defined in the guidelines of the Oslo Manual. It states that an innovation is "a new or improved product or process (or a combination thereof) substantially different to the earlier products or processes of an entity which has been made available to potential users (product) or put to use by the entity (process)" (OECD, 2018, p. 20).

Various innovations are discussed in the literature, depending on the criteria of division and the goals to be served. Broad and narrow objective approaches are distinguished. As part of the former, each change to the formation, acceptance and application of new concepts, products and services can be treated as innovation. This view is shared by J. Schumpeter (1939), V.A. Thompson (1969), Ph. Kotler (1994), R.L. Draft and A. Amstrong (2012), among others. The requirement of a precise description of the nature of innovation is of utmost importance in narrow terms (Mansfield, 1968; Freeman, 1982; Sopińska, Wachowiak, 2016).

Innovative activity is an arranged set of scientific, technical, organisational, financial, managerial and commercial actions conducted in order to work out and implement innovations (Baruk, 2015, p. 125). It leads to economic progress and is a potential factor in meeting global social challenges. Innovative activity, besides physical and human capital (Wang, 2013; Kansy, 2018, p. 112), is becoming a key factor in determining economic growth (Asheim et al., 2016; Kergroach, 2016). Innovation activity turns out to be a result of vibrant market developments as well as industrial policy, living standards, innovation activity state and regional backings, socio-economic stability and entrepreneurship revitalisation at all levels, including the regional macro-level (Kuznetsov et al., 2017, p. 396).

Innovativeness is a term derived from innovation. It is most commonly defined as the readiness and ability of entities and organisations to search for, implement and diffuse innovation and other (creative and imitative) changes which lead to the emergence of new values in an economy and the adoption of foreign scientific and technical accomplishments.

According to Pangsy-Kania (2007, p. 58), the innovativeness of an economy is understood as the entrepreneurs' ability and motivation to continue searching for and using in-practice research and development, new ideas, concepts and inventions to improve and develop the existing production, operation and service technologies, introduce new solutions to organisation and management, as well as to improve and develop the infrastructure. However, entrepreneurs' ability and motivation require support through a national innovation system. S. Metcalfe (1995, p. 116) points out that a national innovation system is formed by two key factors: 1) the area of research and development work as the source of innovation and the industrial enterprise sector; 2) state institutions and structures that support the creation and

implementation of innovation. An innovation system is seen as an instrument supporting the realisation of programmes that are part of the innovation policy. The significance of cooperation is emphasised between researchers, business and politics, where innovativeness is perceived as a significant factor in conditioning the good state of an economy (Kokot, Pryciak, 2019, p. 93). The state is the most important subject of an innovation policy as it assumes the burden of financing innovation and R&D (Lent et al., 2018, p. 445). The creation of an effective national innovation system (NIS) is the most crucial task of the scientific, technological and innovation policies of each state (Karasev et al., 2018, p. 702). The innovativeness of an economy depends not only on the normal functioning of the particular institutions, but also on the correct management of the system actors and the environment (Szajt, 2008, p. 34).

The models of the innovation creation process by the science and business sectors have evolved along with globalisation. The currency of a non-linear model based on network connections is underlined, with the rate and effectiveness of introducing innovation acquiring more importance (Kaliszczak, Sieradzka, 2018, p. 78). The open innovation model places a special emphasis on intensive contacts and knowledge sharing in the process of creating innovation (Chesbrough, 2006; Inauen, Schenker-Wicki, 2011, p. 479; Poznańska, 2018, pp. 20–21; Rodriguez, Lorenzo, 2011, pp. 77–84).

Limitations to innovative activities are largely a result of the transfer and diffusion of new technology. The following barriers to technology transfer in highly developed countries are mentioned (Kirkland, 1999): legal (intellectual property rights); financial (the insufficient financing of innovative activities); the poor qualifications of the workforce; barriers to communication between the representatives of science and industry; technical barriers. The problems of new product commercialisation include (Poole, Moore, 2002, p. 22): imperfect information; uncertainty and costs of searching; high transaction costs; an inadequate demand for and supply of research and development results. In Poland, some barriers to innovativeness are identified, which are correlated with a stage of innovation creation (Frankowski, Skubiak, 2012, pp. 120–129).

Concerning the limitations of domestic technology transfer, key barriers – particularly important ones – and other obstacles are highlighted (Jasiński, 2006, pp. 150–151). The first class comprises: a low openness and insufficient readiness of research and development institutions to cooperate with business; an inefficient system of innovative activity support; insufficient (own and external) funding; the absence of innovative culture in enterprise actions. The especially important barriers encompass: the bypassing of the research and development sector by foreign direct investment; poor innovation absorption by the economy; the inefficiency of the technology transfer infrastructure; a lack of adequate funding from the national innovation system.

Methods

The need to identify the conditions of innovativeness of the Polish economy arises from its persistently low standing against the background of the European Union countries. The Synthetic Summary Innovation Index (SII), featured in the European Innovation Scoreboard (EIS) report, is employed to gauge innovativeness in both European Union countries and non-EU states (EIS, 2021). It contributes to the annual ranking of the innovation systems of these countries. According to the 2021 report, Poland is positioned as the fourth-lowest, surpassing only Lithuania, Bulgaria and Romania.

The innovativeness of the Polish economy, compared with some selected European countries, is studied for the years 2014–2021. The choice of the countries draws attention to the distance between the Polish economy and:

- The innovation leaders in Europe – Sweden, Finland, Denmark and Belgium;
- The biggest European Union economies – Germany and France;
- Spain – quite often compared to Poland due to their similar populations;
- The countries of the so-called "Visegrad Group" – Czechia (The Czech Republic), Slovakia and Hungary, which joined the EU at the same time (2004) and have been undergoing systemic transformations like Poland.

The cognitive value of the paper consists of studying the causes of the innovativeness distance of the Polish economy with reference to selected, not all countries (the latter comparison is the object of a prevailing majority of the relevant literature). This approach will provide a clearer evaluation of the strengths and weaknesses of the innovation system in Poland and some recommendations for improving the innovativeness level.

The data is sourced from the European Statistical Office Eurostat publications and the European Innovation Ranking from 2021. The innovativeness of the Polish economy is compared to selected EU countries using the EIS methodology and some methods of numerical data analysis: the method of time series; of cross-sectional data; the analysis of phenomena dynamics; comparative analysis.

Results

The European Innovation Ranking, published in 2021, presents the innovation and research results of the European Union countries in 2021 with reference to 2014. In that period, the average innovativeness performance in Europe grew by 12.5%. The EU is better than China, Brazil, South Africa, Russia and India, and is outranked by South Korea, Canada, Australia, the United States and Japan. South Korea is the most innovative country – its result was 36% greater than the EU in 2014 and 21% higher in 2021.

Figure 1 shows the EU-28 countries' ranking in 2014 and 2021. The countries are ranked in descending order based on the 2021 SII. An analysis of the 2019 edition of the SII indicates that some countries are highly developed, while others lag considerably. The countries with the highest indicator value in 2021 were Sweden, Finland, Denmark and Belgium, while Poland, Latvia, Bulgaria, Romania, Slovakia, Hungary and Croatia displayed the lowest values. These countries are classified as emerging innovators in the current edition (EIS, 2021).

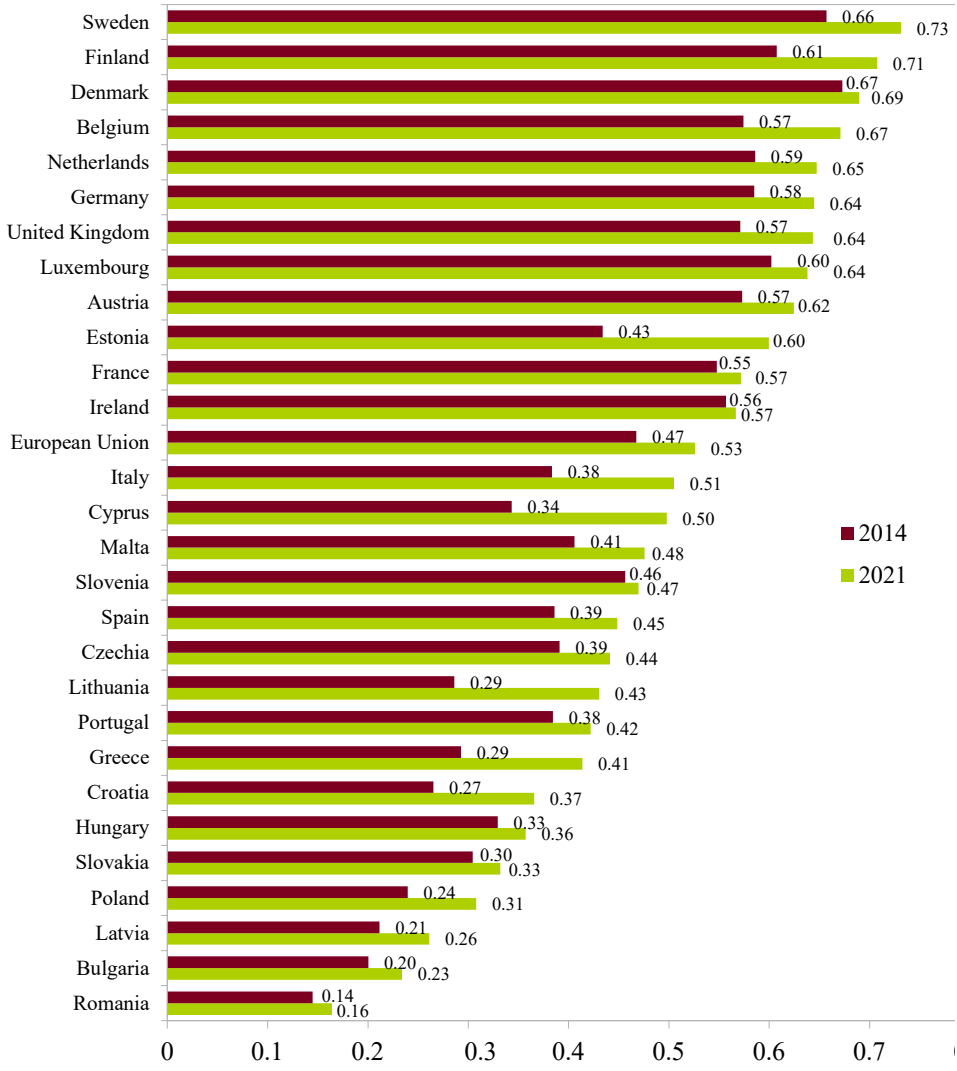

Figure 1. The performance of EU member states' innovation systems according to SII

Source: Authors' work based on EIS (2021).

The figures in Table 1 point to Poland's bottom ranking in the group of selected countries. The distance to the innovation leader is considerable – in 2021, the SII in Poland was lower by 0.423, or 41.4%. However, Poland dramatically improved its innovativeness in the period surveyed – the index had risen by 28.3 percentage points by 2021. Four main types of indicators are taken into account when assessing the Summary Innovation Index: 1) framework conditions; 2) investments; 3) innovation activities and impacts; 4) 12 innovative dimensions that comprise a total of 32 indicators (EIS, 2021).

Table 1. The SII values for selected countries in 2014–2021

Country/ year	2014	2015	2016	2017	2018	2019	2020	2021	Change dynamics 2021/2014
EU	0.467	0.473	0.477	0.482	0.487	0.506	0.513	0.526	112.63
Sweden	0.657	0.661	0.661	0.677	0.685	0.694	0.692	0.731	111.26
Finland	0.607	0.615	0.622	0.620	0.629	0.670	0.681	0.708	116.64
Denmark	0.673	0.674	0.673	0.656	0.664	0.681	0.683	0.689	102.38
Belgium	0.574	0.584	0.588	0.604	0.618	0.634	0.637	0.671	116.90
Germany	0.585	0.582	0.577	0.587	0.594	0.606	0.613	0.645	110.26
France	0.548	0.551	0.556	0.577	0.580	0.574	0.582	0.572	104.38
Spain	0.386	0.395	0.392	0.411	0.416	0.432	0.444	0.449	116.32
Czechia	0.391	0.402	0.404	0.403	0.407	0.425	0.431	0.441	112.79
Hungary	0.330	0.338	0.340	0.337	0.337	0.329	0.341	0.357	108.18
Slovakia	0.304	0.313	0.319	0.324	0.304	0.321	0.335	0.332	109.21
Poland	0.240	0.246	0.254	0.267	0.274	0.286	0.295	0.308	128.33

Source: Authors' work based on EIS (2021).

The indicators contained in Table 2 determine the long-term development prospects of Poland concerning its innovation capacity. An analysis of the 12-part indicators of Poland against the background of selected EU countries shows Poland to score a minimum of 6 (Innovators, Employment Impacts, Attractive Research Systems, Environmental Sustainability, Sales Impacts, Use of Information Technologies – 2021 values).

The low number of innovators (0.09), expressed as SMEs introducing product innovations as a percentage of SMEs and SMEs introducing business process innovations as a percentage of SMEs, is the most significant barrier to innovativeness.

The low value of SII is next determined by the partial indicator of employment impacts (0.15), meaning employment in knowledge-intensive activities as a percentage of total employment (employment in medium-high and high-tech manufacturing and knowledge-intensive services) and employment in innovative enterprises (its value is significantly low).

The attractive research system (0.18) is another weakness of the innovation system in Poland. It consists of an assessment of international scientific co-

Table 2. Twelve (part) indicators included in the SII for selected countries in 2014 and 2021

Index	Sweden		Finland		Denmark		Belgium		Germany		France		Spain		Czechia		Hungary		Slovakia		Poland	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Framework conditions																						
Human resources	0.86	0.80	0.70	0.74	0.80	0.76	0.47	0.50	0.38	0.43	0.64	0.65	0.43	0.61	0.33	0.36	0.22	0.18	0.29	0.33	0.28	0.28
Attractive research systems	0.67	0.74	0.49	0.64	0.70	0.78	0.65	0.71	0.39	0.42	0.57	0.54	0.43	0.42	0.23	0.34	0.20	0.32	0.15	0.26	0.11	0.18
Digitalisation	0.66	0.92	0.72	0.95	0.83	0.95	0.57	0.72	0.53	0.70	0.44	0.53	0.49	0.79	0.41	0.50	0.58	0.75	0.43	0.51	0.27	0.52
Investments																						
Finance and support	0.57	0.67	0.55	0.68	0.52	0.64	0.54	0.72	0.45	0.53	0.76	0.86	0.39	0.41	0.44	0.40	0.46	0.48	0.15	0.15	0.24	0.32
Firm investments	0.78	0.77	0.63	0.61	0.62	0.43	0.57	0.76	0.75	0.86	0.48	0.53	0.24	0.34	0.36	0.47	0.37	0.34	0.28	0.31	0.32	0.32
Use of information technologies	0.91	0.91	0.97	1.00	0.76	0.77	0.78	0.79	0.62	0.56	0.44	0.44	0.44	0.46	0.47	0.58	0.36	0.38	0.31	0.41	0.21	0.39
Innovation activities																						
Innovators	0.56	0.89	0.57	0.78	0.47	0.73	0.63	0.79	0.64	0.93	0.53	0.64	0.15	0.19	0.42	0.55	0.13	0.22	0.22	0.17	0.02	0.09
Linkages	0.64	0.70	0.55	0.71	0.74	0.75	0.64	0.70	0.45	0.61	0.39	0.51	0.30	0.39	0.30	0.35	0.21	0.37	0.18	0.22	0.24	0.31
Intellectual assets	0.71	0.69	0.69	0.70	0.73	0.73	0.43	0.39	0.77	0.64	0.43	0.35	0.38	0.33	0.28	0.25	0.18	0.20	0.17	0.20	0.31	0.35
Impacts																						
Employment impacts	0.65	0.74	0.58	0.69	0.50	0.58	0.60	0.70	0.68	0.70	0.52	0.54	0.31	0.27	0.40	0.43	0.27	0.22	0.21	0.23	0.13	0.15
Sales impacts	0.54	0.69	0.48	0.64	0.62	0.47	0.54	0.66	0.74	0.77	0.63	0.56	0.43	0.46	0.56	0.61	0.57	0.59	0.44	0.50	0.37	0.39
Environmental sustainability	0.49	0.52	0.50	0.46	0.73	0.76	0.54	0.69	0.66	0.69	0.63	0.66	0.59	0.66	0.52	0.55	0.54	0.42	0.60	0.64	0.27	0.36

a – 2014; b – 2021

Source: Authors' work based on EC (2021).

publications per million population, scientific publications among the top 10% most cited publications worldwide as a percentage of total scientific publications of the country and foreign doctorate students. The latter is particularly low.

Poland scores lower than the selected countries in such areas as environmental sustainability (0.36), sales impacts (0.39) and use of information technologies (0.39). It should be pointed out, though, that a component of environmental sustainability – environment-related technologies – ranks high. Poland's index in 2021 is highest in the areas of digitalisation (0.52), ahead of Czechia and Slovakia and similar to that of France (0.53) (Table 2). Compared with 2014, the value of the digitalisation indicator has risen by 92.6 percentage points (from 0.27 to 0.52). This is an indubitable asset in driving a more dynamic development of innovativeness for both enterprises and the economy.

The intellectual assets indicator is quite good (0.35), with Poland ranking equal to France and ahead of Spain, Czechia, Hungary and Slovakia in 2021. This index encompasses such partial indicators as PCT patent applications, trademark applications, and design applications. Their values vary greatly – design applications are strong, whereas PCT patent applications are weak. The two remaining factors – finance and support and firm investments – are similar (0.32). In this respect, Poland outranks Slovakia, yet France and Belgium exhibit nearly twice higher values (Table 2).

The support for innovativeness is realised with R&D spending in the enterprise and public sectors, investment spending, enterprise investments, and non-R&D innovation expenditure. Their values are compared with the EU scores in 2021 compared to 2014 (Table 3).

Table 3. The results of selected countries in comparison to the EU in 2021

Country	R&D expenditure in the public sector	Venture capital expendi-ture	R&D expenditure in the busi-ness sector	Direct and indirect government support of business R&D	Non-R&D innovation expenditure	Innovation expenditure per employee
Sweden	136.8	219.9	188.2	88.8	75.8	186.5
Finland	133.3	304.1	140.2	41.1	77.6	142.3
Denmark	156.1	212.1	139.4	45.6	124.6	47.6
Belgium	115.8	194.0	156.7	169.6	106.9	186.5
Germany	142.5	136.4	168.5	47.2	160.8	186.5
France	94.7	292.8	109.4	213.4	64.7	137.8
Spain	63.2	172.5	51.2	58.0	80.6	76.3
Czechia	98.2	21.4	90.6	93.4	124.6	73.9
Hungary	31.6	124.3	83.5	174.7	67.3	55.6
Slovakia	35.1	25.0	31.5	27.8	105.7	55.6
Poland	54.4	61.9	61.4	86.9	87.9	48.2

Source: Authors' work based on EIS (2021).

The figures in Table 3 prove Poland is far ahead of Slovakia out of the 'Visegrad Group' countries on most partial indicators, yet the values displayed by the two remaining countries, Hungary and the Czech Republic, show more commitment to business expenses and direct and indirect government R&D support for enterprises. The values of innovation expenditure per employee are more than four times higher in the innovation leaders (except Denmark, where this spending is comparable to Poland's).

Poland ranks last but one (ahead of Slovakia) regarding enterprises spending most on R&D. The indicator value of 0.88 demonstrates the enormous distance between Poland and innovation leaders, as well as strong European economies like Germany and France (Table 4).

Table 4. Indicator of enterprise's spending on R&D activities

Country	Enterprises spending on R&D
Sweden	75.95
Finland	62.21
Denmark	76.97
Belgium	28.80
Germany	26.07
France	16.67
Spain	4.40
Czechia	1.25
Hungary	1.02
Poland	0.88
Slovakia	0

Source: Authors' work based on EIS (2021).

Gross national R&D expenditure (GERD) – i.e., total internal spending on R&D activities and internal R&D expenditure in the business sector (BERD) – must be taken into consideration when analysing an economy's level of innovativeness. The levels of R&D expenditure by the higher education sector (HERD) and the government sector (GOVERD) are also important.

Table 5. The relation of internal R&D expenditure to GNP (%) by executive sectors in 2014–2021 in Poland

Detailing	2014	2015	2016	2017	2018	2019	2020	2021
GERD/ GNP	0.94	1.00	0.96	1.03	1.21	1.32	1.39	1.43
BERD/GNP	0.44	0.47	0.63	0.67	0.80	0.83	0.88	0.91
GOVERD/GNP	0.23	0.24	0.02	0.02	0.02	0.02	0.03	0.03
HERD/GNP	0.27	0.29	0.3	0.34	0.38	0.47	0.48	0.50

Source: Authors' work based on Eurostat data (https://ec.europa.eu/eurostat) and GUS, *Research and development activities in Poland in 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021* https://stat.gov.pl/.

The intensity of R&D work continued to grow in the period analysed, from 0.94% in 2014 to 1.43% in 2021 (Table 5). As far as the business sector is concerned, the relation increased from 0.44% to 0.91%, reaffirming the positive shifts in the private sector's R&D activities in recent years.

Despite a distinct growth of the relation of R&D expenditure to GNP, Poland is still far away from the national objective set for 2020, namely, a GERD/GNP indicator of 1.7%. The desire to reach this goal means boosting efforts to intensify R&D activities in the near future is necessary.

In 2014–2021, the business sector incurred a bulk of the total internal spending on R&D work (BERD/GNP). The indicator reached 0.91% in 2021, more than twice the value recorded in 2014 (Table 5). The gradually rising share of the enterprise sector in the internal R&D expenditure was paralleled by a shrinking share of the government sector – from 0.23% in 2014 to 0.03% in 2021. R&D expenditure of the higher education sector continued to grow year by year.

In striving for economic growth and improved living conditions in its Europe 2020 programme, the European Union indicates the need to increase R&D spending to 3% GNP. This goal was only attained by three member states in 2021: Belgium (3.43%), Sweden (3.40%) and Germany (3.13%). The Polish economy is among the states spending the least on research and development (1.43%). Lower ratios were noted only by the Hungary and Slovakian economies (1.40% and 0.92%, respectively) (Figure 2).

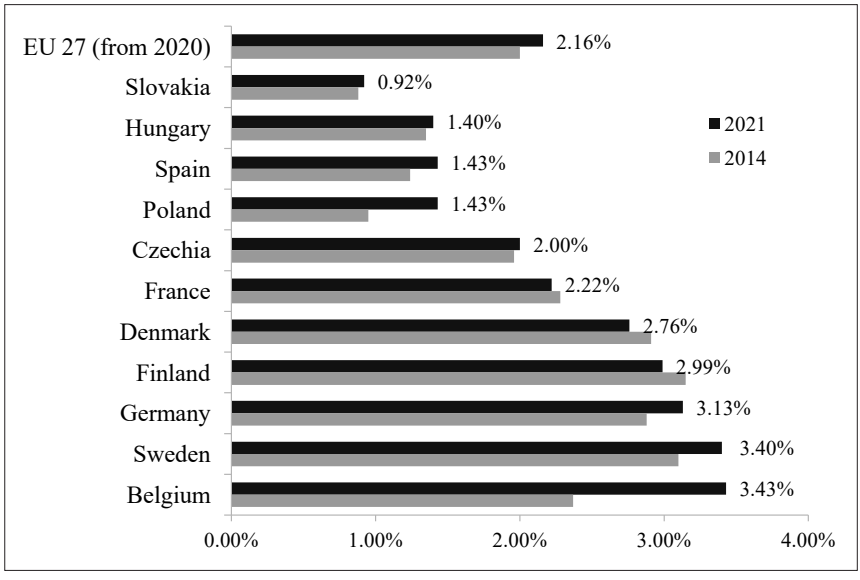

Figure 2. Gross domestic expenditure on R&D (GERD) in selected countries in 2014–2021 (in %)

Source: Authors' work based on *Gross domestic spending on R&D*. https://data.oecd.org/rd/gross--domestic-spending-on-r-d.htm.

CONCLUSION

The 21st century is called 'the age of innovation'; however, a gap continues between the particular countries as far as the creation and transfer of knowledge and innovation are concerned. The analysis of international figures and reports demonstrates Poland's low standing in this respect. "The low level of innovative and technological development is discussed by Firley and Firley (2015, p. 204), who stated that to ensure the achievement of economic and social cohesion, a competitive economy based on knowledge and cooperation of enterprises, administration and sciences should be created" (Bernat, Jasek, 2018, p. 24).

Public institutions in Poland should focus on building the national innovative potential to bridge the gap in private innovation spending and attract foreign direct investments with their high shares of development work. Strengthening the area of R&D will be of paramount importance to the future development of Poland; however, given the huge difference between business expenditure on research and development in comparison with the innovation leaders and the share of research and development expenditure in GNP, Poland's standing is not going to improve soon. R&D spending did grow, but too slowly for the needs in place. The progress in digitalisation is an advantage. Poland invested in boosting saturation with broadband connections in the years under discussion.

The issue of improving innovativeness should be seen in the context of building an innovation system, including linkages and cooperation between science and business. The attractiveness of research systems persists as a weakness of innovation in Poland. Investment in skill development and research and development potential of enterprises are key challenges to the national innovation system. The Polish innovation policy should consider market instruments to a greater extent by adapting the mechanisms of business R&D support applied to the prevailing trends in developed economies. Increased support is recommended for private research and development initiatives and the development of high technology industries, especially with a view to financing the absorption of technology and modernisation of business infrastructure as well as to enhance the insufficient human capital resources in the high technology sector.

Actions for improved innovativeness should, first of all, foster a culture of entrepreneurship relying on a relative strength of the Polish economy – namely, human capital. Pro-innovative attitudes and creative competencies should be nourished since their absence gives rise to barriers to innovativeness.

BIBLIOGRAPHY

Asheim, B., Grilitsch, M., Trippl, M. (2016). Regional Innovation Systems: Past-present-future. In: R. Sharmur, C. Carrincazeaux, D. Doloreux (eds.), *Handbook on the Geographies of Innovation* (pp. 45–62), Cheltenham: Edward Elgar Publishing.

Baruk, J. (2015). Innovation activity management in scientific and research and development. *Marketing of Scientific and Research Organisations, Minib, 17*(3), 121–145.

Bernat, M., Jasek, S. (2018). Barriers to innovation activity. The macro-, mezo-, and microeconomic approach on the example of Poland. *Barometr Regionalny, 16*(4), 23–35.

Bloom, N., Van Reenen, J., Williams, H. (2019). A toolkit of policies to promowe innovation. *Journal of Economic Perspectives, 33*(3), 163–184. DOI: 10.1257/jep.33.3.163.

Chesbrough, H. W. (2006). *Open Business Models: How to Thrive in the New Innovation Landscape*. Boston: Harvard Business School Press.

Drucker, P. F. (1992). *Innowacja i przedsiębiorczość. Praktyka i zasady*. Warszawa: Państwowe Wydawnictwo Ekonomiczne.

Dzhukha, M. V., Kokin, N. A., Li, S. A., Sinyuk, Yu. T. (2017). Research and Development Intensity in Business: Russia and EU. *European Research Studies Journal, 20*(1), 64–76. DOI: 10.35808/ersj/596.

European Innovation Scoreboard 2021. Retrieved from: https://euraxess.ec.europa.eu/worldwide/asean/european-innovation-scoreboard-2021-published (2022.12.05).

Frankowski, P., Skubiak, B. (2012). Bariery innowacyjności w Polsce. *Zeszyty Naukowe Uniwersytetu Szczecińskiego, 28*, 118–130.

Freeman, Ch. (1982). *The Economics of Industrial Innovation*. London: F. Printer.

Inauen, M., Schenker-Wicki, A. (2011). The Impact of Outside-In Open Innovation on Innovation Performance. *European Journal of Innovation Management, 14*(4), 496–520. DOI: 10.1108/14601061111174934.

Jasiński, A. H. (2006). *Innowacje i transfer techniki w procesie transformacji*. Warszawa: Difin.

Kaliszczak, L. Sieradzka, K. (2018). *Zachowania przedsiębiorcze – współczesne wyzwania*. Radom: Wyd. Instytut Naukowo-Wydawniczy „SPATIUM".

Kansy, D. (2018). Innowacyjność polskiej gospodarki na tle Unii Europejskiej z uwzględnieniem specyfiki sektora informatycznego. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Szczecinie, Studia Ekonomiczne, 362*, 111–126.

Karasev, O., Beloshitsky, A., Trostyansky, S., Krivtsova, A., Valerievna, V. N. (2018). Development of National Innovation Systems in Developed Countries. *European Research Studies Journal*, *XXI*(2), 701–712.

Kergroach, S. (2016). *Recent International Trends in STI Policy. In OECD, OECD Science, Technology and Innovation Outlook 2016*. Paris: OECD Publishing.

Kirkland, J. (1999). Introduction. In: J. Kirkland (ed.), *Barriers to international technology transfer*. Dordrecht: Kluwer Academic Publishers.

Kokot, B., Pryciak, M. (2019). Narodowe systemy innowacji Unii Europejskiej w zarządzaniu przedsiębiorstwami. *Zeszyty Naukowe Politechniki Częstochowskiej, 34*, 91–104. DOI: 10.17512/znpcz.2019.2.08.

Kotler, Ph. (1994). *Marketing. Analiza, planowanie, wdrażanie i kontrola*. Warszawa: Gebethner & Ska.

Kuznetsov, I. A., Malitskaya, V. B., Sukhova, V. E., Ivanova, A. V., Proskurina, I. Yu. (2017). Innovation Activity of Russian Business Entities and its Determinants. *European Research Studies Journal, XX*(3B), 395–402.

Lent, B., Kościelniak, H., Łukasik, K., Brendzel-Skowera, K. (2018). An Analysis of the Environment and Personality Impact in Innovative Non-Existent Projects. In: Proceedings of the Third International Conference on Economic and Business Management (FEBM 2018), Series: Advances in Economics (pp. 450–455). Paris: Business and Management Research, Atlantis Press. DOI: 10.2991/febm-18.2018.104

Mansfield, E. (1968). *The Economics of Technological Change*. New York: Norton and Co.

Metcalfe, S. (1995). The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspective. In: P. Stoneman (ed.), *Handbook of the Economics of Innovation and Technological Change* (pp. 409–512). Oxford–Cambridge: Blackwell.

Oslo Manual. (2018). Guidliness for collecting, reporting and Rusing data on innovation, OECD/EU. Retrieved from: https://read.oecd-ilibrary.org (2021.11.12).

Pangsy-Kania, S. (2007). *Polityka innowacyjna państwa a narodowa strategia konkurencyjnego rozwoju*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego.

Poole, G. R., Moore, R. (2002). A theoretical model of commercialization. *International Journal of Technology Transfer and Commercialisation, 1*(1/2), 201–215. DOI: 10.1504/IJTTC.2002.001785.

Porter, M. E. (2001). *Porter o konkurencji*. Warszawa. Państwowe Wydawnictwo Naukowe.

Poznańska, K. (2018). *Nowe formy innowacji*. Warszawa: Oficyna Wydawnicza SGH.

Rodriguez, J. L., Lorenzo, A. G. (2011). Open Innovation: Organizational Challenges of a New Paradigm of Innovation Management. *European Research Studies Journal, XIV*(1), 77–84. DOI: 10.35808/ersj/311.

Schumpeter, J. (1960). *Teoria rozwoju gospodarczego*. Warszawa: Państwowe Wydawnictwo Naukowe.

Sieradzka, K. (2021). Start-upy jako przejaw przedsiębiorczości i innowacyjności we współczesnej gospodarce. In: M. Lament, J. Bukowska (eds.), *Gospodarka XXI wieku* (pp. 217–236). Warszawa: Wyd. CEDEWU.

Sopińska, A., Wachowiak, P. (2016). Innowacyjność przedsiębiorstw działających w Polsce. *Przegląd Organizacji, 5*(916), 17–23. DOI: 10.33141/po.2016.05.02.

Szajt, M. (2008). *Aktywność innowacyjna a wzrost gospodarczy Polski. Analiza statystyczno-ekonometryczna*. Częstochowa: Wydawnictwo Politechniki Częstochowskiej.

Thompson, V. A. (1969). *Bureaucracy and Innovation*. Tuscaloosa: University of Alabama Press.

Wang, C. (2013). *The Long-run Effect of Innovation on Economic Growth*. Sydney: School of Economics, UNSW.

Wich, U. (2017). Innowacyjność Polski w ocenie Unii Europejskiej i z perspektywy regionów. *Annales Universitatis Mariae Curie-Skłodowska Lublin – Polonia Sectio H, LI* (1), 101–111. DOI: 10.17951/h.2017.51.1.101.

Summary

The paper identifies the level of innovativeness of the Polish economy against the background of selected European countries and determines the conditions and change tendencies in this respect. It is of particular importance to designate the SII components that are of high significance to determine the levels of innovativeness. A research hypothesis was posited as well: The causes of

low innovativeness in Poland are varied and multidimensional. More spending on research and development should be the starting point for its improvement.

The theoretical section follows a thorough review of leading specialist literature, while the empirical part uses the Summary Innovation Index (SII), published in the European Innovation Scoreboard (EIS) report. It is used to measure the innovativeness of European countries. Additionally, some selected methods of numerical data analysis were used in order to verify the research hypothesis.

The fostering of R&D will be of paramount importance to the future development of Poland; however, given the huge differences in research and development spending by enterprises in the innovation leaders, Poland's position will not improve soon.

National authorities can use the results as guidelines on the Polish economy's innovativeness growth factors. They also will give information what actions need to be taken to improve the situation.

The cognitive value of the paper consists in studying the causes of the innovativeness distance of the Polish economy with reference to selected, not all countries (the latter comparison is the object of a prevailing majority of the relevant literature). This approach will provide a clearer evaluation of the strengths and weaknesses of Poland's innovation system. It will allow for giving some recommendations for innovativeness level improvement.

Keywords: innovation, economy, barriers of innovation.

Uwarunkowania i tendencje zmian innowacyjności polskiej gospodarki na tle wybranych krajów europejskich

Streszczenie

Celem artykułu jest identyfikacja poziomu innowacyjności polskiej gospodarki na tle wybranych krajów europejskich oraz określenie uwarunkowań i tendencji zmian w przedmiotowym zakresie. W szczególności ważne jest wskazanie, które składowe SII mają istotne znaczenie w kształtowaniu poziomu innowacyjności. W artykule postawiono hipotezę badawczą: Przyczyny niskiego poziomu innowacyjności w Polsce są zróżnicowane i wieloaspektowe, a punktem wyjścia w jej poprawie powinien być wzrost poziomu nakładów na działalność badawczo-rozwojową.

Część teoretyczna artykułu została napisana na podstawie przeglądu wiodącej literatury przedmiotu. Natomiast w części empirycznej do weryfikacji postawionej hipotezy badawczej wykorzystano syntetyczny wskaźnik Summmary Innovation Index (SII), publikowany w raporcie European Innovation Scoreboard (EIS), służący do pomiaru poziomu innowacyjności w krajach europejskich oraz wybrane metody analizy danych liczbowych.

Kluczowe znaczenie dla przyszłego rozwoju Polski będzie mieć wzmocnienie sfery B+R, jednak obserwując ogromną różnicę wartości wydatków przedsiębiorstw na badania i rozwój w porównaniu do liderów innowacji, poprawa pozycji Polski nie nastąpi szybko.

Wyniki mogą posłużyć władzom krajowym jako wytyczne dotyczące czynników wzrostu innowacyjności polskiej gospodarki oraz informacja, jakie działania należy podjąć, aby poprawić sytuację.

Wartością poznawczą artykułu jest badanie przyczyn dystansu innowacyjności polskiej gospodarki w odniesieniu do wybranych krajów, a nie do wszystkich (co obejmuje zdecydowana większość opracowań prezentowanych w literaturze przedmiotu). Takie ujęcie pozwoli na czytelniejszą ocenę mocnych i słabych stron systemu innowacji w Polsce oraz formułowanie rekomendacji dla poprawy poziomu innowacyjności.

Słowa kluczowe: innowacyjność, gospodarka, bariery innowacyjności.

JEL: C10, O30, O12.

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The efficiency of scientific activities and technology transfer in higher education in Poland[3]

Introduction

Since the 1980s, knowledge, innovation, and technology transfer have been recognised as the most important factors of growth, socio-economic development and the competitiveness of highly developed countries. These resources have become even more significant in the recent years of this century with increased globalisation and competition and the desire of many developing countries (including BRICS) and recently considered developed countries (e.g., Poland) to advance their development in terms of civilisation and technology (Kirby, El Hadidi, 2019; Rossoni et al., 2023).

The presented challenges require new solutions from societies that arise in national (NIS), regional (RIS) (Łącka, Brzezicki, 2021), and local innovation systems (LIS). The efficiency and productivity of these systems determine the possibility of overcoming challenges, reducing barriers, and taking advantage of development opportunities in the modern economy. Poland, for several years, has been trying to make changes in the functioning of its national innovation system (Łącka, Brzezicki, 2021) and its components within the higher education sector (Łącka, Brzezicki, 2020). The goal is to increase the role of universities in the technology transfer process between science, industry and society within

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the so-called third (Compagnucci, Spigarelli, 2020) and even fourth mission of the university (Lucovics, Zuti, 2015). This requires cooperation within helix models from the simplest form (the so-called triple helix) to developed models of cooperation between science and business (quadruple and quintuple helix models) (Yoda, Kuwashima, 2019; Łącka, 2020). According to Osuch-Rak, "studies on technology transfer largely focus on the subject of academic entrepreneurship originating from universities and colleges" (2017, p. 133).

Over the last decade, the Polish higher education system has been changed and reformed several times (2011, 2018) to adapt it to new social and economic conditions and expectations, both domestic and international ones. The introduced changes concerned didactic activity and many other issues, such as evaluating scientific publications, commercialising research, university funding algorithms, scientific development, activities of academic bodies, and many other problems. In 2011, the Ministry of Science and Higher Education in Poland (MSHE) developed and implemented a central integrated system for the activities of higher education and science in Poland, which is called "POL-on". On the basis of data in the POL-on system on teaching, scientific and implementation activities, decisions were made on the implemented scientific policy of the state.

In 2012, the MSHE established a list of scientific journals with the number of points awarded for publications in these journals. Meanwhile, the articles outside the MSHE list were rated the lowest. The introduction of the list of journals was one of the elements of higher education reform in Poland introduced in 2011.

It is also worth noting that for several years now, one can observe an increased interest in the MSHE and the promotion of the idea of knowledge and technology transfer to the economy among universities through numerous financial programmes addressed to the academic community. This is reflected in the state's introduction to the evaluation of scientific units (including universities) of an assessment of knowledge and technology transfer from the world of science to the economy (Ministry of Science and Higher Education, 2020).

Therefore, it is reasonable to conduct research to measure and assess the efficiency of scientific research and technology transfer to the economy through higher education institutions. The objective of the article is to assess the efficiency of scientific activity and technology transfer to the economy by public universities in Poland and to formulate recommendations for state policy to increase the effectiveness of the technology transfer process by them.

Literature review

Due to their scientific and research potential, universities are a source of knowledge and technologies that should be used in the modern world for socio-economic development (Amry et al., 2021; Barra et al., 2021). Scientists show

less interest in researching the efficiency of university technology transfer (UTT) using quantitative and qualitative methods (e.g., Anderson et al., 2007; Kim et al., 2008; Tseng, Raudensky, 2014). An important contribution to the presentation of the effects of university technology transfer offices in the Republic of Korea is the research of Han (2018). Stochastic Frontier Analysis was used to study the efficiency in this regard. In recent years, more and more scientists from various countries have undertaken research on technology transfer carried out by universities and its determinants. A synthetic discussion of the scope of these studies, based on a literature review, is presented in the study by Rybnicek and Königsgruber (2019), de Wit-de Vries *et al.* (2019), Padilla Bejarano *et al.* (2023) and O'Dwyer *et al.* (2023).

Technology transfer can be understood in a narrow and broad sense. Perceiving technology transfer narrowly, we say that it trades in patents, utility models, licenses and know-how. This is also the mechanism leading to the dissemination of technology. In a broader sense, technology transfer includes the creation of knowledge, the transfer of technology and its acceptance and implementation by the end user. In this case, technology is understood as the result of the use of: scientific knowledge (e.g., resulting from research and development work carried out at universities), practical knowledge (know-how), appropriate technical equipment, and methods of process implementation and organisation (e.g., spin-offs), which through the appropriate structure and systems contained in it is able to ensure optimal use of technology. In this approach, an important role in the process of technology transfer is played by scientific and research units which, while implementing the third mission of the university, create new solutions or cooperate in this area with the industry (Osuch-Rak, 2017; Perkmann et al., 2021; Sharma, 2022).

In Poland, this issue is even less explored, and there is a lack of research allowing the measurement and evaluation of the efficiency of technology transfer processes in university-type HEIs of different natures (universities, technical, medical, economic, agricultural, and military HEIs) and from different sectors (public and private).

Researching the achievements of academic centres usually comes down to selecting the appropriate input and output data and then measuring efficiency using various quantitative methods. In this approach, university activity is seen as a process by which inputs are transformed into outputs. From the review of educational research in the world by De Witte and López-Torres (2017), it can be concluded that they are very diverse in various respects. However, research on the efficiency of universities is most often performed using the non-parametric DEA method or the parametric Stochastic Frontier Analysis (SFA). The Rhaiem (2017) analysis shows that more research is carried out with DEA than with SFA.

The authors studying the efficiency of higher education used very different DEA models (Table A1 in Appendix), ranging from classic (CCR, BCC, SBM) to advanced (DDF, network DEA, dynamic SBM) models. Scientists chose the DEA model for analysis based on the research concept and the purpose of the research. Each model has different analytical possibilities, which were used depending on the research needs, e.g., the network DEA model allows for consideration of the network of connections, and the dynamic SBM model allows for inter-periodic variables. Some authors used a two-stage analysis to study higher education. In the first stage, the efficiency indicators were calculated using the DEA method, and in the second stage, regression was used to determine the factors influencing the efficiency level.

Typically, inputs were accepted as the number of academic staff or research and development (R&D) staff, funds for R&D, room space or fixed assets, and outputs included the number of publications or citations, patents, and grants. In the R&D activity of universities, some authors considered the number of publications, while others considered the number or the value of financial grants. However, Gralka *et al.* (2019) suggest that these two outputs can be included interchangeably in research. The authors (Gralka et al., 2019) argue that most publications are financed by grants, so these two variables are closely related. It is worth noting that most of the authors who study the efficiency of higher education (e.g., Foltz et al., 2012; Visbal-Cadavid et al., 2017; Wolszczak-Derlacz, 2018) in one model consider data related to teaching activity (e.g., the number of students or graduates) and R&D activity (e.g., the number of publications) or technology transfer (e.g., the number of the patents) and primary research (e.g., the number of journals, citations), which is a fundamental limitation, as it is not known which activity affects the efficiency level of a particular university to a greater extent. Some authors notice this problem. Therefore, they use a two-stage network DEA model (Yang et al., 2018), in which the first stage is related to basic research and the second to technology transfer. A few authors (e.g., Wolszczak-Derlacz, 2013; Chuanyi et al., 2016; Łącka, Brzezicki, 2020) use two separate empirical models adopting other variables. Wolszczak-Derlacz (2013) separately estimated the efficiency of scientific and implementation activities of 31 public higher education institutions in Poland (mainly universities and polytechnics) in 2001-2008. The author's study found that polytechnics (technical universities) were more efficient than universities in terms of scientific and implementation activities. However, since the Wolszczak-Derlacz (2013) study, several systemic changes have been introduced, including a comprehensive evaluation of the scientific activity of HEIs, the creation of a point system for ranking scientific journals, and a system for reporting the effects of the higher education and science system (POL-on), which could have improved the situation of HEIs. It is worth noting that Angori *et al.* (2023) analysed the evolution of basic, mission-oriented and applied research

at European universities from 1978 to 2015. The results of the study indicate that over the years, patents from publicly funded academic research have become more basic research-oriented and basic research has become more mission-oriented at HEIs. Applied research, on the other hand, has declined since the late 1990s. Accordingly, the following research hypotheses were formulated for this study.

H1: All surveyed HEIs are more efficient in basic research than in technology transfer to the economy.

H2: Technical universities are more effective in technology transfer and universities are more effective in basic research.

All studies performed using classical and advanced DEA models assume that the values of the variables must be positive. This is the basic principle of the DEA method and its fundamental limitation. In economic practice, it happens that resources are used, but no positive effects are obtained, or even losses are incurred, i.e., negative values were obtained, such as the payment of compensation for a defective product that caused damage to the recipient. In either case, the owner of the enterprise sustains losses. In such cases, researchers would often either rescale the data by adding large values to make all the data positive or by adding minimal values to negative data, thereby obtaining positive values. However, this often led to surprising results. Therefore, a solution was sought to enable efficiency testing based on positive and negative data simultaneously. Several DEA models have appeared in the literature that address the above issues. This study uses one of them, which is discussed in detail later in the article.

Research methodology

The Polish higher education system is complex. Most of the 133 public higher education institutions are subordinated to the Ministry of Science and Higher Education (95). Whereas the rest (38) to other ministries depending on their profile, e.g., medical universities (10) are supervised by the Ministry of Health (Brzezicki, 2019). In Poland, HEIs are mainly classified according to their authority to confer doctoral degrees. The word "university" may be used in the name of a university whose organisational units have the authority to confer doctoral degrees in at least ten disciplines. The word "university" supplemented with another adjective or adjectives to define the profile of the university may be used in the name of a higher education institution whose organisational units are authorised to confer at least six doctoral degrees, including at least four in the sciences covered by the university's profile. Different types of higher education institutions engage in R&D activities in very different ways, which is reflected in various numbers of projects and values of funds allocated for this purpose (Table 1).

Table 1. Number of projects and the value of funds allocated for research or development work in 2016 for the implementation of projects by type of university [PLN]

Type of university	Value of projects [PLN]	Number of projects
University	848,029,997.30	8644
Technical University	771,715,862.30	6151
Medical University	221,873,717.30	1219
University of Agriculture / Nature	107,884,809.20	903
Military University	72,139,282.45	256

Note: Universities ranked from the highest to the lowest value of funds.

Source: (Ministry of Science and Higher Education, 2019a).

The leading position of the ranking is occupied by universities, followed by technical and medical universities. It is worth noting that military universities implemented significantly fewer research projects than other universities. Their value was equal to that of technical universities. Universities get different results depending on the nature of the research (e.g., different scientific publications or patents). Therefore, it is reasonable to measure them separately; it will be possible to check which universities specialise in one or the other R&D activity, which would not be possible if one model was used.

On the other hand, comparing the results of both models will make it possible to check how universities related to the other less efficient activity – at what level they generated effects. It was decided to use the suggestions of Gralka *et al.* (2019) when studying the efficiency of university R&D activities in the future and in addition to taking into account scientific publications, to pay more attention to technology transfer, as well as to the relationship between the specificities of different types of universities and their level of efficiency. Therefore, the study distinguished between scientific activities related to scientific publications and practical activities aimed at transferring knowledge to the economy. Separate empirical models (Table 2) were created for both R&D activities of the university: M1 (scientific activities) and M2 (technology transfer).

In consideration of the findings provided by the literature review, it was decided to adopt the following set of outputs (Table 2) for the M1 model: the number of books (y_1), chapters (y_2) and weighted average of articles (y_3). In the case of the number of articles, the weighted average (y_3) was adopted, reflecting the time and effort of the authors to create a given type of article. The above approach has been used many times in the study of higher education, e.g., in the work of Visbal-Cadavid *et al.* (2017). For the M2 model, the following outputs were adopted: patent applications to the Polish and foreign patent office (y_4) and patents obtained from the Polish and foreign patent office (y_5). Two inputs were adopted in both models (M1–M2), but one is the same in the two models, and the

other is different. Fixed asset value (x_2) given by universities for various purposes, and captured in different reports, is identical. Additionally, the variable enables the assessment of the university's size and material wealth. However, in the case of the second input, a distinction was made, resulting from the provisions of the law on higher education and a different way of reporting by universities to Statistics Poland and the MSHE. It is presumed that when an employee is employed full-time at a university, the university is the employee's primary place of employment. Within the scope of duties of academic staff employed in the groups, including scientists and academics, one of the duties is to conduct scientific activities in the form of, e.g., scientific publications and participation in scientific conferences.

Table 2. Summary of inputs and outputs for the study

Specification	Variable	Source	Unit
Model 1	M1: Scientific activities	DEA: SBM	
Inputs	x_1 – Full-time academic staff	MSHE	Number
	x_2 – Fixed asset value	MJ (2019)	Value PLN
Output	y_1 – Books	MSHE (2019b)	Number
	y_2 – Chapters	MSHE (2019b)	Number
	y_3 – Weighted average of articles	MSHE (2019b)	Number
Model 2	M2: Technology transfer	DEA: BP–SBM	
Inputs	x_3 – R&D personnel	HEI	Number
	x_2 – Fixed asset value	MJ (2019)	Value PLN
Output	y_4 – Patent applications to the patent office	HEI	Number
	y_5 – Patents obtained from the patent office	HEI	Number

Note: MSHE – Ministry of Science and Higher Education, MJ – Ministry of Justice, HEI – higher education institutions.

Source: own study.

The groups of employees mentioned above constitute the total of full-time academic teachers employed at educational institutions. Universities provide data on the number of people employed full-time at the MSHE. However, in reports on the R&D activities of universities, which are submitted for statistical purposes to Statistics Poland, universities indicate the total number of R&D employees, as the information mainly concerns the transfer of technology and knowledge to the economy. Therefore, this report also mentions technical staff, other staff and academic teachers. Thus, in the M1 model, the input full-time academic staff (x_1) was assumed, and in the M2 model, R&D personnel (x_3). The literature (de la Torre et al., 2017) points to the problem of allocating resources among the three different activities of universities, especially in terms of personnel. However, in

Poland, for the purposes of the Ministry of Science and Higher Education and public statistics, universities separately report their scientific activity related to scientific publications, and implementation activity related to patents filed and obtained. Therefore, an approach based on two separate DEA models can be used in Poland.

Most of the data for the study was obtained from the MSHE and HEIs based on an application for access to public data. Since it was decided to analyse the situation of Polish universities after the first significant reform of higher education was introduced in 2011 and before the second reform of 2018, the data from 2016 were selected, which should illustrate the results of the first reform. The reform initiated in 2011 has been fully implemented, and its results can be assessed in the following years. The most recent second higher education reform has not yet been fully implemented. Therefore, it is justified to analyse the situation of higher education institutions after implementing the first reform and before introducing the second.

It was decided that the study would cover the two largest groups of universities spending the highest amounts of funds allocated to research or development (Table 1), i.e., universities and technical universities, which together constitute 36 units out of 59 public academic universities independently supervised by the MSHE. Thus, the group's homogeneity of the surveyed units will be maintained. It will also be possible to analyse the efficiency level in relation to the specificity of various types of universities, as indicated by Gralka *et al.* (2019). The complete data from 2016 was obtained for 34 universities for the empirical study (Table A2 in Appendix). The majority of the research sample comprises technical universities (18 units) and a smaller proportion of universities (16 units).

Permanent changes to the higher education system in Poland were also conducive to undertaking research, mainly using the DEA method (Brzezicki, 2020). The article by Charnes *et al*. (1978), in which they presented its first CCR model (from the authors' names), is based on radial efficiency and constant return to scale (CRS). The second BCC model with variable returns to scale (VRS) was presented by Banker *et al.* (1984). The above models are based on radial efficiency; therefore, Tone (2001) suggested the SBM (Slacks-Based Measure) model, based on non-radial efficiency, if individual inputs and outputs have a different impact on the efficiency of an economic entity. The above models are standard DEA models based on which newer, more complex models were developed.

In recent literature, several DEA models can be found that measure the efficiency of an entity based on positive and negative data. Pastor and Ruiz (2007) and Kaffash *et al.* (2018) conducted a brief literature review of negative data in DEA models. Four DEA models and their various modifications are often mentioned in the literature: range directional model (RDM), slacks-based measure model (SBM), variant of radial measure (VRM) and semi-oriented radial

measure (SORM). Even though radial models have a long history and theoretical foundations presenting efficiency measurement utilising the DEA method, the non-radial models (e.g., SBM) much better reflect the practice of economic entities using, e.g., different levels of inputs for generating outputs. The author of the SBM model (Tone, 2001) and other co-authors (Tone et al., 2020) created the base point slacks-based measure model (BP-SBM), which makes it possible to include both positive and negative data. It is worth noting that Tone (2011) had presented dealing with non-positive data in the SBM models earlier. The authors' literature review shows, firstly, that the efficiency of higher education has not been measured using the DEA model in the case of negative data or no output obtained from the inputs used for that purpose. Secondly, in the research conducted so far, the authors included data from several areas of activity (teaching, research, and technology transfer) in one model, which made it impossible to determine the impact of individual actions on the efficiency of a higher education institution. Therefore, a separate assessment of the efficiency of technology transfer and basic research in two, not one model, will determine more precisely which university is more efficient in each activity. However, this, in turn, will indicate their specialisation in activities related to the adopted development strategy of a given higher education institution. The established literature gap will be filled with the present study.

After defining the variables and accepting 34 universities for analysis, the research framework was presented. Firstly, non-radial models (e.g., SBM) better reflect the situation of economic actors than radial models (e.g., CCR), which, depending on the orientation, assume a proportional reduction of inputs or proportional increase of outputs. In non-radial models, individual inputs and outputs have a different impact on the level of efficiency of an economic entity. Secondly, Cooper *et al.* indicate that "If the data set includes numeric values with a large difference in magnitude, e.g., comparing big companies with small ones, the VRS model may be a choice" (Cooper et al., 2007, p. 344). The data of universities accepted for the study differ in size. Third, the university aims to generate the maximum number of results (publications and patents) rather than reduce employees and fixed asset value. Therefore, it was decided to use non-radial SBM output-oriented (O) models with variable-returns-to-scale (VRS or V) for the study.

The empirical research was divided into two stages. In the first stage, the efficiency of scientific activities in higher education (M1) was measured using the standard SBM (the output-oriented SBM under variable-returns-to-scale SBM-O-V) model (Tone, 2001). Each university admitted to the study published several publications of a given type (books, chapters, and articles). There are no zero or negative values in the M1 model. Therefore, there is no need to use any other model than SBM.

In the second stage, the BP-SBM model (Tone et al., 2020) was used to measure the efficiency of technology transfer by universities (M2). In some universities, human, financial, and material outlays were used, but no results were obtained in the form of reported or obtained patents. Therefore, in the case of universities with no output, the number 0 was changed to a constant negative value, as it is a loss of the unit's resources. It is worth emphasising that the BP-SBM (the output-oriented BP-SBM under variable-returns-to-scale BP-SBM-O-V) model is compatible with the classic SBM model (Tone, 2001), which determined its use in the study.

Using the SBM and BP-SBM models makes it possible to conduct comparative studies of various areas of activity of the same economic entity, even in the absence of outputs or in the case of their negative value, which is a significant advantage over other DEA models.

Results and discussion

The average efficiency results for individual groups of universities in both empirical models (M1–M2) are presented in Table 3. The average efficiency measures for all universities show that they were more efficient in scientific activities (M1) than in technology transfer (M2). The difference between the M2 (0.40) and M1 (0.76) models is almost twice as big. When comparing the groups of universities, it can be noticed that universities were more efficient in the M1 model (0.91) and technical universities in the M2 (0.65) model. However, it should be noted that the difference in efficiency between the two groups of universities in the M2 (0.52) model is almost twice as big as in the M1 model (0.28). It is also worth noting that in the group of technical universities, there is a more substantial differentiation of efficiency results (st. dev.) in both empirical models (M1–M2) than in the case of universities. The results of technical universities' efficiency are almost identical in both models (M1: 0.63 and M2: 0.65), which cannot be said about universities whose scores are highly different (M1: 0.91 and M2: 0.13). Thus, technical universities are similarly oriented towards basic research (M1) and technology transfer (M2). In contrast, universities are almost entirely oriented towards basic research and the theoretical dimension of knowledge (M1). The literature (Bonaccorsi et al., 2006) indicates that the scientific and implementation activities of HEIs up to a certain point can coincide, resulting in a mutually self-reinforcing process, but after a certain level, too strong a focus of HEIs on implementation activities can lead to lower scientific performance, in which case the relationship is in the shape of an inverted U.

Table 3. Mean of efficiency in 2016, by the group of higher education

Model	M1			M2		
Group	Univer.	Technical	All	Univer.	Technical	All
Mean	0.91	0.63	0.76	0.13	0.65	0.40
St. dev.	0.15	0.27	0.26	0.10	0.33	0.36

Note: St. dev. – Standard Deviation, Univer. – Universities, Technical – Technical Universities, All – All 34 higher education institutions

Source: own elaboration.

Figure 1 presents the results of the efficiency of individual universities in both empirical models (M1–M2). The following variables were assigned to the studied universities: U1–U34 (Table A2 in Appendix) to present the results in a graphical form. Table A2 in the appendix contains detailed results of efficiency for individual universities. In the M1 model, there were more than twice as many efficient universities as in the M2 model – 14 and 6 units, respectively.

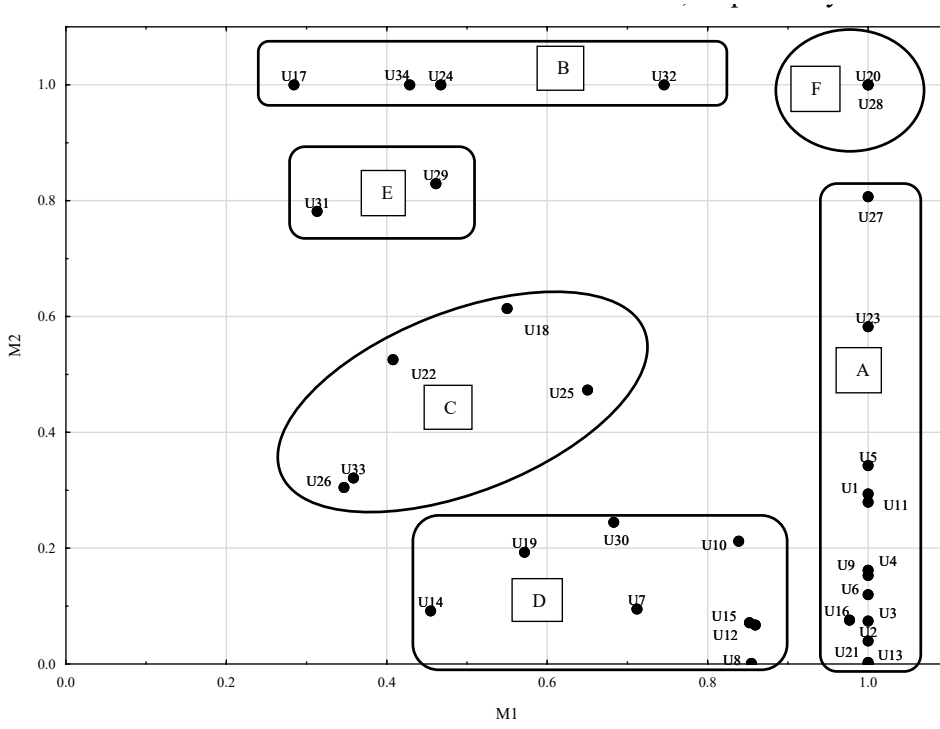

Figure 1. Indicators of efficiency in 2016

Source: own elaboration.

Therefore, it is much more challenging to achieve complete 100% efficiency in technology transfer (M2) than in scientific activities (M1). The University of Technology and Humanities in Bielsko-Biała (U20) and the Lublin University of Technology (U28) turned out to be 100% efficient universities in 2016 in both empirical models (M1–M2). The least efficient university in the M1 model among all respondents was the West Pomeranian University of Technology in Szczecin (U17), and in the M2 model, the Cardinal Stefan Wyszyński University in Warsaw (U13). The universities with the lowest efficiency level in particular groups of universities are also worth mentioning. The lowest efficiency index value among all universities was achieved by the University of Zielona Góra (U14) in the M1 model and the Cardinal Stefan Wyszyński University in Warsaw (U13) M2 model. However, on the other hand, among all technical universities, the West Pomeranian University of Technology in Szczecin (U17) turned out to be the least efficient in the M1 model, and the Częstochowa University of Technology (U21) in the M2 model. However, it should be emphasised that both the Cardinal Stefan Wyszyński University in Warsaw (U13) and the Częstochowa University of Technology (U21) achieved a total 100% efficiency in the M1 model, although in M2, they obtained the lowest results in their groups.

It was decided to use the approach presented by Santos *et al.* (2022), who divided university researchers into three clusters, conducting basic research, experimental research and dealing with two at the same time, but at the university level, in order to identify clusters of universities oriented towards basic research (publication of scientific papers) and development and implementation work (patents). Graphical presentation of the results in a two-dimensional space (Figure 1) made it possible to identify 6 different efficiency groups of higher education institutions:

1. Group A – clearly oriented towards scientific activities (M1),
2. Group B – clearly oriented towards technology transfer (M2),
3. Group C – similarly oriented towards scientific activities (M1) as it is towards technology transfer (M2),
4. Group D – more oriented towards scientific activities (M1) than technology transfer (M2),
5. Group E – more oriented towards technology transfer (M2) than scientific activities (M1),
6. Group F – maximum-oriented technology transfer (M2) and scientific activities (M1).

Group A comprises the largest number of universities (13), and the second-largest group is D (8), followed by C (5), B (4), E (2) and F (2). The individual efficiency groups indicate both what strategies are implemented by universities and which R&D activity is treated as their priority. HEIs with similar performance results in one or both models (M1–M2) can significantly increase their R&D

performance by entering into collaborations, and the resulting group performance will be even across all units. On the other hand, classified efficiency groups determine optimal development directions and strive for 100% efficiency. The two most numerous groups (A and D) indicate the general rule that the studied HEIs mostly follow. Universities in group A achieved the maximum 100% efficiency in the M1 model. However, it can be seen that they are starting to strive towards efficiency in model M2 as indicated by the distribution of units, with individual colleges higher on the M2 axis setting the direction for most of the other units. By contrast, group D is firmly committed to efficiency in the M1 model, only slightly engaging its resources to generate outputs in the M2 model. The results show that universities first strive for total 100% efficiency in scientific activities (M1), and after obtaining it, they turn their attention towards technology transfer (M2). Such activities have substantive justification, as the MSHE, apart from teaching activities of individual universities, has assessed scientific and research activity, paying attention to the publishing activity of units.

On the other hand, based on this evaluation, the MSHE awarded academic categories linked to both the amount of funding awarded and the university's prestige. The opposite strategy concerning groups A and D was implemented by universities in groups B and E, which first sought to achieve total efficiency in the M2 model and, after obtaining it, increased the efficiency in the M1 model. Conversely, strategies of the middle development path were implemented by universities in group C. It is also worth analysing the situations of universities and technical universities in the respective performance groups separately. The separation of the results into the two types of universities indicated that almost the entirety of groups A and D consist exclusively of universities (apart from the two technical universities in groups A and D). In contrast, the remaining groups, B, C, E and F, consist entirely of technical universities.

The results in the M1 model clearly show that universities are almost exclusively focused on scientific activities. Meanwhile, in the case of technical universities, the situation is more complex, as they achieved higher efficiency in technology transfer (M2) than universities. Still, equally often, they obtained medium or high-efficiency results in the field of scientific activities (M1). Their efficiency in scientific activities (M1) was varied and depended on individual technical universities. The results obtained in the present study agree with those of Werker and Hopp (2020), who, based on a survey of three leading European technological universities, studied the impact of research orientation and networks of researchers on their productivity. According to the Werker and Hopp (2020) study, only a small group of scientists who are able to successfully balance research and applications have been reported. However, the vast majority of scientists focus on either basic or applied research. These scientists face a trade-off between scientific publication and innovation.

However, the mere calculation of the efficiency level does not exhaust the discussed topic. Therefore, it was decided to use the research approach of Tseng and Raudensky (2014) to present other variables that may affect the university's research and development activities. For the purpose of finding out to which R&D activities universities allocate funds to, the following classification was used. Research and development (R&D) activity in Poland has been divided into three main areas (Figure 2) (Łącka, Brzezicki, 2020): basic research (fundamental), applied research (applied and industrial), and industrial research (development work). The main area of spending funds by both public universities is basic research (Figure 2), which provides new knowledge without the necessity to use it in practice.

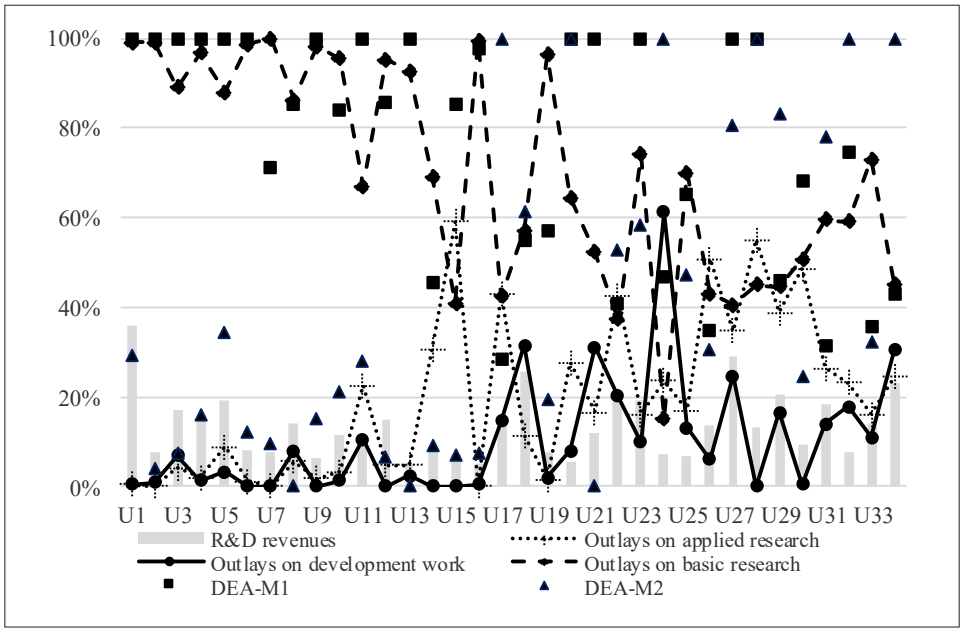

Figure 2. Efficiency in the M1 and M2 model and the allocation of resources to different types of research

Note: U1–U16: Universities, U17–U34: Technical Universities.

Source: own elaboration.

Most universities spend almost all their R&D expenditure on basic research. As a result, they achieved high efficiency in the M1 model. Bentley *et al.* (2015) showed that researchers who specialise in basic research tend to receive less external funding and rely on the university's own resources. They work in environments where there is less emphasis on applied research. As a result, they have fewer professional obligations to apply their knowledge to solving social

problems. However, the results of Cao *et al.* (2023) indicate that there is a U-shaped relationship between basic university research and company innovation. Technical universities incurred spending on applied research and development work. That has allowed them to obtain high and relatively high efficiency in the M2 model. Some universities, such as the University of Zielona Góra (U14) and Kazimierz Wielki University in Bydgoszcz (U15), invested heavily in applied research. Thus, they achieved relatively high efficiency in the M1 model. In the case of the Kielce University of Technology (U24), the expenditure on basic and applied research was relatively small, and the spending on development work accounted for nearly 60%; consequently, this university achieved maximum efficiency in the M2 model. The reason for the differences between the two groups of universities can be traced to what Li and Yang (2023) noted, among others, which indicates that faculty members at research universities spend more time on research-oriented teaching than on curriculum-based teaching. Time spent on curriculum-based teaching has a significant negative relationship with research performance. Another reason for such differences may be the different approaches to knowledge creation and ways of using it in the two groups of HEIs. The literature (Urbanek, 2020) indicates that universities are "sanctuaries of knowledge", much more difficult to adapt to the changing reality and therefore closer to the approach known as the Bohr quadrant (basic research to acquire knowledge regardless of its application) and the Socrates quadrant (research oriented to education). In contrast, technical universities are quicker to respond to the needs of the external environment, and are therefore closer to the approach known as the Pasteur quadrant (basic research also aimed at solving specific problems) and the Edison quadrant (applied research aimed at creating a specific product). This, in turn, affects the different organisational cultures (Shah et al., 2019) of two different types of universities.

One can find another reason for such negligible interest in broadly understood science, knowledge and technology transfer to the economy by HEIs. Brzezicki (2022) indicates that higher education was evaluated primarily in the context of teaching activity, and scientific activity was carried out only to the extent necessary, indicating that it was less important for evaluating the efficiency of HEIs. Implementation activities, however, were practically ignored in the evaluation of university performance. It was only after the higher education reform introduced in 2011 that more attention was paid to scientific activity by evaluating it on the basis of points assigned to various types of scientific publications. On the other hand, it is only in the last few years that one can notice an increased interest in Poland by the Ministry of Science and Higher Education in the transfer of knowledge and technology to the economy. The Ministry of Science and Higher Education has for several years organised various programs and projects to encourage universities and institutes to become more active in this area. However, it was only the evaluation of knowledge and technology transfer that was used in the evaluation of the scientific activity of higher education institutions for 2017–2021. As a result,

the focus of public policymakers and the mass media on the higher education and science sector only in the context of didactics, as well as the negligible interest in matters of science and the transfer of knowledge and technology to the economy, resulted in the fact that higher education institutions, which should be obtaining significant results in this regard, functioned inefficiently, obtaining unsatisfactory results of activity. However, according to Cao *et al.* (2023), neither the supportive nor intervening role of the government can moderate the U-shaped relationship between HEIs and businesses.

The authors' research on the effectiveness of scientific activity and HEI technology transfer in Poland and the research of the team led by Tomasz Geodecki and Jerzy Hausner on the cooperation of Polish universities with businesses (Geodecki, Hausner (eds.), 2023) have shown that these two worlds do not overlap, they do not know each other and rarely communicate with each other. Despite many years of support under the innovation policy for this cooperation in the field of research and development, technology transfer and their commercialisation by scientists, the progress is still relatively small.

As a result, scientists and entrepreneurs "can't work together well and systematically. The reason is the different expectations of these worlds as to the goals and forms of cooperation, the resources they possess, and the quality of the results they strive for and that matter to them. The expectations and criteria for measuring success as well as motivation systems are also different" (Geodecki, Hausner (eds.), 2023, p. 87). For this reason, Polish universities still represent a relatively small research potential, and stimulate the competitiveness and innovativeness of the Polish economy to a relatively small extent. Entrepreneurs are willing to establish cooperation with selected scientists and rent some laboratories, but they do not create lasting and strong links with Polish HEIs.

Conclusions

The authors' research shows that higher education reforms (more evolutionary than revolutionary) undertaken in 2011 focused too little on scientific research (and more on didactic) activities and thus did not bring about appropriate changes in the functioning of its entities in this regard. Only in the last few years can one see a shift in Polish higher education and science policy towards research that can translate into the economic sphere. However, higher education institutions are expected to play a significant role therein. The next reform of higher education and science, introduced in 2018, directly marks the direction of the development of this sector in Poland. However, it should be remembered that reorienting universities' activities and changing the priority of their goals is a complex and protracted process. Therefore, the first significant changes will only be noticeable in a few years.

The result of the changes introduced in 2011, on the other hand, is that universities focused most on basic research, while applied (industrial) research and development work received less attention from researchers. In the latter case, technical universities were more effective than universities. The following reasons can explain the situation:

- little practical usefulness of the conducted research,
- too weak relations between universities and enterprises and too little participation of research teams in projects implemented in cooperation with enterprises (domestic and foreign),
- inappropriate system of incentives to establish collaboration between the university and business,
- the applicable rules for evaluating scientists – relating primarily to achievements in scientific activity and underestimating technology transfer (implementations, patent applications, patents).

The following conclusions can be drawn from the conducted research. A comparison of the average efficiency values of the two models, M1 and M2, for all HEIs, indicates that the studied HEIs obtained higher levels of efficiency in scientific activities (M1) than technology transfer (M2). However, a comparison of efficiency scores between the two groups of HEIs indicates that the two groups differ significantly. The group of universities was more efficient in scientific activities (M1) and technical universities in technology transfer (M2). It was also noticed that the difference in the efficiency of universities between M1 and M2 is very significant, while technical universities obtained similar efficiency values in both models. However, it should be remembered that this study analysed the relationship of achieved outputs to committed inputs by individual universities in relation to other units in 2016. Therefore, the efficiency results of universities should only be assessed in this context.

Universities and technical universities pursued strategies considered rational, which had a factual basis in the period under study. They were also related to the specificity and different nature of the two types of universities. There are many units in the humanities and arts or social sciences in the university structure which cannot provide innovative business solutions for obvious reasons. Technical universities are characterised by a different domain structure, most of which are units in engineering and technology. Whereas universities are better at scientific activities (M1), they mainly specialise in this area of R&D. Conversely, technical universities obtain higher results in technology transfer (M2). Thus, they specialise in this area of R&D. Based on the study, H1 and H2 were confirmed.

The obtained results also confirm the views of scientists and experts dealing with the cooperation of science institutions with enterprises in Poland on the weakness of connections within the helix model, the occurrence of many barriers and difficulties in creating lasting and multilateral relations between science and business. This, of course, limits the transfer of knowledge and technology to the

economy. The authors' research also indicates the occurrence of a situation in Poland in which considerable public funds allocated to the functioning of higher education, support for R&D and innovative activities, and the development of innovation systems do not bring the expected effects.

This forces changes in the policy of supporting cooperation between science and business and technology transfer from HEIs to the economy. Among the numerous recommendations in this regard proposed by experts (e.g., Geodecki, Hausner (eds.), 2023; Matusiak, Guliński (eds.), 2013; Borowy, Sawicka, 2016), the authors point to a rapid change in the rules for evaluating the work of scientists who are currently focused on preparing and publishing high-scoring scientific articles and filling "slots"[4] (author's contribution to a publication). Their periodic evaluation of the employee and their position at the university depends to the greatest extent on this. This causes, apart from the lack of funds for research, that many scientists do not conduct studies and scientific research of an applied nature.

The state should also continue to support the development of academic entrepreneurship and the establishment of spin-off and spin-out companies. This promotes the transfer of knowledge and technology into the economy. It is also necessary to improve the effectiveness of mechanisms facilitating public-private cooperation, which would lead to actual implementations on a larger scale in the creation of scientific-industrial consortia (especially in terms of financing high-risk ventures). The majority of scientists from public universities conducting R&D work face difficulties in financing basic and applied research. Budgetary resources are too small, and the possibility of obtaining research grants is significantly limited. This points to the need for increased funding of R&D activities from both public and private sources.

Entrepreneurs in the SME sector also point to a lack of financial resources as the main problem in undertaking innovative activities. This problem is not mitigated by the possibility of applying for grants and subsidies. Introduced corporate tax credits for innovation activities are ineffective for a number of reasons (Łącka, 2021) and are not popular. "The gap related to the implementation phase is attempted to be managed by non-university seed funds and Venture Capital funds with significant public funds for financing innovation projects" (Borowy, Sawicka, 2016, p. 51). These funds are available to a small number of business entities – technology

[4] A publication slot, or unit share, is a measure of an author's contribution to a publication. A publication with a single author will fill 1 whole slot, while for multi-author publications, such a share must be calculated. For each person included in the "N number" (research staff), there are a maximum of 4 publication slots that will be reported. In the course of the evaluation, all publications can be submitted by the author, and the slots will be filled in the most favourable way. Note that 4 slots will only accrue to an employee who has worked full-time for the entire period covered by the evaluation and has reported only one scientific discipline. In other cases, the number of slots per employee will have to be adjusted by the product of the employee's time and contribution to the discipline and will be 4 times the averaged product of time and contribution in each year.

start-ups with high growth potential. The establishment of spin-off and spin-out companies by scientists provides an opportunity for the effective transfer of knowledge and technology to the economy, as through them, the level of readiness for implementation of research results is raised. As a result, it will be possible to implement new solutions in mature enterprises operating on a large scale.

According to the authors, systematic technological audits and analysis of current business needs should be conducted at universities. This type of research should include applied sciences, basic sciences with a technical and engineering profile, economic sciences and humanities. This will make it possible to reduce the asymmetry of information between the worlds of business and science and create the basis for cooperation in innovative ventures. It is noteworthy that the literature (Łącka, Brzezicki, 2022) increasingly emphasises the need to create ecological innovations, which are, on the one hand, expected by decision-makers of European countries, and, on the other hand, respond to the decisions of companies to implement corporate social responsibility and sustainable and ecological development of the business sector. Therefore, it is important for HEIs to play a significant role in this process.

This article only refers to two groups of higher education institutions (a fundamental limitation), which are among the main entities forming the NIS in Poland. Therefore, future research should focus on analysing the second large group of the research sector, namely public research institutes (PRI), developing and undertaking research in this area (Brzezicki, 2022; Brzezicki, Prędki, 2023) and comparing the two groups with each other. Research on their technology transfer efficiency can be carried out by considering different aspects, e.g., affiliation to networks, scientific consortia, nature of activities in scientific disciplines and other possible categories of analysis.

BIBLIOGRAPHY

Amry, D. K., Ahmad, A. J., Lu, D. (2021). The new inclusive role of university technology transfer: Setting an agenda for further research. *International Journal of Innovation Studies*, *5*(1), 9–22. DOI: 10.1016/j.ijis.2021.02.001.

Anderson, T. R., Daim, T., Lavoie, F. F. (2007). Measuring the efficiency of university technology transfer. *Technovation, 27*(5), 306–318. DOI: 10.1016/j.technovation.2006.10.003.

Angori, G., Marzocchi, C., Ramaciotti, L., Rizzo, U. (2023). A patent-based analysis of the evolution of basic, mission-oriented, and applied research in European universities. *The Journal of Technology Transfer*. DOI: 10.1007/s10961-023-10001-5.

Barra, C., Maietta, O. W., Zotti, R. (2021). The effects of university academic research on firm's propensity to innovate at local level: evidence from Europe. *The Journal of Technology Transfer*, *46*, 483–530. DOI: 10.1007/s10961-020-09791-9.

Barra, C., Castro-Peña, M. Y., Coello, J. G. (2023). Research and knowledge transfer performance in Colombian universities. *Quality & Quantity, 2023,* 1–21. DOI: 10.1007/s11135-023-01627-6.

Bonaccorsi A., Daraio, C., Simar, L. (2006). Advanced indicators of productivity of universities an application of robust nonparametric methods to Italian data. *Scientometrics*, *66*(2), 389–410. DOI: 10.1007/s11192-006-0028-x.

Banker, R. D., Charnes, A., Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*, 1078–1092. DOI: 10.1287/mnsc.30.9.1078.

Bentley, P. J., Gulbrandsen, M., Kyvik, S. (2015). The relationship between basic and applied research in universities. *Higher Education*, *70*(4), 689–709. DOI: 10.1007/s10734-015-9861-2.

Borowy, M., Sawicka, J. (2016). Transfer innowacji z sektora nauki do otoczenia gospodarczego – teoria i praktyka. Przykład polskich uczelni przyrodniczych [Innovation transfer from the science sector to the economic environment on the example of Polish universities of life sciences]. *Roczniki Naukowe Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich, 103*(3), 43–52.

Brzezicki, Ł. (2019). Measurement of efficiency education in public higher education institutions not subject to the supervision of the ministry of science and higher education in Poland. *Polityka i Społeczeństwo*, *4*(17), 139–152. DOI: 10.15584/polispol.2019.4.9.

Brzezicki, Ł. (2020). Przegląd badań dotyczących efektywności i produktywności polskiego szkolnictwa wyższego prowadzonych za pomocą metody DEA i indeksu Malmquista [A review of research on the efficiency and productivity of Polish higher education conducted for the DEA and the Malmquist Index]. *Ekonomia – Wroclaw Economic Review*, *26*(2), 19–40. DOI: 10.19195/2658-1310.26.2.2.

Brzezicki, Ł. (2022). Działalność publicznych instytutów badawczych w Polsce [Operations of public research institutes in Poland]. *Nauki Ekonomiczne*, *36*, 35–83. DOI: 10.19251/ne/2022.36(2).

Brzezicki, Ł., Prędki, A. (2023). An Estimation of the Efficiency of Public Research Institutes in Poland – DEA Approach. *Cracow Review of Economics and Management*, *2*(1000), 33–50. DOI: 10.15678/ZNUEK.2023.1000.0202.

Cao, Q., Li, Y., Peng, H. (2023). From university basic research to firm innovation: diffusion mechanism and boundary conditions under a U-shaped relationship. *Technovation*, *123*, 102718. DOI: 10.1016/j.technovation.2023.102718.

Charnes, A., Cooper, W. W., Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *6*(2), 429–444. DOI: 10.1016/0377-2217(78)90138-8.

Chen, X., Shu, X. (2021). The Scientific and Technological Innovation Performance of Chinese World-Class Universities and its Influencing Factors. *IEEE Access*, *9*, 84639–84650. DOI: 10.1109/ACCESS.2021.3087659.

Chuanyi, W., Xiaohong, L., Shikui, Z. (2016). The Relative Efficiencies of Research Universities of Science and Technology in China: Based on the Data Envelopment Analysis and Stochastic Frontier Analysis. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(10), 2753–2770. DOI: 10.12973/eurasia.2016.02302a.

Compagnucci, L., Spigarelli, F. (2020). The Third Mission of the university: A systematic literature review on potentials and constraints. *Technological Forecasting and Social Change*, *161*, 120284. DOI: 10.1016/j.techfore.2020.120284.

Cooper, W. W., Seiford, L. M., Tone, K. (2007). *Data Envelopment Analysis. A Comprehensive Text with Models, Applications, References and DEA-Solver Software*. New York: Springer.

De Witte, K., López-Torres, L. (2017). Efficiency in education: a review of literature and a way forward. *Journal of the Operational Research Society*, *68*(4), 339–363. DOI: 10.1057/jors.2015.92.

de la Torre, E. M., Agasisti, T., Perez-Esparrells, C. (2017). The relevance of knowledge transfer for universities' efficiency scores: an empirical approximation on the Spanish public higher education system. *Research Evaluation*, *26*(3), 211–229. DOI: 10.1093/reseval/rvx022.

de Wit-de Vries, E., Dolfsma, W. A., van der Windt, H. J., Gerkema, M. P. (2019). Knowledge transfer in university–industry research partnerships: a review. *The Journal of Technology Transfer*, *44*, 1236–1255. DOI: 10.1007/s10961-018-9660-x.

Foltz, J. D., Barham, B. L., Chavas, J. P., Kim, K. (2012). Efficiency and technological change at US research universities. *Journal of Productivity Analysis*, *37*(2), 171–186. DOI: 10.1007/s11123-011-0249-8.

Geodecki, T., Hausner, J. (eds.). (2023). *Współpraca uczelni z biznesem. Polska na tle wybranych krajów Unii Europejskiej [University-business cooperation. Poland in comparison with selected EU countries]*. Kraków: Fundacja Gospodarki i Administracji Publicznej.

Gralka, S., Wohlrabe, K., Bornmann, L. (2019). How to measure research efficiency in higher education? Research grants vs. publication output. *Journal of Higher Education Policy and Management*, *41*(3), 322–334. DOI: 10.1080/1360080X.2019.1588492.

Han, J. (2018). Effects of Technology Transfer Policies on the Technical Efficiency of Korean University TTOs. *KDI Journal of Economic Policy*, *40*(4), 23–45. DOI: 10.23895/kdijep.2018.40.4.23.

Hou, B., Hong, J., Shi, X. (2019). Efficiency of university–industry collaboration and its determinants: evidence from Chinese leading universities. *Industry and Innovation, 28*(4), 456–485. DOI: 10.1080/13662716.2019.1706455.

Kaffash, S., Matin, R. K., Tajik, M. (2018). A directional semi-oriented radial DEA measure: an application on financial stability and the efficiency of banks. *Annals of Operations Research*, *264*, 213–234. DOI: 10.1007/s10479-017-2719-5.

Kim, J., Anderson, T., Daim, T. (2008). Assessing university technology transfer: a measure of efficiency patters. *International Journal of Innovation and Technology Management*, *5*(4), 495–526. DOI: 10.1142/S0219877008001497.

Kirby, D. A., El Hadidi, H. H. (2019). University technology transfer efficiency in a factor driven economy: The need for a coherent policy in Egypt. *The Journal of Technology Transfer*, *44*(5), 1367–1395. DOI: 10.1007/s10961-019-09737-w.

Li, T., Yang, X. (2023). Conflict or facilitation? Faculty members' teaching time and their research performance. *Higher Education, 2023*. DOI: 10.1007/s10734-023-01071-3.

Łącka, I. (2020). Barriers to using of quintuple helix model to create innovations in Polish regions. *Scientific Papers of Silesian University of Technology. Organization and Management Series, 146*, 232–251. DOI: 10.29119/1641-3466.2020.146.18.

Łącka, I., Brzezicki, Ł. (2020). Efficiency of the research and development activities of technical universities in Poland. *Nierówności Społeczne a Wzrost Gospodarczy*. *Social Inequalities and Economic Growth*, *63*(3), 258–274. DOI: 10.15584/nsawg.2020.3.13.

Łącka, I. (2021). Skuteczność dotychczasowych i przyszłych ulg podatkowych wspierających działalność innowacyjną przedsiębiorstw a innowacyjność Polski [Effectiveness of past and future tax incentives to support business innovation and Poland's innovativeness]. In: A. Bielecki, D. Szafrański, T. Gąsior (eds.), *Problemy prawa polskiego i obcego w ujęciu historycznym, praktycznym i teoretycznym*, cz. 12, (pp. 91–116). Warszawa: C.H. Beck.

Łącka, I., Brzezicki, Ł. (2021). The Efficiency and Productivity Evaluation of National Innovation Systems in Europe. *European Research Studies Journal*, *24* (Special Issue: 3), 471–496. DOI: 10.35808/ersj/2440.

Łącka, I., Brzezicki, Ł. (2022). Joint analysis of national eco-efficiency, eco-innovation and SDGS in Europe: DEA approach. *Technological and Economic Development of Economy*, *28*(6), 1739–1767. DOI: 10.3846/tede.2022.17702.

Leitner, K.-H., Prikoszovits, J., Schaffhauser-Linzatti, M., Stowasser, R., Wagner, K. (2007). The impact of size and specialisation on universities' department performance: A DEA analysis applied to Austrian universities. *Higher Education*, *53*, 517–538. DOI: 10.1007/s10734-006-0002-9.

Lucovics, M., Zuti, B. (2015). New Functions of Universities in Century XXI Towards "Fourth Generation" Universities. *Transition Studies Review, 22*(2), 33–48. DOI: 10.14665/1614-4007-22-2-003.

Matusiak, K. B., Guliński, J. (eds.). (2013). *Rekomendacje zmian w polskim systemie transferu technologii i komercjalizacji wiedzy* [*Recommendations for changes in the Polish system of technology transfer and knowledge commercialisation*]. Warszawa: PARP.

Ministry of Justice (2019). Monitor Sądowy i Gospodarczy. View monitors. Retrieved from: https://ems.ms.gov.pl/msig/przegladaniemonitorow (2019.03.01).

Ministry of Science and Higher Education (2019a). *Scientific projects in the selected year*. Retrieved from: https://radon.nauka.gov.pl/raporty/projekty-naukowe (2019.03.01).

Ministry of Science and Higher Education (2019b). *Polish Scientific Bibliography. Analytical Module: Analysis of publications*. Retrieved from: https://pbn.nauka.gov.pl/pbn-report-web (2019.03.01).

Ministry of Science and Higher Education (2020). Ewaluacja transferu wiedzy i technologii – nowe rozwiązanie w systemie szkolnictwa wyższego i nauki [Evaluation of knowledge and technology transfer a new solution in the system of higher education and science]. Retrieved from: https://www.gov.pl/web/edukacja-i-nauka/ewaluacja--transferu-wiedzy-i-technologii--nowe-rozwiazanie-w-systemie-szkolnictwa-wyzszego-i-nauki (2020.09.01).

Osuch-Rak, E. (2017). Transfer technologii w Polsce na przykładzie spółek odpryskowych wywodzących się z instytutów badawczych i naukowych [Technology transfer in Poland on the example of spin-offs from research and scientific institutes]. *Kwartalnik Kolegium Ekonomiczno-Społecznego. Studia i Prace*, *3*, 131–149. DOI: 10.33119/KKESSiP.2017.3.9

Padilla Bejarano, J. B., Zartha Sossa, J. W., Ocampo-López, C., Ramírez-Carmona, M. (2023). University Technology Transfer from a Knowledge-Flow Approach–Systematic Literature Review. *Sustainability*, *15*, 6550. DOI: 10.3390/su15086550.

Pastor, J., Ruiz, J. (2007). Variables with negative values in DEA. In: J. Zhu, W. Cook (eds.), *Modeling data irregularities and structural complexities in data envelopment analysis* (pp. 63–84). New York: Springer.

Perkmann, M., Salandra, R., Tartari, V., McKelvey, M., Hughes, A. (2021). Academic engagement: A review of the literature 2011–2019. *Research Polic*y, *50*(1), 104114. DOI: 10.1016/j.respol.2020.104114.

Rhaiem, M. (2017). Measurement and determinants of academic research efficiency: a systematic review of the evidence. *Scientometrics*, *110*, 581–615. DOI: 10.1007/s11192-016-2173-1.

Rossoni, A. L., Gondim de Vasconcellos, E. P., de Castilho Rossoni, R. L. (2023). Barriers and facilitators of university-industry collaboration for research, development and innovation: a systematic review. *Management Review Quarterly, 2023,* 1–37. DOI: 10.1007/s11301-023-00349-1.

Rybnicek, R., Königsgruber, R. (2019). What makes industry–university collaboration succeed? A systematic review of the literature. *Journal of Business Economics, 89*, 221–250. DOI: 10.1007/s11573-018-0916-6.

O'Dwyer, M., Filieri, R., O'Malley, L. (2023). Establishing successful university–industry collaborations: barriers and enablers deconstructed. *The Journal of Technology Transfer*, *48*, 900–931. DOI: 10.1007/s10961-022-09932-2.

Santos, J. M., Horta, H., Luna, H. (2022). The relationship between academics' strategic research agendas and their preferences for basic research, applied research, or experimental development. *Scientometrics, 127*, 4191–4225. DOI: 10.1007/s11192-022-04431-5.

Shamohammadi, M., Oh, D.-H. (2019). Measuring the efficiency changes of private universities of Korea: A two-stage network data envelopment analysis. *Technological Forecasting & Social Change*, *148*, 119730. DOI: 10.1016/j.techfore.2019.119730.

Shah, S. I., Shahjehan, A., Afsar, B. (2019). Determinants of Entrepreneurial University Culture Under Unfavorable Conditions: Findings from a Developing Country. *Higher Education Policy*, *32*(3), 1–23. DOI: 10.1057/s41307-018-0083-y.

Sharma, P. (2022). A Framework to Manage University-Industry Technology Transfer. *International Journal of Innovation and Technology Management, 19*(08), 2250033. DOI: 10.1142/S021987702250033X.

Statistics Poland (2019). *High education and its finances in 2018*. Warsaw: GUS.

Tone, K., Chang, T.-S., Wu, C.-H. (2020). Handling Negative Data in Slacks-Based Measure Data Envelopment Analysis Models. *European Journal of Operational Research*, *282,* 926–935. DOI: 10.1016/j.ejor.2019.09.055.

Tone, K. (2001). A slacks based measure of efficiency in data envelopment analysis. *European Journal of Operational Research*, *130*(3), 498–509. DOI: 10.1016/S0377-2217(99)00407-5.

Tone, K. (2011). Slacks-Based Measure of Efficiency. In: W. W. Cooper, L. M. Seiford, J. Zhu (Eds.), *Handbook on Data Envelopment Analysis* (pp. 195–209). New York: Springer.

Tseng, A. A., Raudensky, M. (2014). Performance Evaluations of Technology Transfer Offices of Major US Research Universities. *Journal of Technology Management & Innovation*, *9*(1), 93–102. DOI: 10.4067/S0718-27242014000100008.

Urbanek, P. (2020). The Evolution of Institutional Logic in Poland's Higher Education System under Reform, *Gospodarka Narodowa. The Polish Journal of Economics*, *302*(2), 95–122. DOI: 10.33119/GN/120625.

Visbal-Cadavid, D., Martínez-Gómez, M., Guijarro, F. (2017). Assessing the Efficiency of Public Universities through DEA. A Case Study. *Sustainability*, *9*, 1–19. DOI: 10.3390/su9081416.

Werker, C., Hopp, C. (2020). Balancing act between research and application: how research orientation and networks affect scholars' academic and commercial output. *Journal of Business Economics*, *90*, 1171–1197. DOI: 10.1007/s11573-020-00979-x.

Wolszczak-Derlacz, J. (2013). *Efektywność naukowa, dydaktyczna i wdrożeniowa publicznych szkół wyższych w Polsce – analiza nieparametryczna [Scientific, didactic and implementation efficiency of public higher education in Poland – non-parametric analysis]*. Gdańsk: Wydawnictwo Politechniki Gdańskiej.

Wolszczak-Derlacz, J. (2018). Assessment of TFP in European and American higher education institutions – application of Malmquist indices. *Technological and Economic Development of Economy*, *24*(2), 467–488. DOI: 10.3846/20294913.2016.1213197.

Xiong, X., Yang, G.-L., Guan, Z.-C. (2020). Estimating the multi-period efficiency of high-tech research institutes of the Chinese Academy of Sciences: A dynamic slacks--based measure. *Socio-Economic Planning Sciences*, *71*, 100855. DOI: 10.1016/j.seps.2020.100855.

Xiong, X., Yang, G.-L., Zhou, D.-Q., Wang, Z.-L. (2022). How to allocate multi-period research resources? Centralized resource allocation for public universities in China using a parallel DEA-based approach. *Socio-Economic Planning Sciences*, *82*(B), 101317. DOI: 10.1016/j.seps.2022.101317.

Yaisawarng, S., Ng, Y. C. (2014). The impact of higher education reform on research performance of Chinese universities. *China Economic Review*, *31*, 94–105. DOI: 10.1016/j.chieco.2014.08.006.

Yang, G.-L., Fukuyama, H., Song, Y.-Y. (2018). Measuring the inefficiency of Chinese research universities based on a two-stage network DEA model. *Journal of Informetrics*, *12*(1), 10–30 DOI: 10.1016/j.joi.2017.11.002.

Yoda, N., Kuwashima, K. (2020). Triple Helix of University-Industry-Government Relation in Japan: Transitions of Collaborations and Interactions. *Journal of the Knowledge Economy, 11*, 1120–1144. DOI: 10.1007/s13132-019-00595-3.

APPENDIX

Table A1. Empirical studies using the DEA method to measure the efficiency of Higher Education and Sciences

Author	Inputs (I)/Outputs (O)	Methodology
Leitner *et al.* (2007)	I: number of staff and room space O: financial funds provided by third parties, finished projects, monographs, original papers, project reports, patents, presentations, other publications, number of finished, supervised PhD-theses	CCR, BCC
Foltz *et al.* (2012)	I: number of faculty, post-doctoral researchers, graduate students O: number of journal articles, patents, trained undergraduate students, and trained PhD graduate students	Two-stage analysis, DDF
Wolszczak--Derlacz (2013)	I: number of academic staff, total revenue O: patent applications, patent registrations, publications, citations, grants	Two-stage analysis with bootstrap, Malmquist
Yaisawarng and Ng (2014)	I: research staff, research expenditure, ranking of the previous year O: number of publications, international articles, domestic articles, grants	Meta-frontier DEA, Malmquist
Chuanyi *et al.* (2016)	I: faculties, annual educational expenditure, area of classrooms, area of laboratories O: bachelor, master and doctor degree, publication, patents	BCC, SBM
Visbal-Cadavid *et al.* (2017)	I: FTE academics, admin staff expenditure, total revenue (without the income of research), fixed assets O: articles, number of indexed journals, faculty mobility, number of undergraduate and postgraduate students	CCR, BCC, SBM, CE model, Malmquist
Yang *et al.* (2018)	I: R&D funds, teaching and research staff and government block funds O: number of publications, the total number of students, the total number of patents (including patent applications and authorised patents), the number of other intellectual property forms (e.g., software copyrights).	Two-stage network DDF, Network Luenberger
Hou *et al.* (2019)	I: FTE of universities' R&D personnel, universities' science funds entrusted by enterprises and institutions per teacher, O: number of scientific and technological achievements and technology transfer contracts, patents for co-application between universities and enterprises.	Two-stage analysis with bootstrap, Malmquist

Author	Inputs (I)/Outputs (O)	Methodology
Shamohammadi and Oh (2019)	I: number of full-time academic staff, number of full-time non-academic staff, amount of annual research funds, number of undergraduate and postgraduate students, fixed assets O: number of publications and citations, international patents, degree-awarded students: undergraduate and postgraduate Intermediate I/O: number of degrees awarded to undergraduate students in an academic year	A variant of the two-stage network DEA
Gralka *et al.* (2019)	I: sum of annual personnel and other current expenditures, wages O: research grants, publications, the total number of graduates by science and non-science subject categories.	DEA (BCC), SFA
Łącka and Brzezicki (2020)	I: R&D personnel O: patent applications, patent registrations Carry-over links: expenditure R&D	Dynamic SBM
Xiong *et al.* (2020)	I: R&D personnel, internal expenditures for scientific and technological innovation activities O: number of citations, domestically applied patents, domestically granted patents Carry-over links: accumulated R&D expenditure	Dynamic SBM
Chen and Shu (2021)	I: number of full-time personnel, the internal expenditure on research funds, the number of S&T subjects O: number of papers, citations, patent authorisations, the national award for S&T achievements, income from technology transfer, patent sale and school-run industries	Superefficient BCC, Malmquist
Xiong *et al.* (2022)	I: R&D personnel, government funding, number of postgraduates O: number of high-quality papers, number of granted patents, knowledge transfer and transformation	Parallel DEA
Barra *et al.* (2023)	I: academic staff, number of enrolled students, non-academic staff, ratio between enrolled students and teachers O: books, scientific events, teaching activities, position of the university in SCIMAGO Institutions rankings, publications, invention patents	BCC, Malmquist

Note: Publications ranked by year of publication.

Source: own elaboration based on literature.

Table A2. The efficiency of higher education institutions in model M1 and M2 in 2016

G*	U*	Names	M1	M2	Mean
Universities	U1	University of Warsaw	1.000	0.294	0.647
	U2	University of Białystok	1.000	0.040	0.520
	U3	University of Gdańsk	1.000	0.075	0.538
	U4	Adam Mickiewicz University in Poznań	1.000	0.162	0.581
	U5	Jagiellonian University in Kraków	1.000	0.343	0.672
	U6	University of Łódź	1.000	0.120	0.560
	U7	Maria Curie-Skłodowska University in Lublin	0.711	0.095	0.403
	U8	Nicolaus Copernicus University	0.854	0.001	0.428
	U9	Opole University	1.000	0.153	0.577
	U10	University of Silesia	0.839	0.212	0.526
	U11	University of Warmia and Mazury	1.000	0.279	0.640
	U12	University of Wrocław	0.859	0.068	0.464
	U13	Cardinal Stefan Wyszyński University	1.000	0.001	0.501
	U14	University of Zielona Góra	0.455	0.092	0.274
	U15	Kazimierz Wielki University in Bydgoszcz	0.852	0.072	0.462
	U16	Jan Kochanowski University in Kielce	0.976	0.076	0.526
Technical Universities	U17	The West Pomeranian University of Technology in Szczecin	0.284	1.000	0.642
	U18	Warsaw University of Technology	0.550	0.614	0.582
	U19	Białystok University of Technology	0.571	0.193	0.382
	U20	University of Technology and Humanities in Bielsko-Biała	1.000	1.000	1.000
	U21	Częstochowa University of Technology	1.000	0.003	0.502
	U22	Gdańsk University of Technology	0.407	0.526	0.467
	U23	Silesian University of Technology	1.000	0.583	0.792
	U24	Kielce University of Technology	0.467	1.000	0.734
	U25	Koszalin University of Technology	0.650	0.473	0.562
	U26	Cracow University of Technology	0.347	0.305	0.326
	U27	AGH University of Science and Technology	1.000	0.807	0.904
	U28	Lublin University of Technology	1.000	1.000	1.000
	U29	Łódź University of Technology	0.461	0.830	0.646
	U30	Opole University of Technology	0.683	0.245	0.464
	U31	Poznań University of Technology	0.313	0.781	0.547
	U32	Kazimierz Pulaski University of Technology and Humanities in Radom	0.745	1.000	0.873
	U33	Rzeszów University of Technology	0.358	0.322	0.340
	U34	Wrocław University of Technology	0.428	1.000	0.714

Note: G* – Group, U* – Number of units.

Source: own elaboration based on literature.

Summary

The objective of the article is to measure and evaluate the efficiency of scientific activity and technology transfer to the economy by public higher education institutions (HEIs) in Poland and to formulate recommendations for state policy to increase the effectiveness of the technology transfer process by them. The study measured scientific activity and technology transfer separately in two groups of higher education institutions (i.e., universities and technical universities). Two non-radial models, SBM and BP-SBM, which belong to the non-parametric Data Envelopment Analysis (DEA) method, were used for the study.

All examined higher education institutions are more efficient in basic research than in transferring technology to the economy. However, technical universities are more efficient in technology transfer and universities in basic research. In most cases, technical universities are more accomplished in scientific activity than universities in technology transfer. Research shows that universities have been almost entirely focused on basic research, and technical universities have engaged in basic research and technology transfer to the economy in various ways. The research results confirmed the existence of very weak links between science and business in terms of knowledge and technology transfer to the economy. This is due to many factors. The authors presented recommendations for necessary actions that will enable the increase of technology transfer by public universities in Poland.

An interesting direction of future research is the measurement and evaluation of the effectiveness of technology transfer of the second group of NIS entities in Poland, i.e. research institutes.

Keywords: higher education, technology transfer, efficiency, DEA.

Efektywność działalności naukowej i transferu technologii w szkolnictwie wyższym w Polsce

Streszczenie

Celem artykułu jest pomiar i ocena efektywności działalności naukowej i transferu technologii do gospodarki przez publiczne szkoły wyższe w Polsce oraz sformułowanie rekomendacji dla polityki państwa na rzecz zwiększenia efektywności procesu transferu technologii przez nie. W badaniu dokonano pomiaru aktywności naukowej i transferu technologii oddzielnie w dwóch grupach szkół wyższych (tj. uniwersytetach i politechnikach). Do badania wykorzystano dwa modele nieradialne SBM i BP-SBM, należące do nieparametrycznej metody Data Envelopment Analysis (DEA).

Wszystkie badane szkoły wyższe są bardziej efektywne w zakresie badań podstawowych niż transferu technologii do gospodarki. Uczelnie techniczne są bardziej efektywne w transferze technologii, a uniwersytety w badaniach podstawowych. W większości przypadków uczelnie techniczne są bardziej efektywne w działalności naukowej niż uniwersytety w transferze technologii. Badania pokazują, że uniwersytety niemal w całości koncentrowały się na badaniach podstawowych, a uczelnie techniczne w różny sposób angażowały się w badania podstawowe i transfer technologii do gospodarki. Wyniki badań potwierdziły występowanie bardzo słabych powiązań nauki i biznesu w zakresie transferu wiedzy i technologii do gospodarki. Wynika to z wielu czynników. Autorzy przedstawili rekomendacje niezbędnych działań, które umożliwią zwiększenie transferu technologii przez publiczne uniwersytety w Polsce. Interesującym kierunkiem przyszłych badań jest pomiar i ocena efektywności transferu technologii drugiej grupy podmiotów NSI w Polsce, tzn. instytutów badawczych.

Słowa kluczowe: szkolnictwo wyższe, transfer technologii, efektywność, DEA.

JEL: I21, I22, I23.

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Impact of the COVID-19 pandemic on IT competencies of students

Introduction

The COVID-19 pandemic has increased the need for computer literacy skills in both personal and professional contexts. Demographic factors, such as age and education level, may impact the level of these competencies.

The aim of this study is to determine the level of computer literacy of the respondents. Various computer literacy competencies were verified, such as using a computer, using a smartphone/phone, technical Internet operation, using new software, using mobile devices, and using mobile applications.

The motivation behind this research was the growing importance of computer literacy skills in the digital era, particularly considering the COVID-19 pandemic and the increasing shift to remote learning and work. The study aims to explore the extent to which people possess these skills and to identify any areas where individuals may need additional support or training.

The main research hypothesis is that the majority of respondents possess basic computer literacy skills, but they may have varying levels of proficiency in specific computer literacy competencies, such as using new software.

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Impact of the COVID-19 pandemic on the functioning of higher education institutions in Poland

The COVID-19 pandemic has had an impact on the functioning of higher education institutions in Poland. It has affected the organisation of work, the mode of education, and the relationships between academic staff and students (Bao, 2020). As a result of the pandemic, schools and universities in Poland were forced to move their classes to online mode, which required academic staff and students to adapt to new methods of work (Bao, 2020). At the same time, some universities had difficulties in providing adequate sufficient IT infrastructure and Internet access for students (Trust, Whalen, 2020). The pandemic also affected the finances of universities, as many of them experienced a decrease in the number of students and a reduction in funding (Al-Samarrai, Gangwar, Gala, 2020).

During the COVID-19 pandemic, many higher education institutions around the world decided to move their classes to online mode, which required changes in the way academic teachers and students organised their work (Bao, 2020). In Poland, most universities decided to conduct classes online or in a hybrid mode, where some classes were held in-person and some in online mode (Trust, Whalen, 2020). The organisation of classes in online mode required academic teachers to adapt the content and teaching methods to the new conditions and skills in using e-learning platforms (Kukolja Taradi et al., 2005). Students had to adapt to the new mode of work, organise their time and ensure effective remote learning (Kukolja Taradi et al., 2005). At the same time, the transfer of classes to online mode affected the relationships between academic teachers and students, who had to cope with new challenges related to communication and interaction in remote mode (Kukolja Taradi et al., 2005).

Competencies in information technology and COVID-19 pandemic

Digital competencies refer to a set of skills and knowledge related to the use of digital technologies. They include computer literacy, Internet and digital application usage, efficient information retrieval, as well as programming and website creation skills. Digital competencies are essential in modern education and work, as digital technology is present in all aspects of life and the economy. Individuals with strong digital competencies are able to effectively use available digital tools, which in turn allow them to work, learn, and communicate more efficiently.

According to the European Committee for Standardization (CEN), digital competencies are "general and specialist skills related to the use of digital technologies, which include communication and information skills, multimedia usage, problem-solving, Internet use, programming, content creation, and ensuring online safety" (Ferrari, 2013, p. 3).

Research suggests that the COVID-19 pandemic has had an impact on the digital competencies of students worldwide (Bao, 2020; Trust, Whalen, 2020; Daniel, 2020). As a result of the pandemic, students became more interested in digital technologies, including educational applications (Daniel, 2020). Many schools and universities moved their classes online, which required students to develop skills in using various digital tools (Bao, 2020). However, some students from disadvantaged families who did not have access to appropriate equipment or Internet connectivity experienced difficulties in accessing education (Trust, Whalen, 2020).

During the COVID-19 pandemic, students faced many challenges related to digital competencies that were necessary for remote work and online learning. Often, students struggled with access to adequate IT infrastructure, including fast and stable Internet connectivity and appropriate computer equipment (Al-Samarrai, Gangwar, Gala, 2020). Moreover, some students had difficulties using e-learning platforms and applications that were new to them and required them to develop new skills (Kukolja Taradi et al., 2005). Difficulties were also reported in effectively organising their work time and in maintaining motivation for remote learning (Kukolja Taradi et al., 2005).

Tools and platforms used in universities for conducting online classes

During the COVID-19 pandemic, many universities around the world decided to switch to remote learning. To enable this, various tools and platforms were used, allowing classes to be conducted online. Among the most commonly used tools were Microsoft Teams, Zoom, Google Meet, Moodle, and e-courses (Trust, Krutka, Carpenter, 2016). Each tool has its own advantages and disadvantages. Microsoft Teams makes it easy to organise online meetings and share materials, but requires a stable Internet connection (Bao, 2020). Zoom supports online meetings with many participants at once, but may be less stable than other tools and requires a fast Internet connection (Bao, 2020). Google Meet is a user-friendly tool, but requires a Google account (Bao, 2020). Moodle makes it easy to share materials and conduct interactive classes, but requires certain technical skills (Trust, Krutka, Carpenter, 2016). E-courses, on the other hand, are easy to use and provide remote learning in an asynchronous mode, but require a lot of work to create content (Trust, Krutka, Carpenter, 2016).

The problem of digital exclusion in higher education

Digital exclusion is a phenomenon in which individuals who lack digital skills or access to digital technologies are excluded from full participation in social,

cultural, or economic life (Warschauer, 2004). According to other definitions, digital exclusion is inequalities in access and skills in using information and communication technologies that affect the social, economic, and educational situation of individuals (Hargittai, 2002).

Digital exclusion in higher education is a serious problem that has been exacerbated during the COVID-19 pandemic. According to research, many people are experiencing difficulties in using digital technologies, which leads to exclusion from the learning process (Zhang et al., 2020). This problem affects not only students but also academic and administrative staff who, for various reasons, are not proficient with modern tools (Zhang et al., 2020).

According to another study, the problem of digital exclusion in higher education is due, among other things, to a lack of access to appropriate hardware and software, a lack of computer skills, and poor Internet access (Bozkurt, Sharma, Stockdale, 2020). As a result of these difficulties, many people are unable to participate in online classes, which in turn leads to a deterioration in academic performance and limits opportunities for professional development (Bozkurt, Sharma, Stockdale, 2020).

Information technology skills required of students during the COVID-19 pandemic

The COVID-19 pandemic has somewhat forced students to acquire certain computer skills, including (see Table 1):

- general computer skills,
- smartphone/phone skills,
- technical Internet support skills,
- skills in using new software,
- skills in using mobile devices,
- skills in using mobile applications.

Table 1. IT competencies

Skills	Specification
1	*2*
Skills in operating a computer	– Operating e-learning platforms – Time management – Technical skills – Online communication – Self-education
Skills in operating a smartphone/phone	– Ability to use remote education, communication, and time management platforms – Ability to manage the time of using mobile devices to prevent negative consequences of excessive screen exposure

1	*2*
Skills in technical handling of the Internet	– Proficient use of computer and Internet devices – Knowledge of basic terms related to the Internet – Ability to use different Internet browsers and applications – Knowledge of basic functions of office applications – Ability to use e-learning platforms and tools for online communication – Knowledge of basic Internet safety rules
Skills in operating new programs	– Ability to install and update software – Knowledge of basic functions of videoconferencing programs – Familiarity with teamwork tools – Knowledge of video and graphic editing software – Knowledge of basic principles of user interface design and website creation –Knowledge of cloud computing technology
Skills in operating mobile devices	– Knowledge of basic functions of mobile devices – Familiarity with distance education tools – Familiarity with tools for organising work – Knowledge of applications for creating and editing documents – Familiarity with project management tools – Knowledge of basic principles of digital security and privacy protection
Skills in operating mobile applications	– Navigation and usability of mobile interfaces – Mobile application installation and updating – Knowledge of mobile operating systems (Android, iOS) – Ability to customise mobile device settings – Ability to use different types of mobile applications (social media, productivity, entertainment) – Knowledge of mobile security principles – Ability to troubleshoot mobile application issues – Ability to manage and organise mobile applications

Source: own work, based on (Kimmons, Veletsianos, 2020; Hew, Cheung, 2014; Gilster, 1997; Eshet-Alkalai, 2004, pp. 93–106; Ala-Mutka, 2011; Hodges et al., 2020; Zawacki-Richter et al., 2019; Lemola et al., 2015; Wang et al., 2009).

Diverse skills are required from students in the context of remote learning, as well as work and life in the digital era. With the development of technology, technical skills have become essential for people in various aspects of life. Specifically, skills in operating e-learning platforms, online communication, and using mobile devices are necessary in the era of the COVID-19 pandemic, where many activities are carried out remotely (Hsin, Cigas, 2013; Bosch, 2009; Ribble, Bailey, 2007; Lemola et al., 2015, Wang et al., 2009).

Time management is also crucial to ensure effective work and learning in the digital era. This requires self-discipline and planning skills to ensure regular participation in classes, completion of homework, and project implementation (Kirschner, Karpinski, 2010; Jaggars, Xu, 2016).

Knowledge of the basic principles of digital security and privacy protection is also very important, especially in the context of using the Internet and mobile devices. Technology users should know how to protect their data and avoid cybercrime threats (Gallardo-Echenique et al., 2015; Joksimović et al., 2018).

In the digital era, new technologies and tools are constantly evolving, which requires people to continuously learn and improve their skills. The ability to quickly acquire new skills and adapt to changing conditions is crucial for survival and success in today's world of work and learning (Weller, 2020; Pappano, 2012).

Presentation of empirical research

This study cites the results of empirical research conducted in February 2021. The aim of the research was to illustrate the computer skills of the individuals surveyed. The research sample consisted of 649 respondents. During the research, the authors obtained the following socio-demographic data:

- gender: 415 females (63.9% of those surveyed) and 234 males (36.1% of those surveyed) participated in the study;
- educational level: most of the respondents had a bachelor's or engineering degree – 367 people (56.5%), while 282 people (43.5%) had a master's degree;
- occupational activity: most of the respondents worked permanently – 511 people (78.7%), 54 people (8.3%) did not work, 46 people (7.1%) worked part-time, and 38 people (5.9%) owned their own business;
- expected form of employment: the majority of the respondents, 451 people (61.3%), expected to be employed in a full-time job. 167 people (22.7%) wanted to run their own business, 85 people (11.5%) expected a contract for specific work or a task, and 33 people (4.5%) planned to work as freelancers;
- current position: most of the respondents, 444 people (68.4%), worked as employees. 56 people (8.6%) held mid-level managerial positions, 54 people (8.3%) held low-level managerial positions, and 33 people (5.1%) held top-level managerial positions. 53 people (8.2%) did not work, and 9 people (1.4%) were completing an internship.

Future workplace: The largest group of the respondents, 196 people (30.2%), planned to run their own business. 154 people (23.7%) wanted to work in a medium-sized company employing up to 100 people, 126 people (19.4%) in an international corporation, and 109 people (16.8%) in a large company employing up to 1000 people. 64 people (9.9%) expected to work in a small family business with up to 10 people. The total number of respondents was 649 people, but the column regarding the expected form of employment yielded a result of 736 people, which indicates that some respondents chose more than one answer to this question.

The research was aimed at determining the computer skills of each individual surveyed. Various computer skills were verified (computer usage, smartphone/telephone usage, technical Internet support, new program usage, mobile device usage, mobile app usage).

The overview of the respondents' answers is optimistic. The vast majority of respondents possess the mentioned skills, although some individuals in the surveyed group have difficulties using new programs. Detailed data on this topic are presented in Table 2.

Table 2. Skill level of IT competencies

Skill level						
Respondents' answers	In the use of a computer	In the use a smartphone / phone	In technical support of the Internet	In the use of new programs	In the use of mobile devices	In the use of mobile applications
Definitely not	2	1	2	3	1	1
Rather not	3	3	11	33	4	3
I have no opinion	7	5	33	107	33	34
Probably yes	195	103	216	312	242	242
Definitely	442	537	387	194	369	369
Total	**649**	**649**	**649**	**649**	**649**	**649**

Source: own work.

The study shows that the majority of the respondents declared IT competencies in using computers, smartphones/phones, technical Internet support, as well as mobile devices and applications. However, there are people who have difficulties in handling new programs.

In this study, cross-relationships between variables were also determined. To this end, the Pearson correlation coefficient was used, which is a measure of the linear dependence between the following variables. The correlation coefficients obtained are presented in Table 3.

Table 3. Correlation between variables

Variables	No.	1	2	3	4	5	6
In the use of a computer	**1**	**1**	0.937	0.738	0.453	0.870	0.870
In the use a smartphone/phone	**2**	0.937	**1**	0.750	0.456	0.879	0.879
In technical support of the Internet	**3**	0.738	0.750	**1**	0.670	0.823	0.824
In the use of new programs	**4**	0.453	0.456	0.670	**1**	0.614	0.615
In the use of mobile devices	**5**	0.870	0.879	0.823	0.614	**1**	1.000
In the use of mobile applications	**6**	0.870	0.879	0.824	0.615	1.000	**1**

Source: own work.

The correlation matrix shows strong positive correlations between all pairs of skills. The strongest correlations are observed between the use of a computer and the use of a smartphone/phone (r = 0.937), as well as between the use of mobile devices and mobile applications (r = 1.000). The weakest correlation is observed between the use of new programs and the use of a computer (r = 0.453).

Overall, the results suggest that the respondents who reported higher skill levels in one area of IT also tended to report higher skill levels in other areas. This may indicate that IT skills are interrelated and that proficiency in one area can facilitate learning and using other areas of IT. However, the weak correlation between the use of new programs and the use of a computer suggests that some respondents may need additional training to improve their proficiency in using new programs.

Conclusions

The literature reviews conducted indicated that, in the digital era, technology development requires a variety of skills that are essential in the context of remote learning, work, and everyday life. In particular, technical skills, such as operating e-learning platforms, online communication, and using mobile devices, are vital in the era of the COVID-19 pandemic. Time management is also key to ensure effective work and learning in the digital age. This requires self-discipline and planning skills. Familiarity with the basic principles of digital security and privacy protection is also very important. Continuous learning and improving one's skills are crucial for survival and success in today's world of work and education.

The empirical studies conducted focused on a group of students, indicating that computer skills are essential for effective participation in remote learning processes and for conducting projects, research, and analysis online. In the times of the COVID-19 pandemic, when many classes and projects had to be moved to the virtual world, computer skills became key for students and academic staff. Possessing these skills can also increase the chances of finding employment and professional career development in the digital era.

Finally, it should be noted that while these results mainly concern students, most people realise that ICT competencies are increasingly necessary in today's world and strive to develop their skills. Nevertheless, there is a group of people who still need help learning new technologies.

The recommendation for people, especially students, who have difficulty using new programs is to seek help on the Internet, where you can find plenty of tutorials and online courses. It is also worth taking advantage of training and workshops that are organised in various places, including online.

A good practice for everyone, especially young people, is to regularly update their skills and follow new trends and technologies. In today's times, changes in the field of computing are very fast and it is important to stay up-to-date.

The results of the empirical study conducted among students show that most of them have ICT competencies, but it is worth continuing to develop their skills and to use available resources. People who have difficulty operating new programs should seek help on the Internet and take advantage of various trainings and workshops.

However, it should be remembered that these conclusions may not necessarily apply to all age and occupational groups. Therefore, the interpretation of the results should be limited to the studied group, i.e. students, and not generalised to the whole society. In the context of further research, it would be worth expanding the research group and comparing results between different age and occupational categories, in order to better understand how ICT skills affect different social groups.

Bibliography

Ala-Mutka, K. (2011). Mapping Digital Competence: Towards a Conceptual Understanding. *JRC Technical Reports*, JRC67075, 70–75. DOI: 10.13140/RG.2.2.18046.00322.

Al-Samarrai, S., Gangwar, M., Gala, P. (2020). *The Impact of the COVID-19 Pandemic on Education Financing*. Economic Impact of COVID-19. World Bank. Retrieved from: http://hdl.handle.net/10986/33739 (2023.06.15).

Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies, 2*(1), 113–115. DOI: 10.1002/hbe2.191.

Bosch, T. E. (2009). Using online social networking for teaching and learning: Facebook use at the University of Cape Town. *South African Journal for Communication Theory and Research, 35*(2), 185–200. DOI: 10.1080/02500160903250648.

Bozkurt, A., Sharma, R. C., Stockdale, S. (2020). Emergency remote teaching in a time of global crisis due to CoronaVirus pandemic. *Asian Journal of Distance Education, 15*(1), 1–6.

Daniel, S. J. (2020). Education and the COVID-19 pandemic. *Prospects, 49*(1–2), 91–96. DOI: 10.1007/s11125-020-09464-3.

Eshet-Alkalai, Y. (2004). Digital Literacy: A Conceptual Framework for Survival Skills in the Digital Era. *Journal of Educational Multimedia and Hypermedia, 13*(1), 93–106.

Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Luxemburg: Publications Office of the European Union.

Gallardo-Echenique, E. E., Marqués-Molías, L., Bullen, M., Strijbos, J. W. (2015). Let's talk about digital learners in the digital era. *International Review of Research in Open and Distributed Learning, 16*(3), 156–187. DOI: 10.19173/irrodl.v16i3.2196.

Gilster, P. (1997). *Digital Literacy*. New Jersey: Wiley Computer Publishing.

Hargittai, E. (2002). Second-level digital divide: Differences in people's online skills. *First Monday, 7*(4), 1–10. DOI: 10.5210/fm.v7i4.942.

Hew, K. F., Cheung, W. S. (2014). Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges. *Educational Research Review, 12*, 45–58. DOI: 10.1016/j.edurev.2014.05.001.

Hodges, C., Moore, S., Lockee, B., Trust, T., Bond, A. (2020). The Difference Be-tween Emergency Remote Teaching and Online Learning. *Educause Review,* 27.03.2020. Retrieved from: https://er.educause.edu/articles/2020/3/the-difference-between--emergency-remote-teaching-and-online-learning (2023.06.15).

Hsin, C. T., Cigas, J. (2013). Short videos improve student learning in online education. *Journal of Computing Sciences in Colleges, 28*(5), 253–259.

Jaggars, S. S., Xu, D. (2016). How do online course design features influence student performance? *Computers & Education, 95*, 270–284. DOI: 10.1016/j.compedu.2016.01.014.

Joksimović, S., Poquet, O., Kovanović, V., Dowell, N., Mills, C., Gašević, D., Brooks, C. (2018). How do we model learning at scale? A systematic review of research on MOOCs. *Review of Educational Research, 88*(1), 43–86. DOI: 10.3102/0034654317740335.

Kimmons, R., Veletsianos, G. (2020). Public internet data mining methods in instructional design, educational technology, and online learning research. *TechTrends, 64*(5), 835–847. DOI: 10.1007/s11528-020-00507-1.

Kirschner, P. A., Karpinski, A. C. (2010). Facebook® and academic performance. *Computers in Human Behavior, 26*(6), 1237–1245. DOI: 10.1016/j.chb.2010.03.024.

Kukolja Taradi, S., Taradi, M., Radić, K., Pokrajac, N. (2005). Blending problem-based learning with Web technology positively impacts student learning outcomes in acid--base physiology. *Advances in Physiology Education, 29*(1), 35–39. DOI: 10.1152/advan.00026.2004.

Lemola, S., Perkinson-Gloor, N., Brand, S., Dewald-Kaufmann, J. F., Grob, A. (2015). Adolescents' Electronic Media Use at Night, Sleep Disturbance, and Depressive Symptoms in the Smartphone Age. *Journal of Youth and Adolescence, 44*, 405–418.

Pappano, L. (2012). The Year of the MOOC. *The New York Times, 2*(12), 2.11.2012.

Ribble, M., Bailey, G. (2007). *Digital Citizenship in Schools*. Washington: ISTE.

Trust, T., Whalen, J. (2020). Should Teachers be Trained in Emergency Remote Teaching? Lessons Learned from the COVID-19 Pandemic. *Journal of Technology and Teacher Education, 28*(2), 189–199.

Trust, T., Krutka, D. G., Carpenter, J. P. (2016). "Together we are better": Professional learning networks for teachers. *Computers & Education, 102*, 15–34. DOI: 10.1016/j.compedu.2016.06.007.

Wang, M., Shen, R., Novak, D., Pan, X. (2009). The impact of mobile learning on students' learning behaviours and performance: Report from a large blended classroom. *British Journal of Educational Technology, 40*(4), 673–695. DOI: 10.1111/j.1467-8535.2008.00846.x.

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge: MIT Press.

Weller, M. (2020). *25 Years of Ed Tech*. Athabasca: Athabasca University Press.

Zawacki-Richter, O., Marín, V. I., Gouverneur, F., Bond, M. (2019). Systematic re-view of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education, 16*(1), 16–39. DOI: 10.1186/s41239-019-0171-0.

Zhang, W., Wang, Y., Yang, L., Wang, C. (2020). Suspending Classes Without Stopping Learning: China's Education Emergency Management Policy in the COVID-19 Outbreak. *Journal of Risk and Financial Management, 13*(3), 55. DOI: 10.3390/jrfm13030055.

Summary

In the current COVID-19 pandemic era, computer skills have become essential for students and academic staff who participate in remote learning or work on online projects, research, and analysis. Due to the need to shift many activities and projects to the virtual world, having computer skills has become critical for effective functioning in the current situation. The aim of the article was to investigate the level of computer competencies of students in the context of the COVID-19 pandemic. The hypothesis was that most respondents have basic computer skills, but they may have varying levels of proficiency in specific computer competencies, such as the use of new software. To achieve this goal, the authors presented empirical research results conducted in February 2021. The study sample included 649 respondents.

The research show that the majority of the respondents declared possessing computer competencies such as the use of computers, smartphones/phones, technical internet support, and mobile devices and applications. However, there were some individuals who faced difficulties in operating new software. Therefore, it was recommended to focus on developing computer competencies in the area of new software use through training or courses that will assist those who have difficulty in this area. It is also important to continue monitoring progress and the effectiveness of such actions. This will increase the level of computer competencies in the whole group of respondents, which may contribute to improving work efficiency and increasing job market opportunities. The conducted Pearson correlation allowed us to draw the following conclusions: there are strong positive correlations between all pairs of IT skills, which suggests a mutual relationship.

Keywords: IT skills, COVID-19 pandemic, students.

Wpływ pandemii COVID-19 na kompetencje informatyczne studentów w świetle badań własnych

Streszczenie

W obecnych czasach pandemii COVID-19, umiejętności informatyczne stały się niezbędne dla studentów i pracowników naukowych, którzy uczestniczą w procesie nauczania zdalnego lub pracują nad projektami, badaniami i analizami w trybie online. Wiele zajęć i projektów musiało zostać przeniesionych do świata wirtualnego, co sprawiło, że posiadanie umiejętności informatycznych stało się kluczowe dla skutecznego funkcjonowania w obecnej sytuacji. Celem artykułu było zbadanie poziomu kompetencji informatycznych studentów w kontekście pandemii COVID-19. Postawiono hipotezę, iż większość badanych posiada podstawowe umiejętności informatyczne, jednak mogą oni mieć zróżnicowany poziom w poszczególnych kompetencjach informatycznych, takich

jak posługiwanie się nowymi programami. W tym celu przedstawiono autorskie wyniki badań empirycznych, przeprowadzonych w lutym 2021 r. Ich celem było przedstawienie obrazu kompetencji informatycznych osób, objętych badaniem. Próbę badawczą stanowiło 649 respondentów.

Badania pokazały, że większość respodentów posiada kompetencje informatyczne w zakresie posługiwania się komputerem, smartfonem/telefonem, techniczną obsługą Internetu oraz mobilnymi urządzeniami i aplikacjami. Jednakże, istnieją osoby, które mają trudności w obsłudze nowych programów. Z tego powodu wysunięto rekomendację, iż istotne jest skupienie się na rozwijaniu kompetencji informatycznych w zakresie posługiwania się nowymi programami. Można to zrobić poprzez szkolenia lub kursy, które pomogą osobom, które mają trudności w tym obszarze. Ważne jest również kontynuowanie badania, aby monitorować postęp i skuteczność takich działań. W ten sposób można zwiększyć poziom kompetencji informatycznych w całej grupie badanych, co może przyczynić się do poprawy efektywności pracy oraz zwiększenia ich szans na rynku pracy. Przeprowadzona analiza korelacji Pearsona pozwoliła na wyciągnięcie następujących wniosków: Istnieją silne dodatnie korelacje między wszystkimi parami umiejętności IT, co sugeruje ich wzajemne powiązanie.

Słowa kluczowe: kompetencje informatyczne, pandemia COVID-19, studenci.

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Patients' perceptions of ambulatory healthcare work organisation and communication in healthcare entities

Introduction

Social inequalities are an inherent part of human development. They occur between countries, cities, social groups or individuals (Pliszka, 2015, p. 449). They are defined as socio-economic phenomena related to unequal access to resources, power, culture, economic goods or services, healthcare, and education or manifested by differential incomes of individual social groups. Social inequalities hinder access to socially valued goods people desire because they satisfy their needs and aspirations and bring satisfaction (Wypych-Ślusarska et al., 2019, p. 230).

This article discusses selected social determinants that may contribute to inequalities in access to healthcare. This is an issue that is still topical and extremely important for every patient. This is because the existence of inequalities in access to healthcare reduces the quality of life of the individual. The effect of these inequalities can be a reduction in health (Bayo-Idowu et al., 2023), a weakening of social bonds and trust in the health facility and the staff employed there, as well as the perception that the quality of the clinic's services is unsatisfactory from the

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patient's point of view (Padamata, Vangapandu, 2023). The cause of inequalities in access to healthcare will be differences in perceptions of the goods and services provided by the healthcare entity, and this aspect became the main motivation for undertaking the research topic.

The main aim of the study was to analyse the relationship between the ratings of perceived elements of the organisation and communication of the healthcare entity and the age of the patients. The methodology used in the study made it possible to verify the significance of differences in the ratings due to the age of the respondents, and for this purpose, the Mann-Whitney U test and the Spearman rank correlation coefficient were used. The main focus of the paper was on non-medical benefits for the patient, which may influence patient satisfaction and choices. The paper does not evaluate professional services or treatment outcomes, which are the main focus of the clinic and should be at the centre of the health facility's attention.

The main rationale behind the need for the study was the willingness to verify patients' perceptions, which were expressed as the degree of satisfaction with the clinic's services. The study investigated two aspects: the organisation of the clinic's work and the clinic's communication with the patient. The study was conducted among patients of ambulatory healthcare in Częstochowa. Respondents were divided into four test groups depending on their age. An original, anonymous survey questionnaire was used to obtain data.

The following research hypotheses were formulated in the survey design process:

(H1) Age of respondents influences perceptions of elements of the clinic's work organisation;

(H2) Age of respondents influences perceptions of elements of the clinic's communication with patients;

(H3) Satisfaction with the healthcare entity's services (in terms of organisation and communication) increases with patient age.

Statistical methods were used to verify the stated hypotheses. Calculations were made using the Statistica software.

The structure of the paper includes an introduction to social inequalities, including issues related to the accessibility of health services, patient satisfaction surveys, and a presentation of empirical research with conclusions, including research implications and limitations.

Patient satisfaction surveys and related works

Today, patient satisfaction is becoming an important indicator of the competitiveness of healthcare entities. Winning patient satisfaction is not easy. The feeling arises in a specific situation, usually when the patient's expectations

are met or even exceeded. Satisfaction is most often defined as an emotional state, an emotion closely related to individual preferences and needs. It is a subjective feeling, difficult to measure and predict, a psychological state resulting from the confrontation between what the patient expects and what he or she actually experiences. Nowadays, patient satisfaction is considered an important element in the measurement of healthcare quality, perception of health inequalities or access to healthcare. Indeed, patient satisfaction can be explained as the fulfilment of the patient's expectations. Meeting these expectations provides a basis for introducing measures to foster the elimination of these inequalities. Measuring patient satisfaction can also provide clues as to the direction of the organisation's development, the introduction of organisational changes or the verification of patient needs. By measuring satisfaction with the services provided by a healthcare facility or with non-medical elements such as work organisation or communication, it is possible to identify gaps in service and access to healthcare and, on the basis of these gaps, take action to improve the situation.

There is a significant number of papers in the literature on patient satisfaction, research into perceptions of the quality of health services or inequalities in access to healthcare. Such studies have been conducted, for example, among patients in Germany. Patient satisfaction with German healthcare providers was rated highly, as evidenced by the results presented by K. Achstetter *et al.* (2022). As in this study, despite the overall highly rated patient satisfaction, organisational aspects in medical centres were identified as problem areas.

The results of most of the studies presented here indicate that as people get older, respondents are more satisfied with the services they receive in the medical centre. It is well known that the older a person is, the more ailments bother them. Consequently – they are more likely to use the services of a doctor and medical treatments (Braimah et al., 2022; Williams et al., 2020). Similar observations were made in an article by Steward Williams *et al.* (2020) based on a WHO study, where patients aged 50 plus from five countries: China, Ghana, India, Russia and South Africa, rated the surveyed items on medical care higher as their age increased.

Similar conclusions can be found in the study by Tille F. *et al.* (2019) – older patients rated ambulatory healthcare higher compared to younger ones (Tille et al., 2019). In the results of Tille F.'s study, more than 90% of all patients rated their last visit to their GP positively in terms of trust, communication, respect for personal dignity and autonomy, although in the case of trust in the GP, only 50.3% did so (in the research presented in this article, the result was more than 70% positive). Poor ratings were mainly given by 18–34 year-olds – these similarities can be seen in the article presented here.

The impact of inadequate quality of healthcare services was also approximated by Pui-Mun Lee *et al.* – using Singapore as an example (Lee et al., 2006). The authors of this study showed how the healthcare sector is negatively affected by

poor quality of healthcare services, causing losses and the departure of current as well as potential patients. They pointed out the need for a holistic approach to patient care, with a view to considering quality, cost and efficiency factors.

A study on the perceptions of patient inequality by medical staff in a psychiatric facility was conducted in the UK (Bayo-Idowu et al., 2023). The authors of this study used a survey questionnaire aimed at hospital staff. In the study, they demonstrated the negative impact of inequality on patients' mental health and subsequent treatment. They stressed the importance of the need to train medical staff in this area in order to be able to counteract inequalities among patients and thus improve their quality of life.

Capturing perceptions of healthcare quality from the patient and staff perspectives also became the focus of a study in Indian hospitals (Padamata, Vangapandu, 2023). The authors of the study – as in this study – used the Mann-Whitney test for data reliability testing and descriptive analysis.

Patient satisfaction with health services is an issue addressed by many authors (Abera et al., 2017; Gonzalez, 2019; Hussain et al., 2019; Manzoor et al., 2019; Sun et al., 2017; Shabbir et al., 2016). All are unanimous in pointing out the need to take care of this aspect of patient service, always with a priority on treatment outcomes and health improvement. Patient satisfaction is now becoming one of the measures of the quality of services provided and a key factor in determining the success of a health facility (Gupta et al., 2022; Ferreira et al., 2020; Lagrosen et al., 2020; Rahman et al., 2021; Yarimoglu, Ataman, 2021; Yoon, Lee, 2022; Martínez et al., 2021; Vieira et al., 2022). According to scientific research, patient satisfaction also affects loyalty to the healthcare facility (Yıldırım et al., 2022).

Materials and methods

The empirical research was carried out in 20 entities performing medical activity in Częstochowa (Poland) in 2018–2019. All medical centres participating in the study operate on a commercial basis as non-public healthcare facilities. The present study involved 552 respondents – patients currently using healthcare services, 53% of whom were women and 47% men (adults only). The research sample for the study was determined using the formula for the minimum size for the structure indicator. The structure of the obtained sample turned out to be consistent with the structure of the population of Częstochowa (according to the data of the Central Statistical Office), thanks to which it can be considered representative (the minimum sample size was determined as 384 units).

The subject of the analyses of this study was the opinions (perceptions) of respondents regarding selected (non-medical) components of service provision by healthcare entities – organisation and communication. The structure of respondents

was analysed by age. The main assumption in determining the age groups was the change of generations and the resulting differences in the perception of health services and their different needs and expectations. The cognitive value of such a division is that by verifying the assessments of respondents from different age groups (with regard to the surveyed elements), it is possible to try to adjust the clinic's services to their expectations and thus influence their satisfaction. The higher the level of satisfaction, the more patients a given medical facility can attract. Therefore, the respondents were divided into four age categories: up to 25 years old (14% of respondents), 26–45 years old (32%), 46–65 years old (34%) and over 65 years old (20%).

The empirical research was based on a survey questionnaire (anonymous). The survey questionnaire included a metric, 8 questions assessing the organisation of the clinic's work and 4 questions assessing the clinic's communication with patients. Both the organisation of the clinic's work and communication were considered in terms of the availability of health services for specific age groups. Customer satisfaction with specific components of health service provision was assessed with the use of a 5-point Likert scale.

In the study, the author applied methods from the field of multivariate statistical analysis. The Mann-Whitney U test and Spearman's rank correlation coefficient were used to verify the significance of differences in respondents' evaluations. Statistica software was used for the calculations. The determined Alpha-Cronbach coefficient (0.954) confirmed the validity and reliability of the survey questionnaire.

RESULTS OF EMPIRICAL RESEARCH

Competition in the healthcare market is huge, and it is growing constantly. Currently, there is a trend that patients are increasingly looking for medical facilities that meet their expectations not only in terms of treatment effects (which is always a priority), comprehensive services and employed specialists, but also due to the availability of the health centre. An important element – from the healthcare provider's point of view – should be the verification of patients' perception of work organisation in the surveyed clinics. The empirical research carried out in selected medical centres served this purpose.

In order to verify the perception of ambulatory healthcare patients about the organisation of work in the healthcare entity, an analysis of patient satisfaction with individual elements in this area was carried out. As for the general assessment of the organisation of the clinic's work by the respondents, it was generally positive. The highest ratings were given to the centres' opening hours (80.3% positive), premises (79.8% positive) and location (73.0% positive). The centre's accessibility for people with disabilities was rated negatively by 15.6% of respondents, and

the availability of specialist doctors/admission limits by 19.8%. However, the availability of parking for the clinic's clients was negatively assessed by as many as 26.2% of respondents, and positive opinions did not exceed 50% (47.8%). In order to deepen the analysis and verify the hypothesis (H1), the Mann-Whitney U test was used, where the test groups were divided according to the age of the respondents (Table 1).

Table 1. Mann-Whitney U test values and their significance in relation to the correlation between age and elements of the clinic's work organisation

Test groups	elements of non-medical benefits	clinic's location	parking nearby	clinic's working hours	housing conditions	social conditions	service for disabled people	admission limit	doctor queues
≤25/ 26–45	Z	-0.321	2.049*	2.947*	1.414	0.065	2.639*	1.985*	-0.085
	p	0.748	0.040	0.003	0.157	0.948	0.008	0.047	0.932
≤25/ 46–65	Z	-2.655*	2.153*	0.594	1.149	- 0.600	2.999*	1.741	-0.062
	p	0.008	0.031	0.552	0.250	0.548	0.003	0.082	0.950
≤25/ >65	Z	-2.717*	2.525*	-0.585	-0.083	-2.051*	2.949*	-0.120	-1.625
	p	0.007	0.012	0.559	0.934	0.040	0.003	0.904	0.104
26–45/ 46–65	Z	-3.056*	0.407	-3.280*	-0.467	-0.958	0.998	0.243	-0.088
	p	0.002	0.684	0.001	0.641	0.338	0.318	0.808	0.930
26–45/ >65	Z	-2.971*	0.627	-4.565*	-1.924	-2.842*	0.738	-2.682*	-1.863
	p	0.003	0.531	0.000	0.054	0.004	0.461	0.007	0.062
46–65/ >65	Z	-0.026	0.120	-1.557	-1.570	-1.981*	- 0.148	-2.388*	-1.656
	p	0.979	0.904	0.120	0.116	0.048	0.882	0.017	0.098
≤45/>45	Z	-4.073*	1.588	-3.494*	-0.690	-2.202*	2.273*	-0.708	-1.119
	p	0.000	0.112	0.000	0.490	0.028	0.023	0.479	0.263

* statistically significant values at the level of $\alpha = 0.05$.

Source: own study based on the questionnaire survey.

While analysing the results of the Mann-Whitney U test, it can be concluded that people aged up to 25 years rated the availability of a car park for the centre's clients significantly higher compared to people aged 26–45 years (Z = 2.049; p = 0.040), 46–65 years (Z = 2.153; p = 0.031) and over 65 years (Z = 2.525; p = 0.012). Opening and closing hours of medical centres were rated significantly higher by those aged up to 25 years compared to those aged 26–45 years (Z = 2.947;

p = 0.003). Persons aged 26–45 rated medical centre opening hours lower compared to those aged 46–65 (Z = -3.280; p = 0.001) and those over 65 (Z = -4.565; p < 0.001).

In general, people up to 45 years of age rated the opening hours of medical centres significantly lower compared to people older than 45 years of age (Z = -3.494; p < 0.001). Younger people have fewer leisure time resources due to both paid work and childcare and other types of commitments, especially when compared to those of retirement age. Hence, there is likely to be a different approach to assessing the operating hours of medical centres. This is also due to the fact that much of the medical centre's work conflicts with the working hours of other establishments, which, excluding sickness situations – when it comes to periodic and specialised examinations – is a major problem.

Those aged over 65 years rated social conditions significantly higher compared to those aged up to 25 years (Z = -2.051; p = 0.040), 26–45 years (Z = -2.842; p = 0.004) and 46–65 years (Z = -1.981; p = 0.048). In general, older people rate the social conditions higher than younger people (Z = -2.202; p = 0.028). Regarding the adaptation of the medical centre to serve people with disabilities, people aged up to 25 years rated it significantly higher compared to people aged 26–45 years (Z = 2.639; p = 0.008), 46–65 years (Z = 2.999; p = 0.003) and over 65 years (Z = 2.949; p = 0.003). The remaining results did not show statistically significant differences.

The next stage of the research focused on analysing patients' perceptions of communication in the clinic. Efficient communication in medical entities is very important. It is a special way of exchanging thoughts and words. We live in an era when time plays an important role in every domain of life. Getting things done quickly by phone or online and appropriate signposting could make everyone's life easier. Patients communicate with the medical centre primarily to make an appointment with the doctor. Sometimes, however, this issue is, for them, a source of frustration and dissatisfaction. Long queues for doctors, distant appointments and rude staff are situations that can be encountered in many medical centres.

The level of patient satisfaction with the different elements of communication in the healthcare provider was therefore investigated. In general, communication between the healthcare provider and the patient was assessed positively by respondents. Adequate signage (77.5% positive) and precise and accessible information (76.6% positive) were rated best. The lowest ratings were given to long queues to see specialists, which are largely driven by external conditions – not directly attributable to the centre. On the other hand, it should be noted that 17.6% of respondents negatively assessed the readability of the website and 18.5% the possibility of making an appointment by phone.

To verify the hypothesis (H2), data from the survey questionnaire was analysed using the Mann-Whitney U test. The results have been summarised in Table 2.

Table 2. Mann-Whitney U test values and their significance in relation to the correlation between age and elements of communication between clinics and patients

Test groups	elements of non-medical benefits	clarity of communication	signage inside the clinic	readability and accuracy of the website	contact by phone/internet
≤25/ 26–45	Z	0.467	-0.370	1.348	1.156
	p	0.641	0.711	0.178	0.248
≤25/ 46–65	Z	-0.248	-1.372	1.228	0.313
	p	0.804	0.170	0.219	0.754
≤25/>65	Z	-0.644	-2.106*	0.187	0.146
	p	0.520	0.035	0.851	0.884
26–45/ 46–65	Z	-0.779	-1.323	-0.150	-0.853
	p	0.436	0.186	0.880	0.394
26–45/>65	Z	-1.264	-2.222*	-1.461	-1.166
	p	0.206	0.026	0.144	0.244
46–65/>65	Z	-0.450	-1.042	-1.317	-0.324
	p	0.652	0.297	0.188	0.746
≤45/>45	Z	-1.108	-2.386*	-0.267	-0.784
	p	0.268	0.017	0.789	0.433

* statistically significant values at the level of α = 0.05.

Source: own study based on the questionnaire survey.

When analysing the values of the ratings of elements of medical centre communication with the patient, discernible differences can only be seen with regard to appropriate signage and information boards. This was rated significantly higher by those aged over 65 years compared to those aged up to 25 years (Z = -2.106; p = 0.035) and those aged 26–45 years (Z = -2.222; p = 0.026). The detailed results were confirmed when the age groups were combined. People up to 45 years of age rated appropriate signage significantly lower compared to people older than 45 years of age (Z = -2.386; p = 0.017). Older people need clear signage and the provision of accurate information, as this makes it easier for them to find their way around the often extensive premises of the medical centre. Information boards reduce the time spent searching for the relevant surgeries and provide necessary information without the need to queue at the information desk. These are important elements that the management of a medical facility should constantly keep in mind, and regularly examine patients' perceptions and respond to any objections in this regard.

The other organisational elements did not demonstrate statistically significant differences in any of the statements.

To extend the analysis and verify the hypothesis (H3), Spearman's rank correlation coefficient was calculated using the Statistica software.

Table 3. Values of Spearman correlation coefficients and their significance for correlations between age and accessibility factors

Question	R	$t_{(N-2)}$	p
clinic's location	**0.149682**	**3.82084**	**0.000146**
car park nearby	**-0.079734**	**-2.01089**	**0.044762**
clinic's working hours	**0.116595**	**2.95362**	**0.003257**
housing conditions	0.032362	0.81720	0.414122
social conditions	**0.106031**	**2.66793**	**0.007830**
service for the disabled	**-0.104843**	**-2.62715**	**0.008823**
admission limit	0.040696	1.02474	0.305876
doctor queues	0.065792	1.66150	0.097106

Note: all statistically significant coefficients are marked in bold
t_n – value of the statistic testing the significance of the Spearman correlation coefficient for n-2 degrees of freedom

Source: own study based on the questionnaire survey.

The obtained Spearman correlation values show that the perception of the accessibility of the location of the clinic increases significantly with the age of the patient and the patient's satisfaction with the convenience of the location of the clinic (r =0.1496).

Based on Table 3, when analysing the correlational relationships between patient age and perception of customer/patient parking accessibility, it was observed that younger patients rated the accessibility of the car park (r =-0.0797) and the accessibility of the clinic for disabled people (r =-0.1048) significantly higher. Furthermore, perceptions of the accessibility and comfort of social conditions (r =0.106), and the clinic's opening and closing hours (r =0.1166) increase with patient age. The correlation between the other variables is not statistically significant.

Table 4. Values of Spearman correlation coefficients and their significance for the correlation between age and communication factors

Question	R	$t_{(N-2)}$	p
clarity of communication	0.042656	1.07588	0.282389
signage inside the clinic	**0.103367**	**2.62086**	**0.008981**
readability and accuracy of the website	0.014454	0.35790	0.720543
contact by phone/internet	0.022235	0.55735	0.577490

Note: all statistically significant coefficients are marked in bold
t_n – value of the statistic testing the significance of the Spearman correlation coefficient for n-2 degrees of freedom

Source: own study based on the questionnaire survey.

When analysing the communication factors, it was observed that the evaluation of the communication factor, i.e. appropriate signposting of places/information boards in the clinic, increases significantly with the age of the patient (r =0.1034).

Analyses using the Mann-Whitney U test and the obtained values of Spearman's correlation coefficients allowed positive verification of all hypotheses set.

Conclusions

The results of the analyses showed which elements of work organisation and communication in the healthcare entity require improvement to ensure patient satisfaction, strengthen relationships and reduce inequalities in access to medical care for patients in different age groups. When carrying out this type of research taking into account the age of patients – medical clinics can adjust their opening hours to patients' expectations, provide easy access to the healthcare facility, prepare a car park, design a functional and easy-to-use website, create a pleasant atmosphere in the health centre, ensure the professional appearance of medical staff, regularly train staff in patient care, as well as adjust the clinic to the needs of people with disabilities. Thanks to this, inequalities in access to medical care can be eliminated, which will help to increase patient satisfaction.

Please remember that survey research is not free from limitations. Patients come to a medical facility with various, often very serious problems, and in such a situation, it is inappropriate to ask them to complete a survey. This type of examination, therefore, requires great sensitivity to the situation and assistance from medical staff so as not to disturb the treatment process.

Conducting these types of analyses helps to identify how patients perceive elements of organisation and communication in the health centre, which in the future will help to eliminate inequalities in access to healthcare from the perspective of different age groups. The implementation of patient satisfaction surveys in healthcare entities made it possible to achieve the objective set out in the introduction and to analyse the relationship between the assessments concerning the perception of elements of organisation and communication of the healthcare entity and the age of patients.

The methodology used made it possible to verify the significance of differences in evaluations due to the age of respondents and thus confirmed the truth of the research hypotheses (H1), (H2) and (H3). The results of the study clearly confirmed that the age of patients determines the perception of elements of organisation and communication in healthcare entities (Mann-Whitney U test) and that satisfaction with the healthcare entity's services increases with the age of the patient (Spearman test). It should be emphasised that patients' perceptions of the elements in question vary according to their age, and in order to eliminate inequalities, this factor should always be taken into account.

To summarise the above considerations, it should be emphasised that an effective approach to eliminating inequalities in access to healthcare should include a systematic study of patients' perceptions, identifying the level of their satisfaction and offering services in line with the expectations of both current and potential patients.

BIBLIOGRAPHY

Abera, R. G., Abota, B. A., Legese, M. H., Negesso, A. E. (2017). Patient satisfaction with clinical laboratory services at Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia. *Patient Prefer Adherence*, 11,1181–1188. DOI: 10.2147/PPA.S132397.

Achstetter, K., Köppen, J., Hengel, P., Blümel, M., Busse, R. (2022). Drivers of patient perceptions of health system responsiveness in Germany. *The International Journal Health Planning and Management*, 3.10.2022, 1–21. DOI: 10.1002/hpm.3570.

Bayo-Idowu, E., Fatima, S., Brenisin, K., Trumm, A., Wallang, P., Breen, K. (2023). Staff perceptions of patient inequalities in a UK secure mental healthcare setting. *Equality, Diversity and Inclusion*, 24.04.23. DOI: 10.1108/EDI-04-2022-0095.

Braimah, J. A., Appiah, J. O., Adei, D., Ofori-Amoah, J., Acquah Mensah, A., Agyemang--Duah, W. (2022). Effects of demographic and socio-economic factors on dissatisfaction with formal healthcare utilisation among older adults with very low incomes in Ghana. *Cogent Public Health*, *9*(1), 1–12. DOI: 10.1080/27707571.2022.2108568.

Ferreira, P. L., Raposo, V., Tavares, A. I. (2020). Primary health care patient satisfaction: Explanatory factors and geographic characteristics. *International Journal for Quality in Health Care*, *32*(2), 93–98. DOI: 10.1093/intqhc/mzz134.

Gonzalez, M. E. (2019). Improving customer satisfaction of a healthcare facility: reading the customers' needs, Benchmarking. *An International Journal*, *26*(3), 854–870. DOI: 10.1108/BIJ-01-2017-0007.

Gupta, N., Vrat, P., Ojha, R. (2022). Prioritizing enablers for service quality in healthcare sector – a DEMATEL approach. *Journal of Health Organization and Management*, *36*(5), 633–649. DOI: 10.1108/JHOM-06-2021-0222.

Hussain, A., Asif, M., Jameel, A., Hwang, J. (2019). Measuring OPD Patient Satisfaction with Dierent Service Delivery Aspects at Public Hospitals in Pakistan. *International Journal of Environmental Research and Public Health*, *16*(13), 2340. DOI: 10.3390/ijerph16132340.

Lagrosen, Y., Lagrosen, S. (2020). Gender, quality and health – a study of Swedish secondary school teachers. *International Journal of Workplace Health Management*, *13*(2), 223–238. DOI: 10.1108/IJWHM-09-2018-0125.

Lee, P., Khong, P., Ghista, D.N. (2006). Impact of deficient healthcare service quality. *The TQM Magazine*, *18*(6), 563–571. DOI:10.1108/09544780610707075.

Manzoor, F., Wei, L., Hussain, A., Asif, M., Shah, S. I. A. (2019). Patient Satisfaction with Health Care Services; An Application of Physician's Behavior as a Moderator. *International Journal of Environmental Research and Public Health*, *16*(18), 3318. DOI: 10.3390/ijerph16183318.

Martínez, V. M. C., Ramírez-Orellana, A., Grasso, S. M. (2021). Health Investment Management and Healthcare Quality in the Public System: A Gender Perspective. *International Journal of Environmental Research and Public Health*, *18*(5), 2304. DOI: 10.3390/ijerph18052304.

Padamata, K., Vangapandu, R. D. (2023). The assessment of quality of care in the Indian healthcare industry: the employees' and patients' perspectives. *Benchmarking: An International Journal*, 14.02.23. DOI: 10.1108/BIJ-10-2022-0617.

Pliszka, T. (2015). Nierówności społeczne a zagrożenia z nich wynikające. *Nierówności Społeczne a Wzrost Gospodarczy*, *6*, 449–458.

Rahman, M. K., Bhuiyan, M. A., Zailani, S. (2021). Healthcare Services: Patient Satisfaction and Loyalty Lessons from Islamic Friendly Hospitals. *Patient Preference and Adherence, 15*, 2633–2646. DOI: 10.2147/PPA.S333595.

Shabbir, A., Malik, S. A., Malik, S. A. (2016). Measuring patients' healthcare service quality perceptions, satisfaction, and loyalty in public and private sector hospitals in Pakistan. *International Journal of Quality & Reliability Management*, *33*(5), 538–557. DOI: 10.1108/IJQRM-06-2014-00742016.

Sun, J., Hu, G., Ma, J., Chen, Y., Wu, L., Liu, Q., Hu, J., Livoti, C., Jiang, Y., Liu, Y. (2017). Consumer satisfaction with tertiary healthcare in China: Findings from the 2015 China National Patient Survey. *International Journal for Quality in Health Care*, *29*(2), 213–221. DOI: 10.1093/intqhc/mzw160.

Tille, F., Röttger, J., Gibis, B., Busse, R., Kuhlmey, A., Schnitzer, S. (2019). Patients' perceptions of health system responsiveness in ambulatory care in Germany. *Patient Education and Counseling*, *102*(1), 162–171. DOI: 10.1016/j.pec.2018.08.020.

Yarimoglu, E., Ataman, G. (2021). How service quality in hospitals varies based on hospital ownership and demographics: a study on Turkish patients living urban areas. *Total Quality Management & Business Excellence*, *33*(1), 1–17. DOI:10.1080/1478 3363.2021.1890576.

Yıldırım, Y., Amarat, M., Akbolat, M. (2022). Effect of relationship marketing on hospital loyalty: the mediating role of patient satisfaction. *International Journal of Pharmaceutical and Healthcare Marketing*, *16*(3), 337–353. DOI: 10.1108/IJPHM-01-2021-0010.

Yoon, K., Lee, M. (2022). Comparative Analysis of Factors Affecting Quality of Community-Based Care Services in Korea. *International Journal of Environmental Research and Public Health*, *19*(8), 4641. DOI: 10.3390/ijerph19084641.

Vieira, I., Ferreira, D., Pedro, M. I. (2022). The satisfaction of healthcare consumers: analysis and comparison of different methodologies. *International Transactions in Operational Research*, *30*(1), 545–571. DOI: 10.1111/itor.13098.

Williams, S. J., Myléus, A., Chatterji, S., Valentine, N. (2020). Health systems responsiveness among older adults: findings from the World Health Organization Study on global AGEing and adult health. *Global of Public Health*, *15*(7), 999–1015. DOI: 10.1080/17441692.2020.1742365.

Wypych-Ślusarska, A., Głogowska-Ligus, J., Słowiński, J. (2019). Społeczne uwarunkowania nierówności w zdrowiu. *Pielęgniarstwo i Zdrowie Publiczne*, *9*(3), 229–236. DOI: 10.17219/pzp/100468.

Summary

The aim of the presented research was to analyse the relationship between assessments regarding the perception of elements of organisation and communication of a healthcare entity and the age of patients. The work focused on non-medical benefits for the patient, which may influence their satisfaction and the choices they make. The main rationale justifying the need to conduct research was the desire to verify patients' perceptions, which was expressed as the degree of satisfaction with the clinic's services. Two aspects were examined: work organisation and communication between the clinic and the patient.

The research was conducted in medical facilities in the city of Częstochowa among patients currently using ambulatory medical care. The test groups were divided depending on the age of the respondents. In order to obtain data, an original survey questionnaire was used. The following research hypotheses were formulated: (H1) age of respondents influences perceptions of elements of the clinic's work organisation; (H2) age of respondents influences perceptions of elements of the clinic's communication with patients; (H3) satisfaction with the healthcare entity's services (in terms of organisation and communication) increases with patient age. The basis for formulating the hypotheses was a review of research on social inequalities, inequalities in access to healthcare and patient satisfaction studies. In order to verify the hypotheses, statistical methods were used: the Mann-Whitney *U* test and Spearman's rank correlation coefficient. Calculations were made using the Statistica software.

The obtained results confirmed the validity of all hypotheses. The Mann-Whitney test confirmed that the age of respondents significantly affects the assessment of work organisation and communication between the clinic and the patient (H1 and H2). Furthermore, the obtained Spearman correlation values confirmed that patient satisfaction with the clinic's services increases with the patient's age (H3).

Keywords: social inequalities, inequalities in access to healthcare, patient satisfaction, organisation and communication in healthcare entities.

Postrzeganie przez pacjentów ambulatoryjnej opieki zdrowotnej organizacji pracy i komunikacji w podmiotach leczniczych

Streszczenie

Celem prezentowanych badań była analiza zależności pomiędzy ocenami dotyczącymi postrzegania elementów organizacji i komunikacji podmiotu leczniczego a wiekiem pacjentów. W pracy skoncentrowano się na pozamedycznych korzyściach dla pacjenta, które mogą mieć wpływ na satysfakcję i dokonywane przez niego wybory. Główną przesłanką uzasadniającą potrzebę przeprowadzenia badań była chęć weryfikacji percepcji pacjentów, która wyrażona została jako stopień zadowolenia z usług przychodni. Zbadano dwa aspekty: organizację pracy i komunikację przychodni z pacjentem.

Badania przeprowadzono w podmiotach leczniczych na terenie miasta Częstochowa, wśród pacjentów aktualnie korzystających z ambulatoryjnej opieki medycznej. Grupy testowe podzielono w zależności od wieku respondentów. W celu pozyskania danych posłużono się autorskim kwestionariuszem ankiety. Sformułowano następujące hipotezy badawcze: (H1) wiek respondentów wpływa na postrzeganie elementów organizacji pracy przychodni; (H2) wiek respondentów wpływa na postrzeganie elementów komunikacji przychodni z pacjentami; (H3) zadowolenie z usług podmiotu leczniczego (w aspekcie organizacji i komunikacji) wzrasta wraz z wiekiem pacjenta. Podstawą do

postawienia hipotez był przegląd badań z zakresu nierówności społecznych, nierówności w dostępie do opieki zdrowotnej oraz badań satysfakcji pacjenta. W celu zweryfikowania postawionych hipotez wykorzystano metody statystyczne: test U-Manna-Whitney'a oraz współczynnik korelacji rang Spearmana. Obliczeń dokonano przy użyciu programu Statistica.

Uzyskane wyniki pozwoliły potwierdzić prawdziwość wszystkich hipotez. Wyniki testu Manna-Whitney'a potwierdziły, że wiek respondentów zasadniczo wpływa na oceny organizacji pracy i komunikacji przychodni z pacjentem (H1 i H2). Natomiast uzyskane wartości korelacji Spearmana potwierdziły, że zadowolenie pacjentów z usług przychodni wzrasta wraz z wiekiem pacjenta (H3).

Słowa kluczowe: nierówności społeczne, nierówności w dostępie do opieki zdrowotnej, satysfakcja pacjenta, organizacja i komunikacja w podmiotach leczniczych.

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Positive work environment in public administration[2]

Introduction

Today's government work requires a new kind of public servant that is more adaptable and mobile. Now, staff needs to be able to innovate, persuade, lead and engage. The public service is competing for valuable human capital and it has to take into account that the new generation of employees has very different expectations about job experience than their predecessors. Flexible work arrangements, quality of experience and relationships with their supervisors and team are seen as key elements of a positive work environment.

The aim of this study is to identify the motivators that are key to creating a positive work environment in which public administration employees feel satisfied with their work and feel connected to their organisation. The main concept of the study is to search for such main elements of a positive work environment among general motivators of agile teams. This idea was inspired by a report prepared by the experts engaged in Canada's Public Policy Forum (2015). They emphasise in their report that the application of agility in public administration allows organisations to depart from the paradigm that they must seek mass production efficiencies through bureaucratic structures, hierarchical organisation, and centralised control over production.

Agility, which is generally defined as having the flexibility and courage to reinvent yourself (Canada's Public Policy Forum, 2015), seems to be what governments need to adopt. Agility will allow governments to expand their ability to recruit people who prefer flexible and learning organisations that constantly adapt and resolve emerging problems through the coordinated work of self-

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managed teams. Agile management in public service organisations may be a way to reduce unevenness in creating development opportunities between the public and private sector.

In this study, the search for agile motivators, important in managing public servants, is based on the approach used in research on the motivation of programmers since agile development has become mainstream in software development and knowledge about motivators has improved the management of agile teams. Sharp *et al.* (2009) found 21 motivators in the literature, of which only seven were identified as inherent in software engineering. Similarly, Melo *et al.* (2012), in their cross-case analysis of motivators in agile teams, recognised eleven general motivators and nine specific agile development motivators. This research focuses on general motivators in agile teams that can be adapted to the public administration environment.

The results indicate the importance of three general motivators: development opportunities, respect and teamwork. Younger public servants appreciate development opportunities, while older employees require respect from their superiors. The third motivator, teamwork, works well for young employees focused on achieving professional goals and for older employees who are innovative. The results indicate that, regardless of the age of public servants, teamwork is important for employees with two personality traits: openness and agreeableness.

This study broadens the understanding of how to motivate public servants. There is a deficit of research in this field. The public administration literature contends that this issue should be high on the future agenda (Perry et al., 2010). This research focuses on individual motivation rather than on organisational motivation, which is the focus of current motivation literature. In this study, the motivators are based on Person-Environment fit and fairness in the workplace. Job outcomes include job satisfaction, commitment, and identification with an organisation and exclude performance, turnover, and absenteeism.

The remainder of this article is structured as follows. Section 2 presents the theoretical background consisting of the MOCC model description. Section 3 covers the research framework with hypotheses and data as well as the method. The results are described and their importance is discussed in section 4. The paper is closed with conclusions.

Theoretical background

The MOCC model (Motivators, Outcomes, Characteristics and Context) developed by Sharp and her colleagues (Sharp et al., 2009) was the inspiration for this study. Sharp *et al.* (2009) present the MOCC model to explain motivation in software engineering (SE). In the MOCC model, general motivators include: identifying with the task, career path, variety of work, recognition for work done, development needs addressed, technically challenging work, autonomy, making a contribution,

equity, empowerment/responsibility, trust/respect, employee participation, good management, sense of belonging, rewards and incentives, feedback, job security, good work-life balance, appropriate working conditions, successful company, and sufficient resources (Sharp et al., 2009, Figure 5). Regarding teamwork, Melo *et al.* (2012) classify it as a general motivator in agile teams. This research follows Melo's findings and considers teamwork a general motivator, especially since Kalenda *et al.* (2018) emphasise the key role of teamwork.

A software engineer's characteristics orientate the individual towards certain motivation factors. Sharp *et al.* (2009) divide the software engineer's characteristics into two different categories: characteristics of the individual and expressed needs. Finally, motivators can stimulate some outcomes, such as high performance, low turnover, and absenteeism. The MOCC model does not encompass satisfaction as an outcome, but the enhanced Job Characteristics Model (Couger, Zawacki, 1980) includes general satisfaction.

The characteristics of agile-team members are influenced by their personalities. The MOCC model includes personality as one of the motivation components. Acuña, Gómez and Juristo (2008) found that the human factor is of fundamental importance for the success or failure of agile software development. Research in this area is based on the five-factor model (FFM) of personality developed by Costa and McCrae (1995). Caliendo *et al.* (2011), focusing on the Big Five taxonomy, present an overview of each personality trait. Extraversion is described as including variables indicating the extent to which individuals are assertive, dominant, ambitious and energetic; agreeableness as relating to being cooperative, forgiving and trusting; conscientiousness as encompassing two distinct aspects, being achievement-oriented and being hard-working; emotional stability (opposite of neuroticism) as relating to self-confidence, optimism and the ability to deal with stressful situations; and, finally openness to experience as relating to an individual's creativity, innovativeness and curiosity. Baumgart *et al.* (2015) applied 30 facets suggested by Costa and McCrae (1995) and found that all five factors of the FFM were to some extent relevant for developers. Agreeableness was the primary factor.

The last part of the theoretical background addresses the theoretical foundation for formulating the motivators considered in this research. This study formulates motivators based on job perception. Employees can evaluate their jobs in terms of their perceived person-environment fit and fairness in the workplace. In general, the person-environment fit is defined as the degree to which individual and environmental characteristics match (Kristof-Brown, Zimmerman, Johnson, 2005). The job can be perceived from an equity theory perspective (Thomson, 2009) by assessing fairness in terms of the opportunity to perform. Fairness in the workplace includes procedural justice and interpersonal justice. Procedural justice refers to the fairness of the process that leads to promotion or layoff. Interpersonal justice means that decision-makers treat employees with respect and sensitivity.

The theoretical background, which covers the MOCC model, the Big Five, the Person-Job fit theory and the equity theory, serves as the basis for the hypotheses and research questions.

Research framework

The implementation of the main research objective – identifying the motivators that are key to creating a positive work environment in which public administration employees feel satisfied with their work and feel connected to their organisation – is based on verification of three hypotheses and answers to two questions. The hypotheses are as follows:

Hypothesis 1. The relationships between public servant motivators and job outcomes are indirect and agile motivators mediate these relationships.

Hypothesis 2. The mediators in relationships between motivators and job outcomes are not the same for younger and older public servants.

Hypothesis 3. Agile motivators mediate the effects of pay satisfaction on job outcomes.

Because particular characteristics orientate the individual towards certain motivators, as demonstrated in the MOCC model (Sharp et al., 2009), the first question refers to the effects of two characteristics, innovativeness and achievement-orientation:

Question 1. Which motivators are fostered by innovativeness and achievement-orientation in the case of younger versus older public servants?

Finally, the MOCC model suggests that personality traits influence the effectiveness of motivators, which brings up the second question:

Question 2. Which personality traits influence job outcomes and through which motivators in the case of younger versus older public servants?

The MOCC model also takes into consideration environmental factors and context. This study includes one such factor, namely career stage. Therefore, in testing hypotheses and seeking answers to the research questions, both younger and older public servants are considered.

The source of the data for this study is a questionnaire survey carried out in Poland in November 2016. The participants were employed in public administration. They had attained a tertiary educational level. Including participants with the same, at least formally, level of education allows us to avoid considering the influence of education on agile motivators, which seems self-explanatory.

The participants were 25–45 years of age, of mobile working age (in Poland, students typically graduate from universities when they are 24). Employees over 45 years of age were excluded from the research to avoid two issues that may influence their motivation to participate in agile projects. Firstly, the decline in fluid

abilities exhibited by older employees (e.g. beyond middle age) can result in decreased participation in educational activities because of learning difficulties and lower self-confidence (self-efficacy). Secondly, older employees are less likely to be offered opportunities for development later in their career, which can dissuade them from agile methods.

In November 2016, interviews were carried out with the participants using the CAPI (computer-assisted personal interviewing) method from a nationwide, random-quota sample with a conscious choice of participants. The overall sample of participants is divided into two subgroups of employees: 1) younger public servants employed in public administration and aged between 25 and 35 years; this sub-sample includes 55 participants, and 2) older public servants employed in public administration, aged between 36 and 45 years; this sub-sample includes 64 participants.

For all measures (except personality traits), the participants rated items using a five-point Likert scale (or a seven-point Likert scale in the case of personality traits) where 1 = strongly disagree and 5 (or 7) = strongly agree. When using Likert data, we must consider the controversy regarding the possibility to calculate the mean, the standard deviation and the correlation, to perform t-tests, and to use variables based on this type of the data as predictors in a regression. Summarising the empirical literature survey, Norman (2010) concluded that parametric statistics can be used with Likert data, with small sample sizes, with unequal variances, and with non-normal distributions with no fear of coming to the wrong conclusion. This paper accepts Norman's findings that parametric statistics can be used with Likert data with no fear of coming to the wrong conclusion.

The motivators considered in this study are based on aspects of job perceptions: Person-Environment fit, earnings, embedment, equity, development, work/life balance, training – Table 1. The measures of the motivators are based on items used in the person-environment fit index (e.g. see Chuang et al., 2016) as well as on items from equity theory (Thomson, 2009)

Tables 1. Measures of Motivators

Aspect of job perception	Motivator	Item
1	*2*	*3*
Person-Job fit*	Improving skills	Your present job satisfies your goals and needs for skills enhancement
	Autonomy/Responsibility	Your present job satisfies your goals and needs for autonomy and responsibility
	Promotion and career path	Your present job satisfies your goals and needs for promotion opportunities and career development

1	*2*	*3*
Person-Job fit*	Job enjoyment	In your present job, you do what you like to do
	Teamwork	Your co-workers and you are satisfied with the workload
	Satisfaction with the supervisor	Your supervisor's leadership style and the leadership style you desire match
Earnings	Pay satisfaction	You are satisfied with the earnings in your present job
Embedment	Sense of belonging	You feel a connection with your co-workers
Equity**	Qualification/performance ratio	Your co-workers have better possibilities to demonstrate their skills than you do
	Procedural justice	There is a direct relationship between qualifications and promotions in your present organisation
	Respect (interpersonal justice)	Supervisors treat you with the same respect as others
Development	Development opportunities	In the present workplace, you have many opportunities for professional development
Work/life balance	Job flexibility	You can take a day-off when you need
Training	Training quality	Your present organisation provides you with high-quality training

*Measures based on items used in the person-environment fit index (e.g. see Chuang et al., 2016).
** Measures based on equity theory (Thomson, 2009).

Source: adapted from (Chuang et al., 2016; Thomson, 2009).

Motivators can influence several outcomes of public servants. This study investigates three of them: job satisfaction, organisational commitment, and organisational identification (see Table 2).

Tables 2. Measures of outcomes of Motivated Public Servants

Outcome	Item
Job satisfaction	All things considered, I am satisfied with my job
Organisational commitment	I would be very happy to spend the rest of my career with this organisation
Organisational identification	When someone praises this organisation, it feels like a personal compliment

Source: adapted from (Young et al., 2004; Allen, Meyer, 1990).

The items describing the characteristics of innovativeness and achievement-orientation are adapted from the entrepreneurial attitude orientation scale suggested by Robinson *et al.* (1991) – see Table 3.

Table 3. Measures of Innovativeness and Achievement-Orientation

Characteristics	Items
Innovation-affect	Working with people that have many new ideas makes me tired (reverse--scored)
Innovation-behaviour	I prefer to join a team that is already working on a project than to propose an entirely new project (reverse-scored)
Innovation-cognition	To be successful, I believe one should act in an unconventional way
Achievement-affect	I feel depressed when I don't accomplish any meaningful work
Achievement--behaviour	I often sacrifice personal comfort in order to take advantage of business opportunities
Achievement--cognition	I believe that concrete results are necessary in order to judge business success

Source: adapted from (Robinson et al., 1991).

The personality traits that can influence the effectiveness of motivators are measured by the Ten Item Personality Inventory developed by Gosling *et al.* (2003) – see Table 4.

Table 4. Ten Item Personality Inventory

Personality trait	Item I see myself as
Extraversion	Gregarious, enthusiastic, optimistic
Antagonism	Critical, quarrelsome
Conscientiousness	Conscientious, self-disciplined
Neuroticism	Anxious, easily upset
Openness	Open to new experiences, complex
Introversion	Reserved, quiet
Agreeableness	Sympathetic, warm
Undirectedness	Disorganised, careless
Emotional stability	Calm, emotionally stable
Not open to experience	Conventional, uncreative

Source: adapted from (Gosling et al., 2003).

Gender is included as a control in models that estimate the effects of motivators on the outcomes.

The research uses the conditional process analysis developed by Hayes (2013) to find the indirect relationships between 1) the motivators and the outcomes; 2) the characteristics and the outcomes; and finally, 3) the personality traits and the outcomes. Hayes (2013) defines the conditional process analysis as a modelling strategy undertaken to describe the conditional or contingent nature of the mechanism(s) by which a variable transmits its effect onto another variable, and to test hypotheses about such contingent effects. This method incorporates mediation analysis, which is used to quantify and examine the direct and indirect pathways through which an antecedent variable X transmits its effect onto a consequent variable Y through an intermediary M: $X \rightarrow M \rightarrow Y$ is a causal chain of events. In this research, such causal chains look as follows:

Motivator → Mediator → Job satisfaction;
Characteristic → Mediator → Job satisfaction;
Personal trait → Mediator → Job satisfaction.

Results and discussion

Before presenting the findings, it might be useful to offer a short explanation of the importance of gender as a control. The correlations between gender and outcomes (e.g. job satisfaction, organisational commitment, and organisational identification) are statistically insignificant for both groups of public servants (for the younger 0.252 (p = 0.063); 0.270 (p = 0.046); 0.040 (p = 0.773) and for the older 0.218 (p = 0.084); 0.036 (p = 0.776); -0.029 (p = 0.817), respectively). Similarly, gender was found to be an insignificant variable in all regressions used in the relative weight analysis. Therefore, the findings are presented without the gender variable.

The results of the conditional process analysis (Hayes, 2013) confirm the first two hypotheses that the relationships between motivators and job outcomes are indirect and the mediators are agile motivators (H1). The results also reveal differences in mediators for junior and senior public servants (H2).

The findings show that *Development opportunity* is a key motivator for younger public servants. It is a mediator in the relationships between almost all motivators and two outcomes: *Job satisfaction* and *Organisational Commitment*. It also mediates the effects of *Promotion* and *Pay satisfaction* on *Job identification*. The mediation models uncovered another important motivator – *Teamwork* – which mediates the effect of satisfaction with the supervisor on each of the three outcomes (see Tables 5 and 6).

Development opportunities was found to be an insignificant mediator in the group of older public servants. The motivators influenced their *Job satisfaction* and *Organisational commitment* through *Respect* from their supervisors. All motivators increased the *Organisational identification* of older public servants when they were satisfied with *Teamwork* (see Tables 7 and 8).

Table 5. Direct and Indirect Effects of Motivators on Outcomes, "Development opportunities" as Mediator, Younger Public Servants (25–35 years old), Poland 2016 – Results of Hayes's Conditional Process Analysis

Motivator	Effects of motivator on:								
	job satisfaction			organisational commitment			organisational identification		
	Direct effect	Indirect effect mediated by "Development opportunities"	R^2	Direct effect	Indirect effect mediated by "Development opportunities"	R^2	Direct effect	Indirect effect mediated by "Development opportunities"	R^2
Improving skills	0.066	0.157**	0.267***	0.057	0.237**	0.228***	0.334**	0.154	0.194**
Autonomy/ Responsibility	0.133	0.121**	0.271***	0.179	0.178**	0.240***	-0.044	0.135	0.112**
Promotion and career path	0.161	0.1186**	0.341***	0.221	0.175**	0.260***	-0.228	0.148**	0.121**
Job enjoyment	0.382**	0.058	0.701***	0.457**	0.079	0.361***	0.281	0.055	0.178*
Teamwork	0.387**	0.073	0.742***	0.445**	0.119	0.382***	0.553**	0.054	0.391***
Satisfaction with the supervisor	0.275**	0.055	0.396***	0.382**	0.075	0.559***	0.528**	0.050	0.339***
Procedural justice	-0.003	0.102**	0.267***	0.074	0.143**	0.231***	0.020	0.104	0.121**
Respect	0.148	0.167**	0.545***	0.036	0.260**	0.214***	0.273	0.148	0.168**
Pay satisfaction	0.099	0.134**	0.281***	0.051	0.224**	0.228***	-0.083	0.189**	0.127**
Training quality	0.148	0.223**	0.560***	-0.047	0.258**	0.215***	-0.028	0.189	0.131**

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Table 6. Direct and Indirect Effects of Supervisory Satisfaction/Autonomy/Job Enjoyment on Outcomes Mediated by Teamwork, Younger Public Servants (25–35 years old), Poland 2016 – Results of Hayes's Conditional Process Analysis

Motivator	Effects of motivator on:								
	job satisfaction			organisational commitment			organisational identification		
	Direct effect	Indirect effect mediated by "Teamwork"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2
Supervisory satisfaction	0.045	0.285**	0.465***	0.128	0.329**	0.302***	0.272	0.306**	0.407***
Autonomy/ Responsibility	-------	-------	-------	-------	-------	-------	-0.135	0.226**	0.378***
Job enjoyment	-------	-------	-------	-------	-------	-------	-0.041	0.383**	0.370***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.
------- means that both effects are statistically insignificant.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Table 7. Direct and Indirect Effects of Motivators on Organisational Identification, "Pay Satisfaction" as the mediator, Older Public Servants (36–45 years old), Poland 2016 – Results of Hayes's Conditional Process Analysis

Motivator	Effects of motivator on organisational identification		
	Direct effect	Indirect effect mediated by "Pay satisfaction"	R^2
Improving skills	0.274**	0.106**	0.338***
Autonomy/Responsibility	0.184	0.176**	0.276***
Promotion and career path	0.231**	0.144**	0.303***
Job enjoyment	0.148	0.219**	0.264***
Teamwork	0.328**	0.120**	0.361***
Satisfaction with the supervisor	0.208**	0.131**	0.297***
Procedural justice	0.307**	0.128**	0.341
Respect	0.281**	0.143**	0.303***
Training quality	0.099	0.137**	0.261***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Table 8. Direct and Indirect Effects of Motivators on Outcomes, "Respect" and "Teamwork" as mediators, Older Public Servants (36–45 years old), Poland 2016 – Results of Hayes's Conditional Process Analysis

Motivator	Effects of motivator on:								
	job satisfaction			organisational commitment			organisational identification		
	Direct effect	Indirect effect mediated by "Respect"	R^2	Direct effect	Indirect effect mediated by "Respect"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2
Improving skills	0.141	0.270**	0.409***	0.076	0.191**	0.143***	0.229**	0.151**	0.296***
Autonomy/ Responsibility	0.011	0.329	0.393***	0.233	0.174**	0.166***	0.179	0.181**	0.269***
Promotion and career path	0.071	0.216**	0.398***	0.183	0.131**	0.162***	0.272**	0.103**	0.328***
Job enjoyment	0.417**	0.231**	0.507***	0.275	0.162**	0.177***	0.181	0.186**	0.269***
Teamwork	0.253**	0.296**	0.426***	0.416**	0.111	0.214***	-------	-------	-------
Supervisory satisfaction	0.210**	0.185**	0.435***	0.205	0.120**	0.169***	0.164	0.176**	0.268***
Procedural justice	0.067	0.266**	0.397***	0.246	0.147**	0.174***	0.268**	0.167**	0.302***
Respect	-------	-------	-------	-------	-------	-------	0.125	0.300**	0.249***
Pay satisfaction	0.079	0.146**	0.402***	0.170	0.090**	0.169***	0.273**	0.095**	0.361***
Training quality	0.024	0.184**	0.394***	0.019	0.127**	0.140**	0.216	0.120**	0.261***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.
------- means that both effects are statistically insignificant.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

The mediators *Development opportunity* (in the younger group), *Teamwork* (in both groups of public servants) and *Respect* (in the older group) are important motivators in agile methods and they conditioned the effects of Person-Environment fit and Fairness on job outcomes.

The results in Tables 5–8 allow the author to positively verify the first two hypotheses. They also provide a basis for not rejecting the third hypothesis, which states that agile motivators mediate the effects of pay satisfaction on job outcomes (H3). The findings in Tables 5–8 show that the direct effects of *Pay satisfaction* on job outcomes are statistically insignificant in both groups of public servants (except for *Organisation identification* in the older group, where both the direct and indirect effects are significant). *Pay satisfaction* results in higher job outcomes among younger public servants only when they see development opportunities in their organisations. The older public servants are satisfied with their job and they commit to their organisations when *Pay satisfaction* is mediated by *Respect* and *Teamwork*.

As demonstrated by the MOCC model (Sharp et al., 2009), particular characteristics orientate the individual towards certain motivators. In this study, attention was focused on two characteristics – innovativeness and achievement-orientation – that are important for agility. The findings provide an answer to the first research question: Which motivators are fostered by innovativeness and achievement-orientation in the case of younger versus older public servants? The results of Hayes's Conditional Process Analysis show that all three dimensions of achievement (cognition, behaviour and affect) influence the job outcomes of younger public servants via *Teamwork* (see Table 9), with negative indirect effects of *Achievement-affect (I feel depressed when I don't accomplish any meaningful work)*.

The influence of the characteristics in the group of older public servants is more differentiated (see Table 10). *Achievement-cognition* orientates the older employees towards *Respect*, while *Achievement-behaviour* towards *Satisfaction with the supervisor* and *Pay satisfaction. Innovation-cognition* fosters *Teamwork* and *Satisfaction with the supervisor*.

Table 9. Direct and Indirect Effects of Characteristics on Outcomes via Teamwork, Younger Public Servants, Poland, 2016 – Results of Hayes's Conditional Process Analysis

Characteristic	Effects of characteristic on:								
	job satisfaction			organisational commitment			organisational identification		
	Direct effect	Indirect effect mediated by "Teamwork"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2
Achievement-cognition (I believe that concrete results are necessary in order to judge business success)	0.075	0.235**	0.467***	0.035	0.302**	0.283***	0.238	0.275**	0.404***
Achievement-behaviour (I often sacrifice personal comfort in order to take advantage of business opportunities)	0.038	0.191**	0.462***	-0.004	0.246**	0.283***	0.300**	0.195**	0.453***
Achievement-affect (I feel depressed when I don't accomplish any meaningful work)	0.057	-0.110**	0.192***	0.057	-0.134**	0.287***	0.019	-0.140**	0.369***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Table 10. Direct and Indirect Effects of Characteristics on Outcomes, Older Public Servants, Poland, 2016 – Results of Hayes's Conditional Process Analysis

Characteristic	Effects of characteristic on:								
	job satisfaction			organisational commitment			organisational identification		
	Direct effect	Indirect effect mediated by "Respect"	R^2	Direct effect	Indirect effect mediated by "Respect"	R^2	Direct effect	Indirect effect mediated by "Respect"	R^2
Achievement-cognition (I believe that concrete results are necessary in order to judge business success)	0.068	0.278**	0.396***	-0.413**	0.244**	0.227****	0.129	0.124**	0.153***
	Direct effect	Indirect effect mediated by "Supervisory satisfaction"	R^2	-------	-------	-------	Direct effect	Indirect effect mediated by "Supervisory satisfaction" and "Pay satisfaction"	R^2
Achievement-behaviour (I often sacrifice personal comfort in order to take advantage of business opportunities)	0.062	0.149**	0.171***	-------	-------	-------	0.206 0.169	0.104** 0.140**	0.199*** 0.279***
	Direct effect	Indirect effect mediated by "Teamwork" and "Pay satisfaction"	R^2	Direct effect	Indirect effect mediated by "Teamwork"	R^2	Direct effect	Indirect effect mediated by "Teamwork" and "Pay satisfaction"	R^2
Innovation-cognition (I believe that concrete results are necessary in order to judge business success)	0.158 0.224	0.216** 0.148**	0.315*** 0.206***	0.191	0.198**	0.225***	0.171 0.217	0.167** 0.121	0.271*** 0.197***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.
------- means that both effects are statistically insignificant

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Finally, the MOCC model suggests that personality traits influence the effectiveness of motivators. The results of the estimation of mediation models used in this study provide an answer to the second research question concerning the role of personality traits. According to younger public servants, two personality traits – *Openness* and *Agreeableness* – enhance the effectiveness of *Teamwork*, one of the two key mediators through which motivators influence the job outcomes (see Table 11).

Table 11. Causal Chain of Events Resulting from Personality Traits, Younger Public Servants, Poland, 2016 – Findings of Hayes's Conditional Process Analysis

Causal chain of events	Direct effect	Indirect effect	R^2
Openness → Teamwork → Job satisfaction	0.084	0.128**	0.379***
Openness → Teamwork → Organisational commitment	-0.027	0.175**	0.144***
Openness → Teamwork → Organisational identification	0.205**	0.155**	0.143***
Agreeableness → Teamwork → Job satisfaction	0.000	0.207**	0.460***
Agreeableness → Teamwork → Organisational commitment	-0.237	0.311**	0.328***
Agreeableness → Teamwork → Organisational identification	0.027	0.267**	0.309***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

Four facets of the Big Five were found to be important factors in the MOCC model for older public servants (see Table 12). *Pay satisfaction* enhances *Job satisfaction* in the case of an *extravert* individual while a *neurotic* individual is less satisfied with pay and, consequently, less satisfied with his/her job. *Openness* increases the importance of *Improving skills* as a mediator that stimulates *Job satisfaction* and *Organisational Identification*. A disorganised and careless person (*Undirectedness*) is treated with less *Respect* by his/her supervisors, which contributes to a reduction in all three of his/her job outcomes.

Table 12. Causal Chain of Events Resulting from Personality Traits, Older Public Servants, Poland, 2016 – Findings of Hayes's Conditional Process Analysis

Causal chain of events	Direct effect	Indirect effect	R^2
1	*2*	*3*	*4*
Extraversion → Pay satisfaction → Job satisfaction	0.089	0.169**	0.259***
Neuroticism → Pay satisfaction → Job satisfaction	-0.061	-0.086**	0.261***
Openness → Improving skills → Job satisfaction	0.011	0.146	0.181***

1	*2*	*3*	*4*
Openness → Improving skills → Organisational identification	0.032	0.129**	0.193***
Undirectedness → Respect → Job satisfaction	-0.067	-0.147**	0.409***
Undirectedness → Respect → Organisational commitment	-0.021	-0.088**	0.141***
Undirectedness → Respect → Organisational identification	-0.021	-0.068**	0.141***

** Significance of the direct effect, indirect effect or R^2 at the level of 0.95.
*** Significance of the direct effect, indirect effect or R^2 at the level of 0.99.

Source: own calculations. The results come from Hayes PROCESS for SPSS and SAS.

The key finding from the empirical analysis is that motivation is heavily dependent on the career stage of public servants. Younger public servants are motivated by Person-Job fit and fairness in their workplace as well as pay satisfaction if they see opportunities for development in their organisations. In their literature survey, Sharp *et al.* (2009) cited eleven studies in which development needs addressed is a motivator of software developers. The older group of public servants, who are still of mobile working-age, requires respect from their supervisors in order to respond to motivators. Sharp *et al*. (2009) identified respect as a motivator of software developers in four studies.

Teamwork is the most often cited motivator in agile development (Melo et al., 2012). Teamwork is also an important motivator for both groups of public servants, but it affects them differently. The importance of teamwork is considerably stronger in the group of younger public servants. Satisfaction with the supervisor in this group contributes to job outcomes (job satisfaction, organisational commitment and organisational identification) if members of a team accept their workloads. In terms of characteristics, younger public servants, who are achievement-oriented (i.e. *they believe that concrete results are necessary in order to judge business success* and *they often sacrifice personal comfort in order to take advantage of business opportunities*), attain higher job outcomes when they are satisfied with the teamwork. It should be stressed that employees who *feel depressed when they do not accomplish any meaningful work* do not accept their workloads and their job outcomes are lower. Two personality traits – *Openness* and *Agreeableness* – both of which are important in agile development, influence the effectiveness of *Teamwork* among the group of younger public servants. As for the group of older public servants, *Teamwork* is important for higher organisational identification, with all three job outcomes being attainable by innovative employees in particular. The innovative people in this group also require good management to feel job satisfaction and to identify with their organisation. This result, in general, is con-

sistent with the conclusion of Miao *et al.* (2018) that entrepreneurial leadership is effective at promoting public servants' innovative behaviour.

The findings of the present study suggest that the introduction of agile methods to public administration is likely to decrease the degree of dependence on monetary rewards within organisations for stimulating individual job outcomes. The direct effects of *Pay satisfaction* on job outcomes were found to be insignificant for both groups of public servants. Only indirect effects mediated by the agile motivators of *Development opportunity* and *Respect* were significant. The two personality traits of extraversion and neuroticism had a positive and negative influence on the importance of *Pay satisfaction* in job outcomes, respectively, but only in the group of older public servants.

CONCLUSIONS

This study uses the MOCC model, which was developed to understand motivation in software engineering, to identify the motivators that are key to creating a positive work environment in which public administration employees feel satisfied with their work and feel connected to their organisation. The research identifies the composite of motivators, characteristics and personality traits that affect the behaviour of public servants. The findings help in the management of teams, which can be assembled from existing public servants. Such management should focus on three general motivators: development opportunities, teamwork, and respect. Younger employees must see perspectives for development in their organisations to respond to motivators, while older public servants want respect from their supervisors. Leadership must be focused on guaranteeing high-quality teamwork. Achievement-orientation in younger public servants and innovativeness in older employees, combined with openness and agreeableness, which are two personality traits required in an agile environment, translate into better job outcomes provided that the employees are satisfied with the teamwork.

Managers who work in public administration and are looking to gain insight into their team's behaviour may find the results of this study useful in understanding how to motivate public servants and how to avoid human capital barriers to introducing people-oriented agile methods.

The main limitation of this study concerns the fact that the participants were chosen randomly from different public administration organisations. As a consequence, factors associated with the participants' work environments were not included in the MOCC model. Future research should overcome this limitation by focusing on the local or municipal level of public administration.

Bibliography

Acuña, S., Gómez, M., Juristo, N. (2008). Towards understanding the relationship between team climate and software quality – a quasi-experimental study. *Empirical Software Engineering, 13(4)*, 401–434. DOI: 10.1007/s10664-008-9074-8.

Allen, N. J., Meyer, J. P. (1990). The measurement and antecedents of affective, continuance and normative commitment to the organization. *Journal of Occupational Psychology, 63(1),* 1–18. DOI: 10.1111/j.2044-8325.1990.tb00506.x.

Baumgart, R., Holten, R., Hummel, M. (2015). Personality traits of scrum roles in agile software development teams – a qualitative analysis. *ECIS 2015 Completed Research Papers. Paper, 16*, 1–15. DOI: aisel.aisnet.org/ecis2015_cr/16.

Caliendo, M., Fossen, F., Kritikos, A. S. (2014). Personality characteristics and the decisions to become and stay self-employed. *Small Business Economics, 42*, 787–814. DOI: 10.1007/s11187-013-9514-8.

Canada's Public Policy Forum. (2015). Agile government. Responding to citizens' changing needs. Retrieved from: https://www.pwc.com/si/en/assets/document/agile-government-2015-03 (2015.03.30).

Chuang, A., Shen, Ch-T., Judge, T. A. (2016). Development of a multidimensional instrument of Person-Environment Fit. *Applied Psychology, 65*(1), 66–98. DOI: 10.1111/apps.12036.

Costa, Jr, P. T., McCrae, R. R. (1995). Domains and facets: Hierarchical personality assessment using the revised NEO personality inventory. *Journal of Personality Assessment, 64*(1), 21–50. DOI: 10.1207/s15327752jpa6401_2.

Couger, D. J., Zawacki, R. A. (1980). *Motivating and managing computer personnel*. New Jersey: John Wiley & Sons.

de O. Melo, C., Santana, C., Kon, F. (2012). Developers motivation in agile teams. 38th Euromicro Conference on Software Engineering and Advanced Applications. DOI: 10.1109/SEAA.2012.45.

Gosling, S. D., Rentfrow, P. J., Swann, W. B. Jr. (2003). A very brief measure of the big five personality domains. *Journal of Research in Personality, 37*, 504–528. DOI: 10.1016/S0092-6566(03)00046-1.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* New York: Guilford Press. DOI: 10.1111/jedm.12050.

Kalenda, M., Hyna, P., Rossi, B. (2018). Scaling agile in large organizations: Practices, challenges, and success factors. *Journal of Software: Evolution and Process, 30*, 1–24. DOI: 10.1002/smr.1954.

Kristof-Brown, A., Ryan, L., Zimmerman, D., Johnson, E. C. (2005). Consequences of individuals' fit at work: a meta-analysis of person-job, person-organization, person--group, and person-supervisor fit. *Personnel Psychology, 58*, 281–342. DOI: 10.1111/j.1744-6570.2005.00672.x.

Miao, Q., Newman, A., Schwarz, G., Cooper, B. (2018). How leadership and public service motivation enhance innovative behavior. *Public Administration Review, 1*(2), 71–80. DOI: 10.1111/puar.12839.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education, 15,* 625–632. DOI: 10.1007/s10459-010-9222-y.

Perry, J. L., Hondeghem, A., Wise, L. R. (2010). Revising the motivational bases of public service: twenty years of research and an agenda for the future. *Public Administration Review*, *9*(10), 681–690. DOI: 10.1111/j.1540-6210.2010.02196.x.

Robinson, P. B., Stimpson, D. V., Jonathan, C., Huefner, J. C., Hunt, H. K. (1991). An attitude approach to the prediction of entrepreneurship. *Entrepreneurship Theory and Practice*, *15*(4), 13–31. DOI: 10.1177/104225879101500405.

Sharp, H., Baddoo, N., Beecham, S., Hall, T., Robinson, H. (2009). Models of motivation in software engineering. *Information and Software Technology*, *51*(1), 219–233. DOI: 10.1016/j.infsof.2008.05.009.

Thomson, K. W. (2009). Underemployment perceptions, job attitudes, and outcomes: An equity theory perspective. *Academy of Management Proceedings, 1,* 1–6. DOI: 10.5465/AMBPP.2009.44244108.

Young, G. J., Charns, M. P., Heeren, T. C. (2004). Product-line management in professional organizations: An empirical test of competing theoretical perspectives. *Academy of Management Journal, 47*, 723–734. DOI: 10.5465/20159614.

Summary

Based on the knowledge on motivation in software development teams, who have used agile methods for several years, this research determines the relationships between motivators, individuals' characteristics, personality traits and job outcomes in two age groups of public servants in Poland. This study aims to identify motivators that significantly contribute to creating a positive work environment in which public servants feel satisfied with their work and feel connected to their organisation.

The Motivators, Outcomes, Characteristics and Context (MOCC) model, developed by Sharp *et al.* (2009) to investigate motivation in software engineering, is used to understand the complex topic of motivation in public administration. The analysis of the relationships between the motivators and job outcomes, taking into account achievement-orientation and innovativeness, as well as personality traits, is based on mediation models. The source of the data for the model estimations is a questionnaire survey carried out among public administration employees aged 25–45 with higher education.

The findings show that public servants respond best to three motivators, namely development opportunities, respect and teamwork. Younger public servants need a clear development path, while older public servants want respect from their superiors. Achievement-orientation in younger public servants and innovativeness in older employees, combined with openness and agreeableness, translate into better job outcomes provided that the employees are satisfied with the teamwork.

Keywords: motivators, achievement-orientation, innovativeness, personal traits.

Pozytywne środowisko pracy w administracji publicznej

Streszczenie

W oparciu o wiedzę na temat motywacji w zespołach programistów, którzy od kilku lat stosują metody zwinne, niniejsze badanie określa zależności między motywatorami, charakterystykami osób, cechami osobowości i wynikami pracy w odniesieniu do dwóch grup wiekowych urzędników

administracji publicznej w Polsce. Celem badania jest identyfikacja czynników motywujących, które znacząco przyczyniają się do tworzenia pozytywnego środowiska pracy, w którym pracownicy administracji publicznej czują się usatysfakcjonowani swoją pracą i mają poczucie przynależności do swojej organizacji.

Model *Motivators, Outcomes, Characteristics and Context* (MOCC), opracowany przez Sharp i in. (2009) do zbadania motywacji informatyków, służy w niniejszym opracowaniu do zrozumienia złożonego zagadnienia motywacji w administracji publicznej. Analiza związków między motywatorami a efektami pracy, z uwzględnieniem orientacji na osiągnięcia i innowacyjność pracowników, a także cech osobowości, opiera się na modelach mediacyjnych. Źródłem danych do oszacowania modeli jest badanie ankietowe przeprowadzone wśród pracowników administracji publicznej w wieku 25–45 lat mających wykształcenie wyższe.

Wyniki pokazują, że urzędnicy najlepiej reagują na trzy czynniki motywujące, a mianowicie możliwości rozwoju, szacunek i pracę zespołową. Młodsi urzędnicy potrzebują jasnej ścieżki rozwoju, starsi zaś – szacunku ze strony przełożonych. Nastawienie na osiągnięcia u młodszych urzędników i innowacyjność u starszych pracowników w połączeniu z otwartością i ugodowością przekładają się na lepsze wyniki w pracy pod warunkiem, że pracownicy są zadowoleni z pracy zespołowej.

Słowa kluczowe: motywatory, orientacja na osiągnięcia, innowacyjność, cechy osobowe.

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Prosumerism of companies – opportunities and challenges in the consumers' opinion

Introduction

Nowadays, the business model has changed from an approach focused on the company and its offerings to an approach focused on the consumer and their needs, desires and cooperation with them. Business involves consumers in the value creation process in order to respond to their needs and desires as well as to create positive consumer experiences. As a result, the relationship between businesses and consumers changes as they are increasingly active, informed, networked and open to cooperation with companies. Consumers do not want to just be passive recipients of value created by the market; they want to co-create them. This is why companies take measures to initiate and maintain consumer activity and involvement, involving consumers in their activities by, among others, encouraging them to express their opinions on products or the company, to share their ideas and experiences of using products, and to co-create products and services. Prosumers are not only consumers, but also producers, and through this, they have a sense of influence on market offerings and the company's activities. They are more conscious consumers, recognising their position in the market. At the same time, thanks to new technologies, they can easily create communities of engaged consumers, sharing their opinions, evaluations and information. Prosumption is a creative, entrepreneurial, participatory form of consumption, assuming the participation of consumers in the co-creation of market offerings. Co-creation of products and services takes various forms, from expressing or seeking the opinions of other consumers, to tailoring products/services to their own preferences (including their modification), up to participation in the creation

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process (co-creation), sharing their knowledge and ideas, and creating new solutions. The aim of this paper is to present the importance of prosumerism for companies by showing its benefits and challenges based on the literature analysis and the results of our own research. The selection of literature was made on the basis of a bibliographic search, choosing literature on definitional issues, the role and importance of post-consumerism and prosumerism, as well as their positive and negative aspects.

Concept and goals of prosumption and prosumerism

the concept of prosumption was first presented in 1972 by M. McLuhuon and B. Nevitt (Wereda, Pinzaru, 2023, p. 75), while in 1980, A. Toffler, in his book "The Third Wave," analysed the changes taking place in the sphere of production and consumption, pointing to three waves of social development – from production for personal use, through the period of consumption and production separation as well as market development, to the period of production and consumption reconnection, i.e. prosumption (Toffler, 2006, pp. 306–324). The consumer of the third wave, i.e. the prosumer, combines the roles of consumer and producer. However, the consumer does not produce products independently as in the first period, but creates them with the help of producers. Today's prosumers, in order to create products, need the right tools and materials, which are provided by the market, and prosumption involves the active participation of consumers in the process of value co-creation-at every stage – from product design to consumption (Rzewuska, Wolny, 2020, pp. 246–259). The process of value co-creation begins with understanding the customers and their needs, such as freedom, respect, and appreciation (Payne et al., 2009, pp. 379–389). Prosumption, on the other hand, involves creating value through consumers' actions in producing and using goods that meet their desires, influencing their experience (Xie et al., 2008, p. 110). B. Mika also bases the definition of prosumption on the concept of value, pointing out that prosumption is a consumer action that affects not only the exchange value, but also the use value of a good (Mika, 2014, p. 90). Similarly, D. Serafin defines prosumption as a continuous and dynamic process of co-creating unique value for the consumer, which involves at least three co-creators of this value: the producer, the consumer and the consumer community, and the participation of consumers in the co-creation of value allows the preparation of solutions that meet their needs and expectations (Serafin, 2012, p. 134). Value in its definition is also referred to by J. Tian, L. Shen, and Y. Chen, defining prosumption as value-creating activities undertaken by consumers to produce the products they consume and make up their experience (Tian et al., 2017). On the other hand, according to Ritzer, prosumption is a new form of consumption that is based on the creativity, entrepreneurship and freedom of consumers who want to engage in the company's activities, such as designing and creating solutions, rather than being forced to do so (Ritzer, Jurgenson, 2010, pp. 13–31). The term

prosumption is associated with such concepts as prosumptionism and prosumerism, which are treated as synonyms in the literature. As P. Siuda points out, they denote the orientation of enterprises to stimulate and exploit the activity and involvement of the recipients in order to attract willing people to work for free (Siuda et al., 2013, pp. 6–7). Similarly, prosumerism is defined by K. Krzysztofek, indicating that it means the practices of modern business aimed at encouraging users to multiply the resources of information and knowledge that they use in their activities (Krzysztofek, 2014, p. 49). Prosumerism also helps companies learn about buyers' needs as well as methods and opportunities to improve their offerings. It also allows them to predict trends and consumption patterns, and test and verify whether the product/service will be accepted by buyers (Siuda et al., 2013, pp. 6–7). Therefore, prosumption means the activity of consumers and the actions taken by them to co-create the market offering, while prosumerism is the action taken by companies to encourage and include consumers in the process of co-creating products and services by, among others, creating communication platforms and providing appropriate tools, etc.

Prosumption plays an important role on both economic and social levels. In the social aspect, it allows consumers and companies to connect with each other, build a community of consumers, share their knowledge and experiences, and gain knowledge and learn about the experiences of others. In addition, prosumption also has an integrating function, bringing together individuals with specific interests and passions, thereby strengthening self-esteem. On the economic level, prosumption becomes an opportunity to develop the company by introducing new solutions thanks to the knowledge and activity of consumers. It also facilitates building and maintaining relationships with customers and shaping a positive corporate image. The importance of prosumption on the socio-economic level can be perceived through the prism of its functions, among which A. Baruk includes: (1) communication function – information flow between consumers and producers, (2) educational function – consumers and producers learn from each other, (3) support function – mutual support of consumers and bidders to achieve their goals, (4) relational function – the formation of a partnership relationship between bidder and buyer, (5) image function – building the company's image as a modern entity open to cooperation with customers, (6) innovation function – creating new solutions, (7) therapeutic function – strengthening the buyer's self-esteem and the bidder's social usefulness, and (8) development function – increasing the company's potential (Baruk, 2017, pp. 36–37). Although prosumption is related to the activity of consumers and producers, it can also refer to the activity of consumers in prosumer networks, within which they design solutions, and modify products and services, adapting them to their own needs. This is pointed out by D. Tapscott, who believes that prosumerism involves the active participation of both consumers and producers in the creation of market offerings and the formation of communities with common interests, the users of which help develop, implement, and release new products (Tapscott, 2010, p. 350; Tapscott, Williams, 2008, p. 200). Cooperation

with companies and other consumers within the emerging prosumer communities gives users satisfaction and pleasure and is a form of fun (Ritzer, Jurgenson, 2010, pp. 13–31). In fact, it is all the more true because prosumers are most often young, committed, and people open to cooperation who want to contribute to the process of creating market offerings, such as creating new solutions and tailoring products to their needs (Tapscott, 2010, p. 357). Prosumers are primarily the network generation, which treats the world as a place of creation, not just consumption, and therefore they create prosumer communities, within which they share information on products, work to individualise the market offering, and modify products (Tapscott, Williams, 2008, p. 187). For this to be possible, the products offered by companies should be flexible and "editable", offer many possibilities and reflect the individual tastes of customers (Tapscott, 2010, p. 354). With prosumption, products and services are subject not only to modification, but also to discussion, and are shared with other network members. The involvement of consumers, especially networked consumers, by sharing information and experience can change the consumer's position in the market, who, from a consumer of products, becomes a partner for the company, and thus can influence the reduction of information asymmetry between the consumer and the producer. Prosumers become informed consumers and expect to be able to actively participate in the creation of the final product. Therefore, companies should not marginalise these issues and try to meet prosumers by providing them with the right platforms, tools or materials that allow them to engage in their activities in order not to lose such potential opportunities for broadly improving their offerings "with the help" of consumers.

Prosumerism – positive and negative aspects

currently, there is a departure from the traditional business model, in which customers were only recipients of products/services in the market, towards a model in which customers, with knowledge and skills, have the opportunity to engage in the value co-creation process. Prosumption is a factor of change and innovation on a social and economic level, and is part of a new model referred to as the sharing economy, entrepreneurial economy, creativity, and network economy (Payne et al., 2009, pp. 379–389) or open, collaborative, partnership economy, which Tapscott and Williams refer to as wikinomics (Tapscott, Williams, 2008). To meet these challenges, modern companies often become open, distributed companies, i.e. cooperating with consumers who become employees of the company, and their involvement, activity and willingness to co-create value is important for companies (Tapscott, Williams, 2008, p. 30). According to Tapscott, prosumerism is beneficial to both consumers and producers, as customers receive products tailored to their needs, while companies do not have to pay for their research and development (Tapscott, Williams, 2008, p. 191). Consequently, through prosumerism, companies

can increase sales and marketing as well as promotional potential, improve their image, create communities of partners, create new solutions, improve their market position, educate buyers and increase their market awareness, and establish and maintain good relationships with buyers (Baruk, 2017, pp. 32–33). According to D. Hoyer *et al.*, the positive effects for companies include: cost reduction (inexpensive input from customers, reduced input from employees), increased effectiveness of products/services (better adapted to consumer needs, better perception, better differentiation), strengthened customer-company relationships, higher probability of success and faster diffusion (products/services tailored to customer needs and more hype around them, faster information transfer), savings on marketing expenses (more customer enthusiasm and whisper marketing), savings on customer education and other support activities, and early warning of potential problems with a new product (Hoyer et al., 2010, pp. 283–296). Surveys conducted among managers indicate that they perceive a number of benefits from the prosumption activities of companies. These activities allow, among others, to establish contact with buyers, learn about their opinions and ideas and, through this, create new solutions for the company's brand. On the other hand, openness to cooperation and closeness to customers allows gaining the sympathy of customers, as well as determining the profile of future buyers (Wereda, Pinzaru, 2023, pp. 84–88). Through cooperation with consumers, a company can also shape the quality of its products and services by adapting to their expectations and needs, thereby increasing their satisfaction and loyalty (Przybek et al., 2019, pp. 43–48). Prosumerism influences greater efficiency of flexible production, and allows the creation of better and, at the same time, cheaper products that meet consumer demands (Jin et al., 2022, pp. 1–21). The value of consumers' prosumption activities also becomes apparent in crisis situations. This was shown, for example, during the COVID-19 pandemic, during which the actions of prosumers were particularly important for maintaining the companies' operations, mainly in the service sector – prosumers mobilised to ensure the continued provision of services, thereby increasing the resilience to the crisis and the innovativeness of companies during a difficult economic period. Prosumers helped companies and their communities in areas such as purchasing, delivery, logistics, and promotion by, among others, buying and delivering products to those in need and the elderly, making products themselves (which reduced the negative effects of broken supply chains), posting videos and information on social media on how to cope with challenges, or promoting local products (Lang et al., 2021, pp. 176–189).

However, in addition to the opportunities and positive aspects of cooperation with consumers, there are also barriers to such cooperation. On the part of companies, barriers to prosumerism can be concerns about company secrecy, intellectual property, copyrights, information overload, production quality and feasibility, and the possibility of implementing consumer projects (Hoyer et al., 2010, pp. 283–296). Threats to companies arise from reduced company control,

increased complexity in managing goals, encouraging customers to continue working, submitting ideas, problems in selecting consumer ideas, and managing negative feedback. Management of customer expectations and relationships also poses a challenge for companies (Hoyer et al., 2010, pp. 283–296). This creates a prosumption dilemma for companies – on the one hand, cooperation with consumers involves risk and loss of control, and on the other hand, lack of cooperation can lead to loss of reputation and valuable resources or innovative solutions (Tapscott, Williams, 2008, p. 199). An important issue affecting prosumption involvement is the motivation of consumers to co-create with companies. Such motivators include financial, social, technical, and psychological factors. Companies can stimulate co-creation by increasing the benefits to consumers from co-creation and reducing the costs associated with time spent, effort, etc. (Hoyer et al., 2010, pp. 283–296). However, in order to achieve this, the activities must be attractive enough to effectively encourage consumers to do efficient (company-beneficial) activities and not cause the co-creating consumer to feel exploited. Admittedly, according to K. Krzysztofek, prosumers are motivated by the need to create, which gives them a sense of influence, participation, empowerment and self-realisation (Krzysztofek, 2014, p. 52). Prosumers are motivated not only by creativity and autonomy, but also by the skills and competencies they gain from working with companies and other consumers (Jin et al., 2022, pp. 1–21), but their "activities" can be very financially measurable for companies (revenues, profits) and it is natural that they expect to be compensated for the value they contribute. Although there are other positive effects of prosumption for consumers, such as receiving a product that is not available on the market, higher levels of trust in the company, involvement of other prosumers, higher levels of decision-making, responsibility and power, building mutual loyalty and participation in a social network overseen by the company that allows building relationships with other prosumers and consumers with similar interests, and lower risks of cooperative activities compared to acting alone (Nowacki, 2016, pp. 140–141), researchers point out that prosumerism can also be associated with consumer exploitation, as consumers do the work that was previously done by employees, which in turn leads to job losses. Controlling consumers through acquired information and data about them, analysing their behaviour and learning about their lives, preferences, and needs also constitutes a problem (Fuchs, 2011, pp. 10–12). G. Ritzer points out that the prosumer model shows, on the one hand, a tendency not to pay for the work of consumers and, on the other hand, to offer products for free. Companies are not willing to pay consumers for the work they perform, but consumers also want to have access to free products and solutions. Hence, companies provide many free tools in basic versions to their consumers in order to encourage them to cooperate (Ritzer, Jurgenson, 2010, pp. 13–31). In turn, E. Comor indicates another aspect of prosumption, namely its impact on the individual's sense of alienation. Despite the fact that in the era of prosumption, where individuals produce and co-

create value for self-realisation and do not use their creative potential for salaries, the majority of users are controlled by companies and remain powerless tools in the hands of capital and companies. Meanwhile, only a few, thanks to their skills, do not experience alienation. Prosumption, as Comor points out, becomes a tool for making money, and the existing labour-capital relationship is perpetuated. In addition, he argues that prosumers mostly engage in promotional, entertainment or branding activities (Comor, 2010, pp. 439–454), which often do not match the aspirations or expectations of prosumers.

B. Mika describes prosumption as a would-be revolution, as it was supposed to revolutionise the relationship between production and consumption, but has become another tool for manipulation and marketing activities by companies (Mika, 2014, p. 94), which distorts the idea of prosumption and reduces it to a kind of often costless outsourcing of certain activities/tasks (mostly less attractive ones). However, it does not necessarily have to be this way – the development of new technologies, which allow everyone to communicate and cooperate with everyone anywhere and anytime, prompts companies to change their business model. Instead of a company-centric approach, (where companies set the terms of cooperation, initiate activities, make decisions on projects and retain profits), a prosumer-centric approach takes place, where customers are partners for companies, and cooperation takes place on their terms, in their networks and for their needs, and the company shares profits with them (Tapscott, Williams, 2008, p. 217). In the company-centric model, companies take a customer-centric approach, allowing customers to adapt products to themselves, thereby maintaining control, and the company does not take advantage of the innovation and knowledge of its consumers. The prosumer-centric model, on the other hand, is based on partnership, where companies treat consumers as partners, not just customers, and share benefits with them, making it worthwhile for consumers to engage in joint activities. Obviously, the second model is a desirable one, and not only for consumers, as it is also beneficial for companies prospectively because it is the only one that can ensure that both parties can be winners in the process, unlike the first model, in which the company is usually the only tangible beneficiary.

CONSUMER OPINIONS ON POSITIVE AND NEGATIVE ASPECTS OF COMPANY PROSUMERISM – SURVEY RESULTS

The paper presents survey results conducted online in 2022 on consumer opinions regarding opportunities and threats of prosumerism of companies. The research tool was a survey questionnaire. Consumers' opinions on the prosumerism of companies with particular attention to the expectations, opportunities, and benefits, as well as fears and threats for companies related to prosumerism, constituted the subject of this study.

The survey was conducted online using the CAWI method in a consumer panel with a sample of 1,000 adults (18 years and older), by the research company. A total of 510 women and 490 men participated in the survey. In terms of education, about 44% each consisted of individuals with secondary and higher education (including a bachelor's degree), with the remainder with vocational education (11%) and primary education (2%). The largest percentage of the respondents were individuals in the 30–39 age group (30%); about 1/4 of the respondents were each aged 18–29 and 40–49, and the remainder (about 1/5) were those aged 50 and over. Among the respondents, 72% were employed, 12% were pensioners, and about 8% each were students/pupils or unemployed.

The aim of this study was to get to know consumers' opinions about the prosumerism of companies, the opportunities and challenges, and the risks associated with it and their conditions. The results presented in the paper are part of a broader study of company prosumerism. This paper is the beginning of a series of subsequent papers devoted to analysing consumers' opinions about companies' prosumer activities, and currently focuses only on analysing the benefits and risks of prosumerism.

Following A. Baruk, the study adopted three dimensions of prosumption: innovative, image and relational. Through cooperation with consumers, companies have opportunities to introduce new solutions, build a positive corporate image and form close relationships with consumers (Baruk, 2017, pp. 88–111). It was assumed that prosumptionism, based on the respondents' evaluation, is beneficial for companies in all three of the above-mentioned dimensions. Consumers perceive many positive aspects of prosumerism for companies, but also point to problems of threats associated with it.

Respondents recognise many benefits for companies from cooperation with consumers in relational, innovative, and image dimensions. Respondents point primarily to gaining feedback on products and services (64%), new ideas and consumers' perspectives on market offerings (40.9%), greater consumer satisfaction (41.4%), and thus consumer loyalty (32.2%). According to respondents, thanks to such activities, companies eliminate market-unsuitable products/services (30.3%), and by gaining feedback from consumers, they can eliminate product defects (20.5%) or have the possibility to modify their offerings in accordance with consumer expectations (24%). In addition, cooperation with consumers deepens relationships with consumers (14.4%) and enables the company to build a positive image (11.7%). Respondents also indicate that companies become innovative and create new solutions thanks to consumers' ideas (21.7%), thus increasing the chances of market success (15.1%). The fewest respondents (only 4.4%) indicated cost reduction and less use of their resources. This may result from consumers' belief that their activities are insignificant, not generating high costs, or ignorance about companies' processes and the costs they generate.

Table 1. Benefits for companies resulting from cooperation with prosumers

Indications of respondents	TOTAL		Men		Women		Chi-square test	
	N	%	n	%	n	%	χ^2	p
deeper relationships with consumers	144	14.4	77	15.7	67	13.1	1.35	0.246
positive corporate image	117	11.7	48	9.8	69	13.5	3.37	0.066
elimination of market-unsuitable products/ services and thus reduction of costs	303	30.3	141	28.8	162	31.8	1.06	0.304
consumer loyalty	322	32.2	171	34.9	151	29.6	3.20	0.073
possibility to modify according to consumers' expectations	240	24.0	102	20.8	138	27.1	5.34	0.021
possibility to anticipate changes concerning consumer preferences	93	9.3	47	9.6	46	9.0	0.10	0.755
less use of own resources/cost reduction	44	4.4	28	5.7	16	3.1	3.95	0.047
establishing relationships with consumers	61	6.1	26	5.3	35	6.9	1.06	0.304
gaining feedback from consumers to eliminate product defects	205	20.5	88	18.0	117	22.9	3.81	0.051
gaining new ideas from consumers and their view on market offerings	409	40.9	184	37.6	225	44.1	4.46	0.035
acquiring consumers' opinions and knowledge	640	64.0	314	64.1	326	63.9	0.00	0.958
increasing innovation and creating new solutions	217	21.7	99	20.2	118	23.1	1.27	0.261
chances of market success	151	15.1	75	15.3	76	14.9	0.03	0.858
greater consumer satisfaction	414	41.4	202	41.2	212	41.6	0.01	0.912

Source: own research. Answers do not add up to 100% as respondents could select more than one answer.

Women more often recognise opportunities in prosumption for eliminating products that are not right for the market, the possibility of modifying products, gaining feedback to eliminate product defects, as well as gaining new ideas from consumers and their perspective on the company's offerings, which leads to increased innovation and the creation of new solutions, and thus shapes the company's positive image. Men, on the other hand, more likely indicated that prosumption allows building deeper relationships with consumers, which influences their greater loyalty. A similar percentage of women and men are of the opinion that prosumption leads to greater consumer satisfaction and enables the acquisition of consumer opinions and knowledge, which gives the possibility of anticipating changes and consumer preferences, and thus provides opportunities for market success.

In general, gender does not significantly differentiate respondents' opinions, however – for a significance level of $p < 0.05$ – a significant relationship occurred for three statements. Women were more likely than men to perceive that cooperation with prosumers provides the opportunity to anticipate changes in behaviour and consumer preferences ($p = 0.021$), and the opportunity to obtain consumer feedback ($p = 0.035$), while men were significantly more likely to perceive less use of their own resources ($p = 0.047$) (Table 1).

Respondents most often pointed to the benefits of companies' cooperation with consumers in the relational dimension, but they also perceived them in other dimensions. The relational dimension affects them directly, which is why it is so significant to them. Consumers believe that they are important to the company, and that sharing their opinions is an important part of the company's business. At the same time, by sharing their opinions, knowledge and ideas, they become a partner for the company, thanks to which the company can develop its business, both in the innovative dimension by creating new solutions using the consumers' ideas, as well as in the image dimension – building a positive company image open to the environment and consumers.

Prosumptionism also means specific challenges and problems for companies, as the respondents also point out. According to them, prosumptionism is mainly related to the need for constant innovation (33.5%) to meet consumer expectations, and slightly fewer respondents (28%) point to the costs of such cooperation. Other threats included the need to prepare and offer tools for cooperation (20.4%), loss of control over ongoing processes (19.7%), and a shorter product life cycle (18.5%). In addition, involving consumers in a company's activities can bring such problems as consumer disloyalty, difficulty in maintaining consumer involvement, and a lack of consumer trust in other consumers' knowledge of products and services.

Table 2. Problems and threats for companies related to consumer activity

Indications of respondents	TOTAL		Men		Women		Chi-square test	
	N	%	n	%	n	%	χ^2	p
lack of sufficient customer knowledge and skills	170	17.0	79	16.1	91	17.8	0.52	0.469
need to offer collaboration tools	204	20.4	104	21.2	100	19.6	0.40	0.526
cooperation organisation costs	280	28.0	130	26.5	150	29.4	1.03	0.310
shorter product life cycle	185	18.5	101	20.6	84	16.5	2.84	0.092
need for continuous innovation	335	33.5	171	34.9	164	32.2	0.84	0.359
risk of disloyalty of the consumers involved	239	23.9	116	23.7	123	24.1	0.03	0.869
difficulty in maintaining customer engagement	153	15.3	71	14.5	82	16.1	0.49	0.485
loss of control over ongoing processes	197	19.7	84	17.1	113	22.2	3.97	0.046
lack of trust in other consumers in their knowledge of products and services	211	21.1	101	20.6	110	21.6	0.14	0.711

Source: own research. Answers do not add up to 100% as respondents could select more than one answer.

Women slightly more often indicated the costs of cooperation organisation, difficulties in maintaining customer involvement, loss of control over the processes carried out, or lack of trust in other consumers, and their knowledge of products and services. Men, on the other hand, more often indicated the need to offer tools for cooperation, a shorter product life cycle, and the need for constant innovation. As in the case of benefits, gender does not statistically significantly affect the answers given by respondents. With a significance level of $p<0.05$, significant differences can be observed only for the threat concerning consumer activity and the resulting loss of control over the processes being carried out, where such a threat was perceived most often by women and less by men. The difference is statistically significant only for this indication ($p = 0.046$) (Table 2).

It is important to keep in mind that the opinions expressed concern one party, i.e. consumers, and may differ from the actual threats perceived by the companies. Nevertheless, taking these opinions, consumers direct *de facto* to companies on what they should pay attention to when engaging in cooperation with consumers, especially when it comes to behaviours typical of consumers such as those related to, e.g. loyalty or consumer knowledge.

Conclusion

Cooperation between consumers and companies is important for both companies and consumers, although its forms have been changing over the years. Previously, it mainly consisted of collecting opinions on products/services or testing products released to the market. Currently, in the age of digital society, it is taking on more and more interactive forms. This cooperation can have positive and negative effects for both parties. Research shows that consumers overwhelmingly recognise the need for both parties to cooperate in areas related to the creation of market offerings. Although consumers perceive threats to companies, they believe it brings more benefits. Consumers expect companies to be open to cooperation while expressing their readiness and willingness to engage in value co-creation, but they do not want to do it for free. Consumers unequivocally indicate the necessity of such cooperation on the part of companies, which, according to them, is a condition for keeping up with the market.

Consumers' opinions are important for companies and their planned activities to involve them in the company's operations. There is a need for companies to open up to cooperation with consumers, as it is associated with a number of benefits, such as obtaining information, opinions, and ideas from customers, greater consumer loyalty, and reduced costs by eliminating market misfits, or the ability to modify market offerings in accordance with consumer expectations. This is why it is so important for companies to create platforms and tools that enable and facilitate cooperation with consumers in sharing their opinions, knowledge, and ideas. Companies should also involve consumers in the process of product development, which requires companies to use certain skills to cooperate with consumers at various stages, not just limited to obtaining information or ideas. Through companies' activities aimed at consumers, their involvement can be increased, as they will feel that they co-create the company. This means that companies should create an incentive system for consumers – not only non-financial motivators, but also financial ones, which are important for prosumer behaviours. At the same time, companies should take measures to reduce the disadvantages of such cooperation. The challenge for companies at this point is the proper organisation of cooperation, including the provision of appropriate tools and materials, the security of the company due to the possibility of disloyalty of active consumers, maintaining their commitment or difficulties in cooperation due to insufficient knowledge and skills of consumers and the lack of trust in them.

The paper presents consumers' opinions, i.e. only one party. Therefore, it is justified to conduct a study among companies and learn about their opinions, including the opportunities and threats arising from cooperation with consumers. Nevertheless, these results already indicate the areas to which companies should pay attention when deciding to cooperate with prosumers.

BIBLIOGRAPHY

Baruk, A. I. (2017). *Prosumpcja jako wielowymiarowe zachowanie rynkowe*. Warsaw: PWE.

Comor, E. (2010). Digital Prosumption and Alienation. *Ephemera Theory & Politics in Organization, 10*(3/4), 439–454.

Fuchs, Ch. (2011). New media, Web 2.0 and Surveillance. *Sociology Compass*, *5*(2), 134–147. DOI: 10.1111/j.1751-9020.2010.00354.x.

Hoyer, W. D., Chandy, R., Dorotic, M., Krafft, M., Singh, S. S. (2010). Consumer Cocreation in New Product Development. *Journal of Service Research*, *13*(3), 283–296. DOI: 10.1177/109467051037560.

Jin, Y., Hu, F., Qi, J. (2022). Multidimensional Characteristics and Construction of Classification Model of Prosumers. *Sustainability*, *14*(9), 11931. DOI: 10.3390/su141911931.

Krzysztofek, K. (2014). Rozproszone społeczeństwo: od wielkich centrów wytwórczych do osobistych przemysłów. In: P. Siuda, T. Żaglewski (eds.), *Prosumpcja: pomiędzy podejściem apokaliptycznym a emancypującym* (pp. 23–63). Bydgoszcz: Wydawnictwo Naukowe Katedra.

Lang, B., Dolan, R., Kemper, J., Northey, G. (2021). Prosumers in times of crisis: Definition, archetypes and implications. *Journal of Service Management*, *32*(2), 176–189. DOI: 10.1108/JOSM-05-2020-0155.

Mika, B. (2014). Prosumpcja – niedoszła rewolucja. In: P. Siuda, T. Żaglewski (eds.), *Prosumpcja: pomiędzy podejściem apokaliptycznym a emancypującym* (pp. 65–100). Bydgoszcz: Wydawnictwo Naukowe Katedra.

Nowacki, F. (2016). Prosumenci – przyszłość współpracy konsumentów z przedsiębiorstwami. *Economic Studies*, *255*, 136–144.

Payne, A., Storbacka, K., Frow, P., Knox, S. (2009). Co-Creating Brands: Diagnosing and Designing the Relationship Experience. *Journal of Business Research*, *62*(3), 379–389. DOI: 10.1016/j.jbusres.2008.05.013.

Przybek, P., Turek, P., Szakiel, J., Januszko-Szakiel, A. (2019). Prosumeryzm w kształtowaniu jakości wyrobów. In: M. Gębarowski, M. Jabłoński (eds.), *Jakość wobec wymagań współczesnego rynku* (pp. 43–50). Radom: Sieć Badawcza Łukasiewicz: Instytut Technologii Eksploatacji.

Ritzer, G., Jurgenson, N. (2010). Production, Consumption, Prosumption: The nature of capitalism in the age of the digital prosumer. *Journal of Consumer Culture*, *10*(1), 13–36. DOI: 10.1177/1469540509354673.

Rzewuska, A., Wolny, Ł. (2020). Współtworzenie produktów i współczesnego usług przez odbiorcę. *Transformacje*, *1–2,* 104–105.

Serafin, D. (2012). Defining prosumption for marketing: understanding the nature of prosumption after the emergence of Internet-based social media. *International Journal of Management and Economics*, *36*, 124–141.

Siuda, P., Bomba, R., Kamińska, M., Stunża, G.D., Szylar, A., Troszyński, M., Żaglewski, T. (2013). *Prosumpcjonizm popprzemysłów. Analiza polskich przedsiębiorstw z branży rozrywkowej*. Warsaw: Collegium Civitas Publishing House.

Tapscott, D., Williams, A. D. (2008). *Wikinomia. O globalnej współpracy, która zmienia wszystko.* Warsaw: Academic and Professional Publishing House.

Tapscott, D. (2010). *Cyfrowa dorosłość. Jak pokolenie sieci zmiana nasz świat*. Warsaw: Academic and Professional Publishing House.
Tian, J., Shen, L., Chen, Y. (2017). A study on Customer Prosumption Concept and its Impact on Enterprise Value Co-Creation. *Theoretical Economics Letters*, *7*(7), 2040–2053. DOI: 10.4236/tel.2017.77138.
Toffler, A. (2006). *Trzecia fala*. Poznań: KURPISZ Publishing House.
Wereda, W., Pinzaru, F. (2023). The phenomenon of prosumption in the digital transformation time. *Modern Management Systems*, *18*(2), 73–88 . DOI: 10.37055/nsz/17/6543.
Xie, Ch., Bagozzi, R. P., Troye, S. V. (2008). Trying to prosume: toward a theory of consumers as co-creators of value. *Journal of the Academy of Marketing Science*, *36*, 109–122. DOI: 10.1007/s11747-007-0060-2.

Summary

Prosumerism refers to the practices and activities of companies aimed at including and involving consumers in the co-creation of value and market offerings. The involvement of consumers takes various forms, from encouraging consumers to share their opinions and knowledge, modify the market offering, adapt it to their needs, and participate in its creation. Companies, through such activities, respond to the expectations of consumers who are active and do not want to be just passive recipients of the market offering. The paper addresses the issue of prosumptionism of companies in the consumers' evaluation. It presents the research results on the prosumptionism of companies – the benefits, opportunities and threats related to it, as well as consumers' expectations regarding the activities of companies. Although prosumption and prosumerism have become more common and consumers are increasingly prosumers (even though they are often unaware of it), in addition to the perceived opportunities and benefits, problems or threats to companies are also apparent.

Keywords: prosumption, prosumerism, consumer, social opinions.

Prosumeryzm firm – szanse i wyzwania w opinii konsumentów

Streszczenie

Prosumeryzm to praktyki, działania firm mające na celu włączanie, angażowanie konsumentów we współtworzenie wartości, oferty rynkowej. Angażowanie konsumentów przyjmuje różne formy od zachęcania konsumentów do dzielenia się swoimi opiniami, wiedzą, modyfikowania oferty rynkowej, dostosowywania jej do swoich potrzeb, po udział w jej tworzeniu. Firmy poprzez takie działania odpowiadają na oczekiwania konsumentów, którzy są aktywni i nie chcą być tylko biernymi odbiorcami oferty rynkowej. Artykuł podejmuje problematykę prosumpcjonizmu firm w ocenie konsumentów. Zaprezentowane zostały w nim wyniki badań na temat prosumpcjonizmu firm – korzyści, szanse i zagrożenia z nim związane, a także oczekiwania konsumentów odnośnie działań firm. Bo choć prosumpcja, prosumeryzm stają się coraz powszechniejsze i coraz częściej konsumenci są prosumentami (chociaż często nie mają świadomości, że są nimi), to oprócz dostrzeganych szans i korzyści, widoczne są też problemy czy zagrożenia dla przedsiębiorstw.

Słowa kluczowe: prosumpcja, prosumeryzm, konsument, opinie społeczne.

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The place of culture in sustainable development of European countries – homogeneity or diversity of the phenomenon?

Introduction

European countries are very diverse in terms of the level of sustainable development and the pace of changes of its aspects. Some research conducted in this area demonstrates that the greatest diversification is found in the social component (Klonowska-Matynia, Redlińska, 2018) or that it is the social aspect that diminishes the level of sustainability of European countries to the largest extent (Pondel, 2021). Therefore, this paper focuses on this very component of sustainable development, with a special emphasis on culture.

The authors focus on culture as a factor substantially affecting societies in their pursuit of actions aimed at achieving sustainable development, which is deemed an important element of competitive advantage, determining the level and quality of life of society. A significant role in the way culture is perceived in the context of sustainable development has been played by the UNESCO Declaration, which places culture at the heart of sustainable development policies. The document underlines, among other things, the following:

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- the economic, cultural, social and environmental aspects of sustainable development complement one another,
- the protection, promotion and maintenance of cultural diversity contributes to the social development and cultural well-being of both individuals and groups of people,
- it is necessary to acknowledge the diversity of forms of cultural expression in the development processes as it contributes to reinforcing identity and social cohesion, and fosters inclusive societies which follow the rules of equality and respect for all cultures (UNESCO, 2013).

Therefore, to achieve the sustainable development goals, culture should be integrated within national policies and international cooperation strategies.

The aim of this paper is to evaluate the level of sustainable development in selected European countries, taking into account the economic, social, environmental and cultural dimensions. Taking up research in this area fills the research gap regarding the evaluation of sustainability development in dimensions other than the three principal ones. The analysis assumes that cultural indicators determine the level of the measure of sustainable development. The selection of countries was based on indicators of their ethnic and cultural diversity. The time range of the analysis is 2012 and 2019, and the data source was the Eurostat database. A taxonomic method (linear ordering method) was used in the analysis of the research problem.

Culture and sustainable development – literature review

Differences in the theoretical definitions of culture are based on emphasising different aspects thereof, as well as the use of different terminologies and determining different types of connections and dependencies. Reviews of the meaning of culture for development have been conducted by, among others: Giraud-Labalte *et al.* (2015), Dümcke and Gnedovsky (2013), and Matarasso (1997). The differences in the theoretical approach to sustainable development regard primarily its definition, relations to other categories of unconventional concepts of development (e.g. Borys, 2005), aspects (e.g. Nazarko, Dobrzyński, 2006; Kistowski, 2003), rules or indicators.

The multi-faceted nature of culture and sustainable development is interesting for researchers and offers broad possibilities for approaching the analysis. The literature on sustainable development points to the need to provide more detailed analyses of the factors affecting sustainable development, underlining the necessity of a holistic approach. This allows us to extend the proposed set of indicators monitoring sustainable development by the culture-related ones. This is because culture can be examined in various contexts: symbolic (aesthetic experience, reinforcement of ties), institutional (formally organised institutions),

political (cultural policy), social (development of human and social capital), or economic (a field of the economy) (Plebańczyk, 2018, p. 167).

The proposal to incorporate culture permanently within the sustainable development paradigm is now of crucial importance (after: Pascual, 2009, p. 38). It involves replacing the previous three-faceted approach of sustainable development (social, environmental and economic aspects) with a four-faceted one, incorporating culture as an equally valid aspect (see: Krzyminiewska, Pondel, 2017, pp. 1017–1034). In the works of Mehdinezhad and Nabi (2016) "culture was not considered a separate dimension since it was part of the social dimension of sustainability until the last decade. However, the scenario gradually changed and culture is recognized as an essential factor in achieving sustainable development".

Bearing in mind the above, it is worth noting that the validity of this perspective allows researchers to perceive culture in three contexts:

1. relations taking place between the economy and culture; culture as an equally legitimate factor affecting the development of the economy and referred to the cultural context of entrepreneurship; the economic culture determining the manner of human participation in economic life (see: Glinka, 2008; Nawojczyk, 2009);
2. the impact of the normative system (beliefs, attitudes and values) on the economy; it underlies the considerations of outstanding researchers and their works, today deemed classic (Weber, 2002; Fukuyama, 1997; Landes, 2000; Harrison, Huntington, 2003; and others). They formulate a thesis that culture not only has meaning but (according to Landes) also "determines nearly everything" (more in: Krzyminiewska, 2010);
3. the shape, models and values allowing us to adopt attitudes adequate to the contemporary challenges of the globalised world (Throsby, 2010; Florida, 2010).

Research materials and methods

In substantive terms, this paper includes, in its empirical part, an analysis and evaluation of the level of sustainability development in selected European countries, with a special emphasis on cultural sustainability[3], and a literature review in its theoretical part. The paper is limited to an analysis of institutional statistical data regarding the area of culture, omitting the so-called soft factors of culture, such as values, behavioural patterns, etc.

[3] According to Soini and Birkland (2014), "some of the story lines establish the fourth pillar of sustainability, whereas others can be seen as instrumental, contributing to the achievement of social, economic, or ecological goals of sustainability. The eco-cultural civilization story line suggests culture as a necessary foundation for the transition to a truly sustainable society". *Cultural sustainability means the ability to maintain or improve values and attitudes under the influence of various external factors.*

The European countries to be analysed were selected based on the indicators of their ethnic and cultural diversity. This was the basis for further evaluation of the level of sustainable development in the selected countries, including:

a. countries with high ethnic cohesion and relatively low cultural diversity, such as Portugal, Italy, Poland, Greece and the Netherlands;
b. multinational and highly culturally diverse countries, such as Latvia, Switzerland, Belgium, Estonia and Spain.[4]In terms of time, the analysis covers the years 2012 and 2019, a timeframe that was determined by the availability of data.

The analysis of the research problem was carried out by applying the taxonomic method (the linear ordering method), which allows us to evaluate the diversity of the analysed phenomenon in selected units, based on an analysis of several variables. The selection of indicators for the analysis was determined by the adopted assumptions and the conviction that they would allow us to solve the research problem. This, however, is not tantamount to questioning other approaches to evaluating the place of culture in sustainable development.

An important stage of the applied research method was the choice of diagnostic variables. Material progress is observed in terms of reporting progress in striving for the sustainable development goals. Increasingly more indicators are available, albeit, considering the adopted prerequisites of the analysis, they may not always be used. When investigating the selected European countries, limitations were considered regarding the validity and availability of the data for all the characteristics and entities under analysis.

When pursuing the set research goal, Eurostat data were used. Due to the aforementioned limitations, and most of all, due to the substantive prerequisites, variables were identified regarding four aspects of sustainable development: economic, social, cultural and environmental. To assess whether the proposed potential variables may be useful, the Pearson correlation coefficient and the coefficient of variation were employed. The set of variables selected for the research and their characteristics may be found in Table 1[5].

[4] In the selection, the ethnic diversity indicators (EDI) and cultural diversity indicators (CDI) were used as developed by R. Zenderowski based on J. D. Fearon (Zenderowski, 2019). They were as follows for the selected countries: Portugal – EDI: 0.040 and CDI: 0.040; Italy – EDI: 0.040 and CDI: 0.040; Poland – EDI: 0.047 and CDI: 0.041; Greece – EDI: 0.059 and CDI: 0.050; the Netherlands – EDI: 0.077 and CDI: 0.077; Latvia – EDI: 0.585 and CDI: 0.441; Switzerland – EDI: 0.575 and CDI: 0.418; Belgium – EDI: 0.567 and CDI: 0.462; Estonia – EDI: 0.511 and CDI: 0.492; Spain – EDI: 0.502 and CDI: 0.263. The indicators took values from 1 (maximum diversity) to 0 (lack of diversity).

[5] Initially, 22 variables were pre-selected for the research. Due to the formation of correlations between the variables and referencing the coefficients to the critical value, 7 variables were subsequently excluded from the analysis.

Table 1. Variables considered when evaluating the level of sustainable development in selected European countries and their types

No.	Variable name	Variable type
	Economic aspect	
X_1	Real GDP per capita (euro)	Stimulant
X_2	Nominal labour productivity per person employed (percentage EU-28, current prices)	Stimulant
X_3	Total unemployment rate (% of population in the labour force)	Destimulant
X_4	Gross domestic expenditure on research and development (R&D) (% of GDP)	Stimulant
	Social aspect	
X_5	persons at risk of poverty or social exclusion (% of total peoples)	Destimulant
X_6	People at risk of income poverty after social transfers (% of population aged 18 years or over)	Destimulant
X_7	Young people neither in employment nor in education or training (% of population from 15 to 29 years)	Destimulant
X_8	Adult participation in learning (% of population aged 25 to 64)	Stimulant
	Cultural aspect	
X_9	Cultural employment (% of total employment)	Stimulant
X_{10}	Household expenditure on recreation and culture (% of total expenditure)	Stimulant
X_{11}	General government expenditure on cultural services (% of total expenditure)	Stimulant
X_{12}	General government expenditure on broadcasting and publishing services (% of total expenditure)	Stimulant
	Environmental aspect	
X_{13}	Greenhouse gas emissions per capita (tonnes of CO_2 equivalent per capita)	Destimulant
X_{14}	Share of renewable energy in gross final energy consumption (%)	Stimulant
X_{15}	Area under organic farming (% of total utilised agricultural area)	Stimulant

Source: own elaboration based on (Eurostat, 2022; World Bank, 2022).

Table 2 presents basic measures of descriptive statistics of the diagnostic variables to be further analysed. Due to different units and a differentiated ranges of values of the variables, they were normalised in the analysis using the zeroed unitarisation method. For this purpose, the following formulas were employed (Olejnik, 2006, pp. 198–199; Pondel, 2021, p. 387):

a. for stimulants:

$$z_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}}$$

b. for destimulants:

$$z_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}}$$

where:

z_{ij} – normalised value of the *j*-th variable in the *i*-th country

x_{ij} – value of the *j*-th variable in the *i*-th country.

Based on the set of the normalised diagnostic variables, a synthetic development indicator was determined, i.e. a taxonomic measure of sustainable development (TMSD) of the European countries selected for the analysis both for the particular aspects as well as an aggregate indicator, for the years 2012 and 2019.[6]

For this purpose, the non-model-based linear ordering method was employed[7]:

$$\mathrm{TMSD_i} = \frac{1}{m}\sum_{j=1}^{m} z_{ij}$$

where:
i – ordinal number of the country
j – ordinal number of the diagnostic variable
m – total number of diagnostic variables.

The linear ordering made it possible to assess the examined countries and classify them in terms of the achieved level of sustainable development, both in the particular aspects and in aggregate, in both years under analysis (2012, 2019). When creating the classification, the mean value of the synthetic indicator ($TMSD_{mean}$) for the entire population examined and the standard deviation from the mean (σ) were used.

For the indicators depicting the level of sustainable development in aggregate and in the economic, social, cultural and environmental aspects, four intervals of the indicator value were set, to which the following groups of countries were assigned: countries with a very high, high, low and very low level of development[8].

The results obtained allowed us to determine which aspect of sustainable development fosters or impairs the sustainability level of a country, and, most of all, what the impact is of the cultural component on this level.

Research results

The results from the analysis conducted for ten selected European countries show that the value of the general synthetic sustainable development indicator in 2019 grew in as many as nine of the countries compared to 2012. In the case of one country, the Netherlands, the value of the indicator declined in the period under analysis (Table 3).

[6] The synthetic development indicator takes values from the interval [0.1] – the higher the value, the better the situation of the object (Łogwiniuk, 2011, p. 15; Pondel, 2021, p. 387).

[7] The normalised values of variables Z_{ij} were averaged in the cross section of variables, taking into account weight factors – constant weights were adopted. This means that each variable in the taxonomic analysis has the same significance, which is in line with the essence of sustainable development, which assumes the equality of the economic, social and environmental aspects (Pondel, 2021, pp. 387–388).

[8] Countries with a very high development level: ($TMSD_{mean}$ + σ) and more; countries with a high development level: ($TMSD_{mean}$) to ($TMSD_{mean}$ + σ); countries with a low development level: ($TMSD_{mean}$) to ($TMSD_{mean}$ – σ); countries with a very low development level: ($TMSD_{mean}$ – σ) and less.

Table 2. Basic characteristics of distribution of diagnostic variables

Variable	Mean		Standard deviation		Coefficient of variation		Minimum		Maximum	
	2012	2019	2012	2019	2012	2019	2012	2019	2012	2019
X_1	24,392.00	27,078.00	15,510.16	15,928.06	0.64	0.59	9,680.00	12,530.00	58,820.00	62,800.00
X_2	95.59	93.75	24.88	22.16	0.26	0.24	63.20	69.00	130.20	129.50
X_3	13.14	7.70	7.12	4.82	0.54	0.63	4.50	3.30	24.80	17.90
X_4	1.54	1.75	0.73	0.83	0.48	0.48	0.66	0.64	2.85	3.16
X_5	25.74	22.71	6.79	4.44	0.26	0.20	15.00	16.50	36.20	30.00
X_6	15.71	16.58	3.22	3.67	0.21	0.22	8.90	11.80	21.00	23.60
X_7	15.48	11.31	6.25	4.91	0.40	0.43	6.00	5.20	25.40	21.20
X_8	10.90	12.49	7.59	8.80	0.70	0.70	3.30	3.90	29.10	32.30
X_9	3.97	4.02	0.95	0.80	0.24	0.20	2.90	3.30	5.80	5.40
X_{10}	7.44	7.62	1.69	1.50	0.23	0.20	4.60	5.70	10.70	9.90
X_{11}	1.23	1.26	0.83	0.79	0.68	0.63	0.20	0.30	2.80	2.60
X_{12}	0.39	0.40	0.20	0.12	0.51	0.29	0.10	0.20	0.70	0.60
X_{13}	9.50	8.68	5.50	6.00	0.58	0.69	5.50	6.00	15.30	11.20
X_{14}	17.39	21.79	9.49	10.18	0.55	0.47	4.66	8.89	35.71	40.93
X_{15}	7.99	11.07	3.80	6.00	0.48	0.54	2.61	3.49	14.86	22.33

Source: own elaboration.

Table 3. Values of the synthetic sustainable development indicator for selected European countries in 2012 and 2019

EU country	Economic indicator ($TMSD_{econ}$)		Social indicator ($TMSD_{social}$)		Cultural indicator ($TMSD_{cult.}$)		Environmental indicator ($TMSD_{envir.}$)		Aggregate indicator ($TMSD_{general}$)	
	2012	2019	2012	2019	2012	2019	2012	2019	2012	2019
Countries with low cultural diversity										
Portugal	0.2621	0.3294	0.4127	0.5462	0.1929	0.1070	0.5912	0.6036	0.3647	0.3966
Italy	0.4974	0.4440	0.2196	0.2350	0.1794	0.2420	0.5359	0.5595	0.3580	0.3701
Poland	0.2396	0.3651	0.3478	0.5312	0.2246	0.2742	0.2758	0.1188	0.2720	0.3223
Greece	0.1030	0.0976	0.0189	0.2282	0.1351	0.0179	0.4383	0.4110	0.1738	0.1887
the Netherlands	0.6942	0.6911	0.8818	0.8725	0.5899	0.6405	0.1054	0.0110	0.5678	0.5538
Mean for the group	0.3593	0.3854	0.3762	0.4826	0.2644	0.2563	0.3893	0.3408	0.3473	0.3663
Countries with high cultural diversity										
Latvia	0.1149	0.2025	0.2168	0.2589	0.6414	0.6369	0.8849	0.8602	0.4645	0.4896
Switzerland	0.9928	0.9499	0.8538	0.9214	0.6965	0.6633	0.7076	0.7246	0.8127	0.8148
Belgium	0.7625	0.8256	0.5396	0.6479	0.4634	0.4630	0.2164	0.1087	0.4955	0.5113
Estonia	0.3964	0.3797	0.4958	0.4723	0.7901	0.8314	0.5580	0.5710	0.5601	0.5636
Spain	0.2801	0.3108	0.3545	0.4251	0.3719	0.4173	0.4907	0.4652	0.3743	0.4046
Mean for the group	0.5093	0.5337	0.4921	0.5451	0.5927	0.6024	0.5715	0.5459	0.5414	0.5568
All countries under analysis										
Value	0.4343	0.4596	0.4341	0.5139	0.4286	0.4294	0.4804	0.4434	0.4443	0.4615

Source: own elaboration.

Among the nine countries with a growing general synthetic *TMSD*, none recorded growth in all four partial indicators. In this group of countries, the economic sustainable development indicator increased in five countries, the social one in eight, and the cultural and environmental ones in four. The countries with a growing general synthetic indicator of sustainable development included all five countries from the high cultural diversity group and four countries from the low cultural diversity group.

As demonstrated in Table 3, both in 2012 and in 2019, only in one country, i.e. Estonia, the cultural aspect was the one with the most significant impact on the general sustainable development indicator. It was the least impactful aspect for the development of the general indicator value in four countries in 2012 and in three countries in 2019. Two countries – Portugal and Switzerland – retained this position in both the analysed periods. The value of the cultural indicator declined in those countries; in Switzerland, however, despite the decrease in 2019, the value remained at a high level in general (0.66).

The synthetic sustainable development indicator in the cultural aspect in both years under analysis was lower in the countries with low cultural diversity compared to those with high cultural diversity (Table 3). Only one of the countries from the first group, the Netherlands, recorded the cultural indicator (0.58 in 2012 and 0.64 in 2019) close to the mean for the countries from the second group (0.59 and 0.60, respectively).

By evaluating the general level of sustainability development in the examined European countries in 2012 and 2019, it may be concluded that there were as many countries characterised by a very high level of sustainability development (5) as those characterised by a low and very low level (5) (Table 4). In both periods under analysis, no changes in this area took place in the structure of the countries.

In terms of the economic aspect of sustainable development, both in 2012 and 2019, a larger number of countries (6 and 7, respectively) achieved a low and very low level of development rather than a high and very high level (4 and 3, respectively). Furthermore, the economic climate in Italy declined. A similar situation could be observed for the social indicator – the country that improved its position in 2012 compared to 2019 was Poland. In the cultural aspect, similarly as in the case of the general indicator, the same number of countries was characterised by a very high and high level of sustainability (5) as those characterised by a low and very low level (5). Slight changes were noted in Switzerland (in 2012, it was in the group of countries with a very high cultural indicator, while in 2019, it was in the group with a high indicator), Italy (a change from the group of countries with a very low level of the indicator to those with a low level of the indicator) and Portugal (the reverse situation to the case of Italy).

Table 4. Surveyed European countries by the level of sustainable development

Synthetic sustainable development indicator	2012		2019	
	TMSD value	Country	TMSD value	Country
Aggregate indicator – $TMSD_{general}$				
very high	above 0.6235	Switzerland	above 0.6304	Switzerland
high	0.4443–0.6235	the Netherlands, Latvia, Belgium, Estonia	0.4615–0.6304	the Netherlands, Latvia, Belgium, Estonia
low	0.2651–0.4443	Portugal, Italy, Poland, Spain	0.2926–0.4615	Portugal, Italy, Poland, Spain
very low	below 0.2651	Greece	below 0.2926	Greece
Economic indicator – $TMSD_{econ}$				
very high	above 0.7316	Switzerland, Belgium	above 0.7344	Switzerland, Belgium
high	0.4343–0.7316	Italy, the Netherlands	0.4596–0.7344	Italy, the Netherlands
low	0.1370–0.4343	Portugal, Poland, Estonia, Spain	0.1848–0.4596	Portugal, Italy, Poland, Latvia, Estonia, Spain
very low	below 0.1370	Greece, Latvia	below 0.1848	Greece
Social indicator – $TMSD_{social}$				
very high	above 0.7072	the Netherlands, Switzerland	above 0.7607	the Netherlands, Switzerland
high	0.4341–0.7072	Belgium, Estonia	0.5139–0.7607	Portugal, Poland, Belgium
low	0.1610–0.4341	Portugal, Italy, Poland, Latvia, Spain	0.2671–0.5139	Estonia, Spain
very low	below 0.1610	Greece	below 0.2671	Italy, Greece, Latvia
Cultural indicator – $TMSD_{cult.}$				
very high	above 0.6697	Switzerland, Estonia	above 0.6955	Estonia
high	0.4285–0.6697	the Netherlands, Latvia, Belgium	0.4293–0.6955	the Netherlands, Latvia, Switzerland, Belgium
low	0.1873–0.4285	Portugal, Poland, Spain	0.1631–0.4293	Italy, Poland, Spain
very low	below 0.1873	Italy, Greece	below 0.1631	Portugal, Greece
Environmental indicator – $TMSD_{envir.}$				
very high	above 0.7139	Latvia	above 0.7251	Latvia
high	0.4804-–0.7139	Portugal, Italy, Switzerland, Estonia	0.4434–0.7251	Portugal, Italy, Switzerland, Estonia, Spain
low	0.2469–0.4804	Poland, Greece, Spain	0.1617–0.4434	Greece
very low	below 0.2469	the Netherlands, Belgium	below 0.1617	Poland, the Netherlands, Belgium

Source: own elaboration.

As shown in Table 4, among the four aspects of sustainable development, in 2019, only the environmental aspect was associated with a larger number of countries attaining a very high and high level of the indicator (6) compared to those that attained a low and very low level (4).

When assessing the meaning of the cultural aspect for the level of sustainability development of the selected European countries, linear ordering of the examined countries was conducted, taking into account a synthetic indicator based on four aspects and an indicator based on three aspects. The results are presented in Table 5 below.

Table 5. Level of sustainability development of European countries, results of linear ordering

Country	TMSD (econ.+social+cult. +envir.)		Average position	TMSD (econ.+social +envir.)		Average position
	2012	2019		2012	2019	
Switzerland	1	1	1	1	1	1
the Netherlands	2	3	2.5	2	3	2.5
Estonia	3	2	2.5	4	5	4.5
Belgium	4	4	4	3	2	2.5
Latvia	5	5	5	7	6	6.5
Spain	6	6	6	8	8	8
Portugal	7	7	7	5	4	4.5
Italy	8	8	8	6	7	6.5
Poland	9	9	9	9	9	9
Greece	10	10	10	10	10	10

Source: own elaboration based on Table 3.

As results from this calculation show, culture has a substantial role in sustainable development. In the case of Estonia, the country for which the cultural aspect was the most impactful for the development of the general indicator, eliminating this aspect from the set of sustainable development components impaired the position of this country in the sustainability hierarchy of countries. Latvia is an example of a country in which the cultural aspect was the second most important one for the development of the general sustainability indicator, and so, excluding culture from the measurement of the general indicator shifted the country to a lower position in the ranking. However, eliminating the cultural aspect from the construction of the synthetic indicator of sustainable development definitely had a lower impact on the results of the linear ordering for the countries for which this component only slightly affects the final value of the general indicator, e.g. in Greece.

Discussion

Based on the research conducted, it can be concluded, though with great prudence, that the social component plays a special role in the sustainable development of the analysed countries: an increase in the social indicator in the period of 2012–2019 was noted for the eight out of nine countries in which the general synthetic indicator of sustainable development had grown. There was no unequivocal relationship between the social and economic components of sustainable development: while in Portugal, Poland, Latvia, Belgium and Spain the growing significance of the social component was accompanied by the growth in the economic indicator, Italy, Greece and Switzerland noted the opposite trend. Undoubtedly, the improvement in the economic situation of a country may positively drive the improvement in the synthetic indicator of sustainable development in the social aspect, but it does not have to take place as lower values of this indicator may result, for example, from lower demand among a society for support granted under social policy, or generally from the better quality of life of a society.

In the analysis, the cases of the Netherlands, Greece and Poland are worth underlining. In the structure of the research sample, the Netherlands belongs to the countries with low cultural diversity, and yet it noted a value of the cultural indicator at the mean level of the countries with high cultural diversity. This is certainly an effect of adopting the cultural diversity indicators as of the beginning of the 21st century as the basis for grouping countries according to their cultural diversity. Meanwhile, the most important factor of demographic changes in the Netherlands of the recent years is migration, both economic and by those from places affected by environmental changes or conflicts and wars. The scale of this phenomenon undoubtedly affects the cultural diversity of this country. The Netherlands is also an example of a country where the economic indicator did not change in the analysed period, while the social indicator declined, and this fact did not result from reduced social needs of the residents; the number of people at risk of poverty and social exclusion grew in 2019 compared to 2012. This is most probably also related to the migration wave.

Greece is a country which improved in terms of the level of sustainability in the analysed period, mainly due to a huge increase in the social indicator, accompanied by a parallel significant decrease in the cultural indicator, as well as declines in the other aspects. Despite the material improvement of the social indicator, this country still belongs to the group of countries with a very low level of sustainable development in this area – the reference point was a very low level of the indicator in 2012. Certainly, the changes in the social aspect in this country brought about a drop (in the analysed period) in the number of people at risk of poverty and social exclusion.

Poland is a country which materially improved the value of the social indicator in the analysed period, but unlike Greece, this improvement contributed to

Poland having changed its position in terms of sustainability: in 2019, Poland was one of the countries with a high social indicator (whereas in 2012, the country was in the low indicator group). Undoubtedly, this is a result of the social policy pursued in Poland, including the welfare policy, and the value of cash transfers intended for the implementation of the policy.

As results from the analysis conducted, the cultural aspect has a much bigger role in the sustainability of development of countries with a high cultural diversity level: in this group of countries, the mean values of the cultural indicator in both the analysed years were more than twice the values for the group of countries with low cultural diversity. This may be a sign of the significantly greater challenges that the functioning of multicultural communities brings about. Of course, the examples of Estonia and Latvia do not allow us to generalise the conclusions and determine a general trend in the development of the phenomenon, but they do allow us to observe certain trends.

Research on the importance of the cultural dimension for sustainability is carried out in relation to different countries or regions, covers different research periods, and is based on different data. As Bervar (2019) notes, it is often difficult to determine the specific effects and scale of these relationships due to the lack of comparable and unified analysis criteria. However, some research results confirm certain regularities. Estonia and Latvia are countries where, according to our analysis, the importance of the cultural dimension for sustainable development has been demonstrated. Similar conclusions regarding Estonia and Latvia were drawn by Streimikiene, Mikalauskiene and Kiausiene (2019) based on their research. By determining the integrated cultural value index – based on an expert survey, they showed that in countries such as Estonia, Latvia and Lithuania, there is a very strong positive relationship between the cultural value index and sustainable development goals (correlation coefficient $r = 0.9992$). Bacchini and Valentino (2020), in turn, conducted a multidimensional analysis of homogeneity and heterogeneity between the countries of the European euro area, in which they also showed a relationship between culture and sustainable development.

CONCLUSION

The research results show that the cultural aspect definitely has a greater role in the sustainable development of countries with high cultural diversity. It seems that this may be attributed to the public policies of the given country which support various areas of education (funding language-learning, integration programmes, etc.) and place an emphasis on reinforcing the human capital of minority groups. Although the analysis was based on quite selective data and is a very general examination of the problem, it still allows us, even at this stage of the research,

to observe certain regularities or relations. However, any broader conclusions require the analysis to be extended and significantly deepened, including by way of qualitative research. This is because the above-mentioned three possible areas of research require an analysis of attitudes (behavioural, cognitive and emotional aspects) regarding culture, which is possible by way of sociological research. In a taxonomic analysis, it is only possible to refer to data such as employment in culture, household expenditure on culture or state expenditure in this area. All of them are of great importance precisely because they not only suggest a choice of the development path of a country but also indicate the current level of participation of various aspects of culture in the development.

Emphasis must be placed on synergies occurring between the sustainable development indicators, which emerge when culture is considered in the research, and which may determine the processes of sustainability development. The results of the taxonomic analysis and literature review suggest that it is indispensable to incorporate the existing cultural resources into the development strategies created and the decisions made. Ignoring them may result in alienation of individuals and groups, dangerous processes of social disintegration, disturbance of social order, as well as impairment of the scale and pace of sustainable development. It would also be a mistake to underestimate culture due to strong social-cultural-political changes that in recent years have been dynamically affecting the transformations of the system itself, which today is the reference point for many economies around the world. Taking into account the cultural specificity of a region, the existing systems of values and the way societies are organised will allow us to take advantage of the most valuable endogenous characteristics of each given group to forge an effective relationship with the other components of sustainable development.

Future research on the cultural dimension of sustainable development should focus on a comprehensive and holistic understanding of culture, and not only on its fragmentary (e.g. institutional) approach. However, it will be particularly important to deepen the qualitative research and analyse the impact of soft factors on sustainable development, such as knowledge, customs, habits, abilities and lifestyle. Due to the variability of culture and its multidimensionality, research should reflect the diversity of perspectives on how culture enables or limits actions for sustainable development (e.g. the perspective of society, creators of cultural policies, managers of the cultural sector, experts, non-governmental organisations, etc.).

Bibliography

Bacchini, F., Valentino, P. (2020). Culture for a sustainable development: from theory to evidence. *Economia della Cultura, 3–4*, 413–424. DOI: 10.1446/100734.

Bervar, M. (2019). Importance of Culture for Sustainable Development. *Managing Global Transitions, 17*(3), 195–209. DOI: 10.26493/1854-6935.17.195-209.

Borys, T. (2005). Wąskie i szerokie interpretacje zrównoważonego rozwoju oraz konsekwencje wyboru. In: A. Papuziński (ed.), *Zrównoważony rozwój. Od utopii do praw człowieka* (pp. 64–75). Bydgoszcz: Oficyna Wydawnicza Branta.

Dümcke, C., Gnedovsky, M. (2013). *The Social and Economic Value of Cultural Heritage: literature review.* European Expert Network on Culture (EENC). Retrieved from: https://www.interarts.net/descargas/interarts2557.pdf (2023.07.19).

EUROSTAT. (2022). Retrieved from: https://ec.europa.eu/eurostat/web/main/data/database (2023.07.19).

Florida, R. (2010). *Narodziny klasy kreatywnej: oraz jej wpływ na przeobrażenia w charakterze pracy, wypoczynku, społeczeństwa i życia codziennego.* Warsaw: Narodowe Centrum Kultury.

Fukuyama, F. (1997). *Zaufanie: kapitał społeczny a droga do dobrobytu*. Warsaw: PWN.

Giraud-Labalte, C., Pugh, K., Quaedvlieg-Mihailović, S., Sanetra-Szeliga, J., Smith, B., Vandesande, A., Thys, C. (2015). *Cultural Heritage Counts for Europe. Full Report.* Kraków: International Cultural Centre, CHCFE Consortium.

Glinka, B. (2008). *Kulturowe uwarunkowania przedsiębiorczości w Polsce.* Warsaw: PWN.

Harrison, L. E., Huntington, S. P. (ed.). (2003). *Kultura ma znaczenie. Jak wartości wpływają na rozwój społeczeństwa*. Poznań: Wydawnictwo Zysk i S-ka.

Kistowski, M. (2003). *Regionalny model zrównoważonego rozwoju i ochrony środowiska Polski a strategie rozwoju województw*. Gdańsk-Poznań: Wydawnictwo Naukowe Bogucki.

Klonowska-Matynia, M., Radlińska, K. (2018). Przestrzenne zróżnicowanie zrównoważonego rozwoju wybranych krajów europejskich. Hierarchia i klasyfikacja krajów. *Middle Pomeranian Scientific Society of the Environment Protection, 20/2*, 1372–1385.

Krzyminiewska, G. (2010). *Kultura ekonomiczna młodzieży wiejskiej i jej znaczenie w rozwoju społeczno-gospodarczym obszarów wiejskich*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego.

Krzyminiewska, G., Pondel, H. (2017). The Role of Culture in the Sustainable Development of Voivodships in Poland. *Economic and Environmental Studies*, *17*/4(44), 1017–1034. DOI: 10.25167/ees.2017.44.24.

Landes, D. (2000). *Bogactwo i nędza narodów. Dlaczego jedni są tak bogaci a drudzy tak ubodzy*. Warsaw: Muza.

Łogwiniuk, K. (2011). Zastosowanie metod taksonomicznych w analizie porównawczej dostępu do infrastruktury ICT przez młodzież szkolną w Polsce. *Economy and Managent*, *1*, 7–23.

Matarasso, F. (1997). *Use or Ornament? The Social Impact of Participation in the Arts*. Stroud (UK): Comedia.

Mehdinezhad, J., Nabi., R. N. (2016). Investigating cultural and social sustainability in renovation and durability of vernacular buildings of Iran's architecture (case study: Bazaar of tabriz). *IIOAB Journal*, *7*(4), 486–495.

Nawojczyk M. (2009). *Przedsiębiorczość. O trudnościach w aplikacji teorii*. Kraków: Wydawnictwo Namos.

Nazarko, J., Dobrzyński, M. (2006). Zrównoważony rozwój – podejście holistyczne. In: E.K. Czech (ed.), *Uwarunkowania ochrony środowiska. Aspekty krajowe, unijne, międzynarodowe* (pp. 15–28). Warsaw: Difin.

Olejnik, I. (2006). Wielowymiarowa analiza zróżnicowania przestrzennego rozwoju handlu w Polsce. In: J. Mikołajczyk (ed.), *Handel – znaczenie we współczesnej gospodarce* (pp. 195–202). Poznań: Wydawnictwo Naukowe Wyższej Szkoły Handlu i Usług.

Pascual, J. (2009). Polityki kulturalne, rozwój społeczny i innowacyjność instytucjonalna, czyli: dlaczego potrzebujemy Agendy 21 dla kultury? In: W. Kłosowski (ed.), *Kierunek Kultura. Promocja regionu przez kulturę*. Warsaw: Mazowieckie Centrum Kultury i Sztuki.

Plebańczyk, K. (2018). Role kultury we współczesnych strategiach rozwoju zrównoważonego. *Studia Ekonomiczne*. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, *376*, 163–181.

Pondel, H. (2021). An attempt to evaluate the level of sustainable development in European Union countries. *Ekonomia i Prawo. Economics and Law*, *20*(2), 383–399. DOI: 10.12775/EiP.2021.023.

Soini, K., Birkland, I. (2014). Exploring the scientific discourse on cultural sustainability. *Geoforum, 51*, 213–223. DOI: 10.1016/j.geoforum.2013.12.001.

Streimikiene, D., Mikalauskiene, A., Kiausiene, I. (2019). The Impact of Value Created by Culture on Approaching the Sustainable Development Goals: Case of the Baltic States. *Sustainability,* 11, 6437. DOI: 10.3390/su11226437.

Throsby, D. (2010). *The Economics of Cultural Policy*. Cambridge University Press.

UNESCO. (2013). *Placing Culture at the Heart of Sustainable Development Policies.* Retrieved from: https://www.unesco.pl/fileadmin/user_upload/pdf/Konwencja_w_sprawie_promowania_roznorodnosci.pdf (2023.07.19).

Weber, M. (2002). *Gospodarka i społeczeństwo*. Warsaw: PWN.

WORLD BANK. (2022). *Renewable Energy consumption (% of total final Energy consumption) – Switzerland*. Retrieved from: https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?locations=CH (2023.07.17).

Zenderowski, R. (2019). Od państwa multietnicznego do państwa monoetnicznego. Bilans polskich i węgierskich doświadczeń (1918–2018). In: *Od radości do dramatu. Lata 1918–1920 w odbiorze polskim i węgierskim*. Conference materials. Budapest: Instytut Współpracy PolskoWęgierskiej. Retrieved from: https://www.researchgate.net/publication/348550243_Od_panstwa_multietnicznego_do_panstwa_monoetnicznego_Bilans_polskich_i_wegierskich_doswiadczen_1918-2018 (2023.07.20).

Summary

The aim of this paper is to evaluate the level of sustainable development in selected European countries – taking into account its economic, social, environmental and cultural dimensions, as well as the level of diversification of the phenomenon in the entities under analysis. The analysis assumes that culture has a positive impact on sustainable development measures. The selection of countries was based on indicators of their ethnic and cultural diversity. The time range of the analysis is 2012 and 2019, and the data source was the Eurostat database. A taxonomic method

(linear ordering method) was used in the analysis of the research problem. The achievement of the aim was determined by limitations in the selection of indicators and the availability and validity of data in European statistics. Based on research to date, it can be concluded that, in the cultural aspect, the same number of countries presented a very high and high level of sustainable development (5) as those presenting a low and very low level (5). The cultural aspect has substantially greater meaning for the sustainability development of the countries characterised by high cultural diversity. Taking this aspect into account while conducting analyses makes it possible use the most valuable, endogenous characteristics of a given population for forging an effective relationship with the other elements of sustainable development.

Keywords: culture, sustainable development, diversity, European countries.

Miejsce kultury w zrównoważonym rozwoju krajów europejskich – jednorodność czy zróżnicowanie zjawiska?

Streszczenie

Celem artykułu jest ocena poziomu zrównoważonego rozwoju w wybranych krajach europejskich – z uwzględnieniem jego wymiaru gospodarczego, społecznego, środowiskowego i kulturowego, oraz zróżnicowania zjawiska w badanych jednostkach. W analizie przyjęto założenie, że wskaźniki kulturowe determinują poziom miernika zrównoważenia rozwoju. Doboru krajów dokonano w oparciu o wskaźniki ich różnorodności etnicznej i kulturowej. Zakres czasowy analizy to lata 2012 i 2019, a źródłem danych była baza Eurostatu. Do analizy problemu badawczego wykorzystano metodę taksonomiczną (porządkowania liniowego). Realizacja celu determinowana była ograniczeniami w wyborze wskaźników oraz dostępnością i aktualnością danych w statystyce europejskiej. Na podstawie dotychczasowych badań można stwierdzić, że w wymiarze kulturowym, taka sama liczba krajów charakteryzowała się bardzo wysokim i wysokim poziomem zrównoważenia rozwoju (5), jak niskim i bardzo niskim (5). Wymiar kulturowy odgrywa zdecydowanie większą rolę w zrównoważeniu rozwoju krajów silnie zróżnicowanych kulturowo. Uwzględnianie go w analizach pozwala na wykorzystanie najbardziej wartościowych endogennych cech danej zbiorowości dla ukształtowania efektywnej relacji z pozostałymi składowymi zrównoważonego rozwoju.

Słowa kluczowe: kultura, zrównoważony rozwój, różnorodność, kraje europejskie.

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Changes in Ukraine's foreign trade as a reflection of its progress in integration with the European Union[3]

Introduction

Ukraine's integration into the European Union (EU) has been an essential element of the country's domestic and international policy for many years. After years of consultations, negotiations, and internal perturbations, Ukraine signed an Association Agreement with the EU in 2014. Since January 1, 2016, both parties have implemented their Deep and Comprehensive Free Trade Agreement (DCFTA) as part of this Association Agreement. These processes have been accompanied by economic reforms, the alignment of Ukrainian legislation with that of the EU, and structural changes reflecting the progress of its integration into the EU. Ukraine was granted EU candidate status in June 2022, and the European Commission will monitor its progress as part of a regular enlargement package.

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Economic theory and international experience show that foreign trade and its performance is an essential factor and measure of a country's development, including progress in international integration. The foreign trade performance of an EU candidate country reflects changes in its ability to compete in both the EU and domestic markets. If a country can penetrate the EU market and cope with import competition from EU firms before full membership without the benefit of protective measures such as tariffs or subsidies for domestic producers, then once it becomes a member of the EU, it will be able to withstand competitive pressure from foreign firms and continue to grow. Hence, the EU's accession criteria, known as the Copenhagen criteria, state that to become a member of the EU, a country must prove that it has, among other things, the capacity to cope with competitive pressure and market forces within the EU. The candidate country's goods must, therefore, be competitive.

The paper aims to show that the fundamental restructuring of Ukraine's foreign trade that accompanied its progressive integration into the EU reflected changes in the competitiveness of the Ukrainian economy. So, we show that the progress of Ukraine's integration into the EU resulted from changes in the competitiveness of its production on the EU market. To assess it, we used several measurement metrics. Even though the study encompasses the years 2010–2021, which is before Russia invaded Ukraine and the destruction of a considerable part of its production potential, the intangible part of this potential, specifically knowledge, skills, and understanding of the European market and how it works, endures and can be utilised in the future. However, that will require an influx of capital and technology.

The paper consists of three parts. In the first part, we show the radical changes in geographical trade flows between 2010 and 2021. In the second part, we focus on the changes in the commodity structure of Ukraine's trade with the EU: its concentration and deepening specialisation. In the third part, we estimate the changes in Ukraine's trade competitiveness in the EU market using different measurement metrics. The work closes with the conclusions of the analysis.

Literature review

To date, research on Ukraine's EU integration can be roughly divided into two main groups. The first group focuses on the opportunities and challenges for the Ukrainian economy within the DFTCA and the impact of signing the Association Agreement with the EU (Grytsenko et al., 2021; Savelyev et al., 2021; Soroka, 2022). This group of papers analysed the directions of changes in Ukraine's foreign policy, including foreign trade (Babenko et al., 2019; Balezentis, Yatsenko, 2018; Ruzhynskas, 2022) and regional policy (Babenko et al., 2020; Nowakowska et al., 2022) that will accompany its integration into the EU. These papers focus on

Ukraine's EU integration processes and their impact on its development rather than increasing its ability to compete in the EU market, which marks its progress towards integration.

The second group of papers (Artamonova, 2019; Palinchak et al., 2023; Pliushch, 2020; Shnyrkov et al., 2020; Totska, 2023) examines trends in developing Ukraine's foreign trade with the EU. Some papers (Dankevych et al., 2018; Matyushenko et al., 2018) focus on the prospects for developing Ukraine's foreign trade with the EU in the agricultural sector. In turn, Artamonova (2019), analysing the changes in Ukraine's foreign trade with the EU, assesses the possibilities and directions of its development in the EU market. Palinchak *et al.* (2023) and Totska (2023) examine the impact of the Russian-induced war on Ukraine's foreign trade characteristics. Using a gravity model, Pliushch (2020) estimates the impact of various factors on Ukraine's trade with the EU.

The works cited above do not examine and show the relationship between changes in Ukraine's foreign trade, especially the level and changes in product competitiveness, and the country's progress towards EU integration. The findings of Shnyrkov *et al.* (2020) appear to be complementary from the perspective of the topic addressed in this paper and the research results. Indeed, they show the impact of the integration of the Ukrainian economy into the EU and the significant reduction of Russia's share in Ukraine's foreign trade. Due to the very high concentration of the commodity structure of Ukrainian exports to the EU market, the impact of trade diversification on the progress of the integration of the Ukrainian economy into the EU is negligible. However, it is difficult to expect the Ukrainian economy to progress further towards EU integration without progressive trade diversification. This means that diversification of the commodity structure of Ukraine's foreign trade is becoming a requirement for the future.

Reorientation of the geographical structure of Ukraine's foreign trade in 2010–2021

Since gaining independence in 1991, Ukraine's foreign trade has heavily depended on one partner, Russia. Over time, especially since 2010, the geographical structure of Ukraine's exports and imports has changed radically (Table 1 and Table 2). In 2010, Russia was the leading buyer of Ukrainian goods (with a share of 26.12%) and a source of foreign supplies, and its share in Ukraine's exports was similar to that of the 28 EU countries. The share of other countries in Ukraine's exports did not exceed 6%. Since 2012, Russia's share of Ukraine's goods exports has started to decline rapidly in favour of the EU and China. Besides Russia, the shares of Belarus, Kazakhstan, Iran, and Lebanon also decreased significantly over that period (Table 1).

In 2014, the EU's share of Ukraine's goods exports was nearly twice that of Russia's; in 2021, it was eight times higher. In 2021, the value of Ukraine's goods exports to Poland and Italy was higher than to Russia. This year, Ukrainian exports of goods to the EU were concentrated on deliveries to four countries (Poland, Italy, Germany, and the Netherlands), accounting for almost 50% of Ukrainian exports to the EU. The shares of China, India, and the USA in Ukrainian goods exports also increased strongly between 2010 and 2021 (Table 1).

Table 1. Geographical structure of Ukraine's exports of goods in 2010–2021, in %

Country	2010	2014	2016	2020	2021
Russia	26.12	18.18	9.88	5.5	5.02
Belarus	3.69	3.00	2.48	2.71	2.17
Kazakhstan	2.53	1.98	1.1	0.68	0.64
Lebanon	2.01	0.51	0.93	0.67	0.57
Iran	2.00	1.31	1.94	0.53	0.92
EU, including	25.38	31.54	37.12	37.82	39.36
Poland	3.48	4.91	6.05	6.65	7.68
Italy	4.69	4.58	5.31	3.92	5.1
Germany	2.92	2.95	3.92	4.21	4.21
Netherlands	1.1	2.05	2.74	3.66	3.32
Spain	0.8	2.16	2.76	2.54	2.46
Hungary	1.67	2.8	2.9	2.57	2.38
Romania	1.37	1.08	1.97	2.2	2.27
Czech Republic	1.22	1.43	1.54	1.68	2.08
China	2.56	4.96	5.04	14.43	11.76
Turkey	5.88	6.61	5.64	4.95	6.09
India	2.77	3.37	5.23	4.01	3.66
Egypt	2.58	5.31	6.23	3.29	2.86
Japan	0.2	0.39	0.51	0.37	0.51
USA	1.58	1.24	1.17	2.0	2.37
Canada	0.14	0.13	0.08	0.17	0.24

Source: own calculations based on data from the State Statistics Service of Ukraine.

Table 2 shows the reorientation of Ukrainian imports over 11 years (2010–2021). In 2010, Russia was also the largest foreign supplier of goods to Ukraine (with a share of 36.6%), and its share in Ukraine's imports of goods was only 5.1 percentage points higher than that of the EU. The shares of the other countries did not exceed 8%.

However, between 2010 and 2021, Russia's share in Ukraine's imports of goods was reduced to a quarter of its previous level (from 36.6% to 8.4%), and from 2020 it fell below Germany's share. During this period, the EU's share increased by a third (from 31.5% to 39.8%). At the same time, most EU countries increased their share of Ukrainian imports. China's share of Ukraine's imports doubled (from 7.7% to 15.1%), and the shares of the USA, Turkey, and Switzerland also increased strongly (Table 2). In 2021, Ukraine's imports of goods from the EU were concentrated on supplies from three countries (Germany, Poland and Italy), and their share of Ukraine's imports from the EU was close to 50%.

Table 2. Geographical structure of Ukraine's imports of goods in 2010–2021, in %

Countries	2010	2014	2016	2020	2021
Russia	36.55	23.33	13.12	8.36	8.35
Belarus	4.23	7.3	7.08	5.29	6.62
Kazakhstan	1.26	0.7	1.11	0.78	1.16
EU, including	31.45	38.71	43.67	43.91	39.75
Germany	7.58	9.85	11.0	9.83	8.63
Poland	4.59	5.64	6.86	7.62	6.81
Italy	2.29	2.77	3.46	3.92	3.67
France	1.82	2.33	3.9	2.7	2.42
Hungary	2.00	2.69	2.04	2.58	2.16
Czech Republic	1.23	1.26	1.67	1.77	2.03
Lithuania	1.05	1.9	1.25	1.5	1.77
Netherlands	1.38	1.4	1.39	1.38	1.39
Romania	1.12	1.56	0.97	1.26	1.09
Spain	0.77	1.12	1.28	1.35	1.34
Slovakia	0.73	0.78	1.11	2.1	1.27
Great Britain	1.35	1.27	1.81	1.35	1.53
China	7.74	9.94	11.94	15.31	15.08
Switzerland	0.84	0.96	2.51	1.61	3.43
Turkey	2.14	2.39	2.8	4.45	4.48
Japan	1.32	1.13	1.41	1.98	1.68
India	1.12	1.21	1.24	1.33	1.32
Egypt	0.14	0.17	0.12	0.15	0.2
USA	2.91	3.54	4.3	5.65	4.58
Canada	0.26	0.35	0.55	0.37	0.36

Source: own calculations based on data from the State Statistics Service of Ukraine.

The strong reorientation of Ukraine's foreign trade in goods was very much, if not decisively, influenced by the conflict with Russia in 2014, caused by the annexation of Crimea and Russia's seizure of Ukraine's eastern regions. The largest decrease in the share of Ukrainian exports to Russia was recorded between 2013 and 2015 (by almost 47%) and for imports between 2014 and 2016 (by almost 44%). At the same time, in 2014, Ukraine signed the Association Agreement with the European Union. As a result, the implementation of the Deep and Comprehensive Free Trade Area Agreement (DFTCA) began on January 1, 2016. It introduced several preferences for Ukrainian companies, such as the abolition of customs duties on Ukrainian goods, facilitating their access to the EU market, and helping to improve their competitiveness in this market.

As mentioned above, the sharp decline in Russia's share of Ukraine's foreign trade in goods between 2012 and 2021 was accompanied by a substantial increase in the shares of EU countries (especially Poland and Germany) and China. However, the reorientation of the geographical structure of Ukraine's exports of goods to the EU was more substantial than that of its imports. Indeed, the EU's share of Ukraine's exports of goods increased by 55%, while Ukrainian imports rose by 26%. If in the exports of Ukraine's goods, the place of Russia and other countries (see Table 1) was taken mainly by EU countries, China, and the USA, then in imports against the background of the decrease in Russia's share, in addition to the countries mentioned above, the shares of Switzerland and Turkey also increased substantially. These changes demonstrate the gradual decoupling of Ukraine's trade with Russia and a shift in the direction of Ukraine's foreign trade, mainly towards the EU. All in all, the directions of changes in the geographical structure of Ukraine's foreign trade in goods after 2010 were similar to those in the early 1990s in the post-socialist countries that became EU members in 2004 (Kamiński et al., 1996).

Changes in the commodity structure of Ukraine's foreign trade with the European Union in 2012–2021

Changes in the shares of EU countries in Ukraine's foreign trade have inevitably been accompanied by changes in the commodity structure of this trade. The long-term dependence of Ukraine's exports on Russia has led to a concentration of its commodity structure on raw materials and low-processed products (Table 3). Between 2012 and 2021, raw materials and other manufactured goods, according to the SITC classification, accounted for more than 50% of Ukraine's exports to the EU. During the period under review, their share in the supply of Ukrainian goods to the EU market increased from 55% to 66%. This indicates a growing concentration of Ukrainian exports of goods to the EU (see Figure 1), demonstrating Ukraine's deepening export specialisation in these commodities.

Table 3. Changes in the commodity structure of Ukraine's exports to the EU in 2012–2021, in %

Commodity groups, according to SITC	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Food and drink	16.08	15.67	17.42	20.80	17.83	17.90	20.11	21.47	19.02	14.11
Raw materials	25.17	26.12	24.24	24.00	26.36	27.78	26.44	29.84	30.06	30.71
Energy	10.49	8.21	7.58	4.00	3.88	5.56	3.45	3.66	3.07	3.73
Chemicals	4.90	3.73	3.79	4.00	3.10	3.09	3.45	3.66	3.68	4.56
Machinery and vehicles	10.49	9.70	10.61	11.20	11.63	11.73	12.64	12.04	13.50	10.37
Other manufactured goods	30.07	32.84	32.58	32.00	33.33	31.48	32.76	28.80	30.67	35.68
Other goods	3.50	4.48	3.79	4.00	3.10	3.09	1.72	1.05	0.61	0.41
Total	100	100	100	100	100	100	100	100	100	100

Source: own calculations based on Eurostat data.

In contrast, commodity groups integrated into global supply chains by added value account for a much smaller share of Ukrainian exports to the EU. These are mainly goods in the machinery and vehicles group according to the SITC classification. During the period under review, their share ranged from 9.5% to 13.5%. However, apart from 2021, between 2012 and 2020, the shares of machinery and vehicles (almost 29%) and food and drink (nearly 19%) in the supply of Ukrainian goods to the EU market increased, even though the EU was a net exporter of these products.

The literature (Finger, Kreinin, 1979; Herfindahl, 1955; Oliver, Hirschman, 1946) mainly uses three indicators to measure exports' degree of concentration (diversification). These are the normalised Hirschman index of export concentration, the Herfindahl index of export diversification, and the index of absolute export deviation. In this paper, we will use the normalised Hirschmann concentration index. This indicator (H_{jt}) measures the extent to which a country's exports are concentrated in a small number of products. It is calculated using the following formula (Oliver, Hirschman, 1946):

$$H_{jt} = \frac{\sqrt{\sum_{i=1}^{n}\left(\frac{x_{it}}{X_{jt}}\right)^2} - \sqrt{\frac{1}{n}}}{1-\sqrt{\frac{1}{n}}}, \tag{1}$$

where:

x_{it} – value of the country's *j* exports of goods within the commodity group *i* during the period *t*;

X_{jt} – value of the country's *j* total exports of goods during the period *t*;

n – number of commodity groups.

The normalised Hirschmann concentration index takes values from 0 to 1. The higher the indicator's value, the more concentrated the export commodity structure of a country.

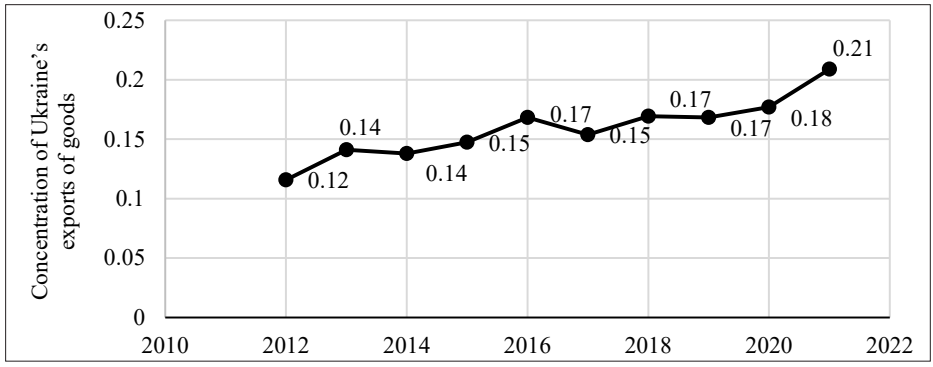

Figure 1. Concentration of Ukraine's exports of goods to the EU in 2012–2021

Source: own calculations based on Eurostat data.

Between 2012 and 2021, the concentration rate of Ukrainian supplies to the EU market increased (Figure 1). This resulted from an increase in the shares of raw materials and other manufactured goods in Ukraine's exports to the EU (see Table 3). Given that Ukraine's exports in the period under review were mainly based on raw materials and low-processed products, the increase in the concentration of the country's exports may reflect an underperforming trend in changes in the country's commodity structure.

Machinery and vehicles accounted for the largest share of Ukraine's imports from the EU between 2012 and 2021 (Table 4). These imports were much higher than other manufactured and chemical product shares. The shares of chemicals, machinery, and vehicles in Ukraine's imports from the EU hardly changed during the period under review. At the same time, the largest increase in Ukraine's share of imports from the EU was recorded in the agri-food sector (almost 28%). Overall, changes in the commodity structure of Ukraine's foreign trade with the EU have not been as strong as in its geographical structure.

Table 4. Changes in the commodity structure of Ukraine's imports from the EU in 2012–2021, in %

Commodity groups, according to SITC	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Food and drink	7.73	7.73	8.98	8.03	8.02	7.58	8.37	9.09	11.26	9.89
Raw materials	2.15	2.58	2.40	2.92	3.09	3.03	2.79	2.48	2.60	2.47
Energy	8.15	11.16	11.98	10.22	6.79	8.59	10.23	8.68	6.06	9.54

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Chemicals	19.31	18.88	20.96	21.90	20.37	19.19	19.07	19.01	19.91	19.79
Machinery and vehicles	36.91	33.91	28.74	29.93	35.80	37.37	35.81	36.78	35.93	35.34
Other manufactured goods	24.03	24.03	25.15	24.82	24.07	22.73	22.79	21.90	22.51	21.55
Other goods	1.72	2.15	1.80	2.19	1.23	2.02	1.86	1.65	1.73	1.41
Total	100	100	100	100	100	100	100	100	100	100

Source: own calculations based on Eurostat data.

Between 2012 and 2021, the commodity structure of Ukraine's imports from the EU was more concentrated than its exports to the EU. In 2012, the share of chemicals, machinery, vehicles, and other manufactured goods in Ukraine's imports from the EU was close to 80%, falling slightly to 76.7% in 2021. While Ukraine's deliveries to the EU in 2012–2021 were mainly based on raw materials and other manufactured goods, the commodity structure of Ukraine's imports from the EU was dominated by machinery, vehicles, chemical, and industrial products. This indicates the low competitiveness of the production of electrical machinery and chemical products. As a result, the growing demand for advanced products from these industries, associated with their expansion and modernisation, has been met mainly by supplies from the EU.

Changes in Ukraine's ability to compete with non-EU suppliers of goods on the EU market

When a new country joins the EU, it faces the challenge of building an economy that can compete in the single market. This is due to the Copenhagen criteria defined by the European Council at the Copenhagen Summit in 1993. These include the existence of a market economy and the ability to cope with competitive pressure within the EU market without the support of trade barriers or tariffs.

Merely presenting and analysing the structure of Ukrainian exports to the EU market is insufficient to draw conclusions on the level and changes in the competitiveness of these exports. In the literature, changes in market shares, e.g. the share of exports in a foreign market, are taken as a measure of changes in the competitiveness of a country's goods. It is crucial to bear in mind that the source of changes in the market share of a country's exports can be driven both by the level of competitiveness of those goods and by changes in demand. On the one hand, an increase in demand can increase the presence of less competitive

production in the market. On the other hand, an increase in the competitiveness of production does not always contribute to the rise in its market share. If the demand for a commodity is declining, the market's share of the commodities whose level of competition has increased may decrease with the intensification of competition in the market (Wziątek-Kubiak, 2000).

In this paper, we use changes in the share of a country's exports in the EU's external imports to measure changes in Ukraine's international competitiveness, reflecting the fulfilment of one of the Copenhagen criteria, i.e. coping with competitive pressure.

Between 2012 and 2021, the share of Ukraine's exports in EU external imports increased by nearly 36% and in EU external imports from European (non-EU) countries by almost 62% (Table 5). This suggests an increase in Ukraine's ability to compete with European (non-EU) countries in the EU market. We verify such a conclusion by estimating two measures of international competitiveness: the Balassa index of revealed comparative advantage (Table 7) and the Lafay index (Table 8).

Table 5. Shares of Ukraine's exports in EU external imports in 2012–2021, in %

Shares	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Shares of Ukraine's exports in EU external imports	0.84	0.82	0.81	0.76	0.80	0.92	0.91	0.99	0.95	1.14
Shares of Ukraine's exports in EU external imports from European non-EU countries	2.28	2.19	2.24	2.25	2.42	2.76	2.73	3.06	3.11	3.70

Source: own calculations based on Eurostat data.

The data in Table 5 show that the competitiveness of Ukrainian goods on the EU market improved between 2012 and 2021. This suggests that Ukrainian goods are adapting to the requirements of the EU market.

Between 2012 and 2021, the share of almost all commodity groups except energy in EU external imports increased (Table 6). Raw materials (up by almost 51%) and other manufactured goods (up by nearly 39%) showed the largest increases. Both groups showed the largest increases in their shares of EU external imports (Table 5) and Ukraine's exports to the EU (see Table 3). This may indicate their improving ability to adapt to the growing demand in the EU market.

During the period under review, the share of Ukraine's exports of chemicals, machinery, and vehicles in EU external imports stabilised. At the same time, although the EU was a net exporter of foods and drinks, the share of Ukraine's exports of these goods in EU external imports increased. This suggests an increase in the competitiveness of these products in the EU market compared to non-EU suppliers.

Table 6. Shares of Ukraine's exports in EU external imports by commodity groups in 2012–2021, in %

Commodity groups, according to SITC	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Food and drink	2.44	2.18	2.33	2.37	2.11	2.55	3.03	3.51	2.72	2.92
Raw materials	4.61	4.77	4.49	4.26	5.08	5.75	5.69	7.02	6.15	6.93
Energy	0.28	0.23	0.23	0.17	0.21	0.27	0.15	0.19	0.21	0.24
Chemicals	0.38	0.31	0.30	0.25	0.19	0.21	0.27	0.28	0.27	0.40
Machinery and vehicles	0.35	0.32	0.31	0.27	0.30	0.34	0.37	0.36	0.37	0.38
Other manufactured goods	1.18	1.24	1.14	0.96	1.02	1.14	1.22	1.16	1.12	1.64

Source: own calculations based on Eurostat data.

The literature (Jarosz-Angowska et al., 2022; Matkovski et al., 2021; Smutka et al., 2018) provides various indicators for measuring export competitiveness. The study will focus on two indicators: the revealed comparative advantage (RCA) index of Balassa (1965) and the Lafay (1992) index. Both indicators are used to assess the competitiveness of the country's exports compared to reference countries or the world. Therefore, we will use them to evaluate the competitiveness of Ukraine's exports of specific commodity groups to the EU market compared to non-EU suppliers. Both indicators therefore refine the results of Table 6, which shows changes in the competitive pressure of Ukrainian goods on the EU market relative to goods exported by non-EU countries.

The RCA index is calculated using the following formula (Balassa, 1965):

$$RCA_{nkj} = \frac{E_{nkj}}{E_{kj}} : \frac{I_{nj}}{I_j}, \tag{2}$$

where:

RCA_{nkj} – revealed comparative advantage index of the country *k* in exports of a commodity *n* in the market of the country *j;*

E_{nkj} – value of exports of a commodity *n* from the country *k* to the country *j*;

E_{kj} – the value of the total exports of commodities from the country *k* to the country *j*;

I_{nj} – value of imports of a commodity *n* to the country *j*;

I_j – value of the total imports of commodities to the country *j*.

The RCA index takes on positive values. The results are, therefore, within a range starting from zero, while the upper limit of the range is not defined. An index exceeding 1 indicates the presence of a revealed comparative advantage, while a value not exceeding 1 indicates the absence of such an advantage.

Our calculations in Table 7 show that between 2012 and 2021, Ukraine had a constant relative advantage in exporting raw materials, agri-food products, and other manufactured goods to the EU market compared to non-EU suppliers.

Table 7. Indexes of revealed comparative advantage (RCA) in Ukraine's exports to the EU by commodity groups relative to non-EU suppliers in 2012–2021

Commodity groups, according to SITC	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Food and drink	2.93	2.70	2.85	3.16	2.60	2.80	3.36	3.54	2.89	2.56
Raw materials	5.49	5.84	5.55	5.65	6.40	6.31	6.32	7.15	6.53	6.14
Energy	0.34	0.28	0.29	0.21	0.24	0.31	0.17	0.20	0.24	0.20
Chemicals	0.47	0.34	0.34	0.33	0.25	0.25	0.30	0.30	0.27	0.36
Machinery and vehicles	0.41	0.38	0.39	0.36	0.36	0.37	0.40	0.37	0.39	0.33
Other manufactured goods	1.42	1.51	1.39	1.26	1.27	1.25	1.34	1.18	1.18	1.44

Source: own calculations based on Eurostat data.

Ukrainian raw materials showed a strong comparative advantage in the EU market. It increased by almost 12% over the period under review. Although there was a slight decrease in the value of the RCA index in Ukrainian agri-food exports to the EU between 2012 and 2021, these products retained a moderate advantage over non-EU suppliers (in some years, the value of the RCA index exceeded 2 or 3). The values of the RCA index for other manufactured goods vary slightly from year to year (see Table 7). This indicates a stabilisation of the specialisation of Ukraine's exports to the EU for the commodity groups mentioned.

During the period under review, Ukraine had no comparative advantage in exporting chemicals, machinery, vehicles, and energy to the EU market. The values of the RCA index for these commodity groups decreased steadily.

Leaving aside raw materials, for which the comparative advantage results from natural resource endowments, the agri-food products and other manufactured goods had relatively higher comparative advantages than non-EU suppliers.

Another measure of foreign trade competitiveness used in the literature is the Lafay index (1992). It is one variation of the RCA index of Balassa. It is based on exports and imports of the country's different commodity groups, which means that it also considers the trade balance. A trade surplus in a given commodity group is equivalent to a country's comparative advantage in exporting the goods of this group. At the same time, a deficit implies the absence of such an advantage.

The Lafay index (1992) is calculated using the following formula:

$$LFI_{nkj} = 100 * \left(\frac{E_{nkj}-I_{nkj}}{E_{nkj}+I_{nkj}} - \frac{\sum_{n=1}^{N} E_{nkj}-I_{nkj}}{\sum_{n=1}^{N} E_{nkj}+I_{nkj}}\right) * \frac{E_{nkj}+I_{nkj}}{\sum_{n=1}^{N} E_{nkj}+I_{nkj}}, \quad (3)$$

where:

LFI_{nkj} – Lafay index of a country's *k* foreign trade of a commodity *n* with the country *j*;

E_{nkj} – value of exports of a commodity *n* from the country *k* to the country *j*;

I_{nkj} – value of imports of a commodity *n* of the country *k* from the country *j*;

N – number of commodity groups.

If the value of the Lafay index exceeds zero, a country has a comparative advantage in exporting goods of a given group to a given market compared to other countries. The higher the value of the Lafay index, the higher the degree of specialisation in exporting the goods of a given group to a given market. In contrast, a value of the index not exceeding zero indicates the absence of such an advantage.

Table 8. Lafay indexes of Ukraine's foreign trade with the EU by commodity groups in 2012–2021

Commodity groups, according to SITC	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Food and drink	3.89	3.65	4.16	6.37	4.88	5.08	5.79	6.03	3.71	2.12
Raw materials	10.79	10.84	10.77	10.52	11.58	12.17	11.63	13.42	13.25	14.08
Energy	1.07	-1.37	-2.17	-3.10	-1.44	-1.50	-3.32	-2.50	-1.46	-2.88
Chemicals	-6.82	-7.01	-8.47	-8.93	-8.57	-7.93	-7.64	-7.62	-7.89	-7.55
Machinery and vehicles	-12.51	-11.20	-8.94	-9.34	-11.99	-12.64	-11.32	-12.32	-10.93	-12.38
Other manufactured goods	2.75	4.02	3.66	3.58	4.62	4.29	4.94	3.28	3.87	7.09

Source: own calculations based on Eurostat data.

The data in Table 8 confirm and complement the research results presented above. From 2012 to 2021, Ukraine's exported raw materials stood out as having the highest comparative advantage on the EU market compared to other commodity groups, as measured by the Balassa RCA index and the Lafay index. In different years, the value of the Balassa RCA index for these goods ranged from 5.5 to 7.2, and the Lafay index from 10.5 to 14. The increase in these two indicators for this commodity group indicates a progressive specialisation of Ukrainian raw material exports in the EU market. During the period under review, two other commodity groups (different manufactured goods and food and drink) also had a comparative advantage in Ukraine's exports to the EU compared to non-EU countries. At the same time, the value of the Lafay index for manufactured goods increased over

the period, while for food and drink, it did not show a unidirectional change trend (see Table 8). Between 2012 and 2021, Ukraine had no comparative advantage in exporting machinery, vehicles, chemical products, and energy to the EU market.

CONCLUSIONS

International economic integration is inevitably accompanied by changes in the geographical and commodity structure of a country's foreign trade, connecting with changes in the specialisation of production and reflecting changes in the international division of labour. These, in turn, result from differences in levels and changes in the competitiveness of goods. Therefore, one of the conditions for EU membership, formulated in the form of the Copenhagen criteria, is that the candidate country must be able to compete in the EU market.

Between 2010 and 2021, there was a very strong reorientation of the geographical structure of Ukraine's foreign trade. The EU took Russia's place. In 2021, Russia's share in Ukraine's exports of goods was smaller than that of Poland and Italy, and its share in imports was smaller than that of Germany. The changes in the geographical structure of Ukraine's foreign trade since 2010 have been similar to those of the ten post-socialist new EU member states in the early 1990s.

Although the radical changes in the geographical structure of Ukraine's foreign trade with the EU have not been accompanied by equally profound changes in the commodity structure, Ukraine's inherited export specialisation in two groups of commodities (raw materials and other manufactured goods) has deepened. Their share of Ukraine's exports to the EU increased from 55% to 66%. This specialisation reflected the significant and improving competitiveness of these commodity groups, as confirmed by the estimates made in the study. The effect of the comparative advantages of Ukraine's food and drink exports has been to increase their share in the EU's external imports from European non-EU countries and (to a lesser extent) in total extra-EU imports. These three commodity groups, which account for 80% of Ukraine's exports to the EU, have been the main drivers of Ukraine's growth in EU market share and have been crucial to its integration with the EU. The small and almost stable shares of exports of chemicals, machinery, and vehicles in the EU's external imports reflect the need for more competitiveness of these goods. The Balassa and Lafay indexes confirm this. Thus, improvements in the competitiveness of Ukraine's highly specialised exports have had a substantial impact on the country's progress towards EU integration, although this progress has been selective. This suggests that foreign trade performance can be used to assess a country's progress in international economic integration. However, it appears that further integration of the Ukrainian economy into the EU will increasingly depend on the diversification of the Ukrainian economy and exports to the EU.

Bibliography

Artamonova, H. (2019). Ukraine's foreign trade with EU: opportunities and challenges. *Journal of European Economy*, *18*(3/70), 338–350. DOI: 10.35774/jee2019.03.338.

Babenko, V., Biletska, Y., Pelyak, H. (2019). Ukraine-EU: economic integration strategy. *Geopolitics under Globalization, 3*(1), 12–23. DOI: 10.21511/gg.03(1).2020.02.

Babenko, V., Perevozova, I., Kravchenko, M., Krutko, M., Babenko, D. (2020). *Modern processes of regional economic integration of Ukraine in the context of sustainable development*. E3S Web of Conferences, 166, 12001. DOI: 10.1051/e3sconf/202016612001.

Balassa, B. (1965). Trade Liberalization and "Revealed" Comparative Advantage. *The Manchester School of Economic and Social Studies*, *33*(2), 99–123. DOI: 10.1111/j.1467-9957.1965.tb00050.x.

Balezentis, A., Yatsenko, O. (2018). Trade integration asymmetries of Ukraine and the EU. *International Economic Policy*, *1*, 33–63.

Dankevych, V., Dankevych, Y., Pyvovar, P. (2018). Clustering of the international agricultural trade between Ukraine and the EU. *Management Theory and Studies for Rural Business and Infrastructure Development*, *40*(3), 307–319. DOI: 10.15544/mts.2018.29.

European Commission. Eurostat. Retrieved from https://ec.europa.eu/eurostat (2023.08.18).

European Union law. EUR-Lex. Accession criteria (Copenhagen criteria). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aaccession_criteria_copenhague (2023.07.12).

Finger, J. M., Kreinin, M. E. (1979). A Measure of "Export Similarity" and Its Possible Uses. *The Economic Journal*, *89*(356), 905–912. DOI: 10.2307/2231506.

Grytsenko, A., Borzenko, O., Burlay, T. (2021). Achievements and challenges of Ukraine's European Integration. *Journal of European Economy*, *20*(3), 518–541. DOI: 10.35774/jee2021.03.493.

Herfindahl, O. C. (1955). Some Fundamentals of Mineral Economics. *Land Economics*, *31*(2), 131–138. DOI: 10.2307/3159626.

Oliver, H., Hirschman, A. (1946). National Power and the Structure of Foreign Trade. *Southern Economic Journal*, *12*(3), 304. DOI: 10.2307/1052282.

Jarosz-Angowska, A., Nowak, A., Kołodziej, E., Klikocka, H. (2022). Effect of European Integration on the Competitiveness of the Agricultural Sector in New Member States (EU-13) on the Internal EU Market. *Sustainability*, *14*(20), 13124. DOI: 10.3390/su142013124.

Kaminski, B., Wang, Z. K., Winters, L. A., Sapir, A., Szekely, I. P. (1996). Export Performance in Transition Economies. *Economic Policy*, *11*(23), 421–442. DOI: 10.2307/1344709.

Lafay, G. (1992). The measurement of revealed comparative advantages. In: Dagenais, M. G., Muet, P.-A. (eds.) *International Trade Modelling* (pp. 209–234). London: Chapman & Hall. DOI: 10.1007/978-1-4757-2150-8_10.

Matkovski, B., Zekić, S., Đokić, D., Jurjević, Ž., Đurić, I. (2021). Export competitiveness of agri-food sector during the EU integration process: Evidence from the Western Balkans. *Foods*, *11*(1), 10. DOI: 10.3390/foods11010010.

Matyushenko, I. Y., Shtal, T. V., Piddubna, L. I., Piddubnyi, I. O., Kvitka, Y. M. (2018). Development prospects of Ukraine's foreign trade in agricultural products in the context of European integration and global challenges. *Journal of Advanced Research in Law and Economics*, *9*(4), 1343–1361. DOI: 10.14505//jarle.v9.4(34).22.

Nowakowska, A., Michalak, M., Lishchynskyy, I., Lyzun, M. (2022). Ukrainian Regional Policy: The Path to European Integration. *Gospodarka Narodowa. The Polish Journal of Economics*, *312*(4), 1–16. DOI: 10.33119/GN/154836.

Palinchak, M., Brenzovych, K., Mashkara-Choknadiy, V., Mayboroda, Y. (2023). The Impact of War on the Reorientation of Trade Flows: The Case of Ukraine. *Studia Regionalne i Lokalne*, (Special Issue), 125–140. DOI: 10.7366/15094995s2310.

Pliushch, D. (2020). Gravity Model of Foreign Trade Between Ukraine and EU Countries. *European Journal of Economics and Management*, *6*(1), 16–23.

Ruzhynskas, O. (2022). Transformation of Ukraine's Foreign Trade Policy in the Context of the Free Trade Agreement with the EU. *Public Security and Public Order*, *22*, 187–198. DOI: 10.13165/PSPO-22-29-27.

Savelyev, Y., Lyzun, M., Kuryliak, V., Lishchynskyy, I. (2021). Economic Integration of the Visegrad Four and Ukraine in the Context of Historical Narratives and Global Challenges. *European Journal of Sustainable Development, 10*(2), 44–58. DOI: 10.14207/ejsd.2021.v10n2p44.

Shnyrkov, O., Rogach, O., Reznikova, N., Nanavov, A. (2020). Ukraine's export diversification: the impact of economic integration and disintegration. *Global Policy and Governance*, *9*(1), 3–18. DOI: 10.14666/2194-7759-9-1-001.

Smutka, L., Maitah, M., Svatoš, M. (2018). Changes in the Czech agrarian foreign trade competitiveness – different groups of partners' specifics. *Agricultural Economics*, *64*(9), 399–411. DOI: 10.17221/399/2016-AGRICECON.

Soroka, S. (2022). Economic Consequences of the Realisation of the EU – Ukraine Association Agreement. *Środkowoeuropejskie Studia Polityczne, 2*, 125–159. DOI: 10.14746/ssp.2022.2.7.

State Statistics Service of Ukraine. Retrieved from: https://ukrstat.gov.ua/ (2023.08.15).

Totska, O. L. (2023). Foreign trade in goods of Ukraine with EU countries: value dimension. *National Interest*, *3*(11), 1–15.

Wziątek-Kubiak, A. (2000). *Dostosowywanie eksportu Polski, Czech i Węgier do zmian importu Unii Europejskiej*. Materiały z konferencji międzynarodowej zorganizowanej w Warszawie 25 listopada 1999 r. „Unia Europejska wobec procesów integracyjnych – wyzwania dla Polski". Warszawa: WSHiFM.

Summary

The study aims to assess changes in the ability of Ukrainian goods to compete in the EU market. It reflects Ukraine's progress towards EU integration in the run-up to Russia's attack on Ukraine. Using foreign trade measures, including international specialisation, we show the specifics of Ukraine's integration into the EU. By estimating the level and changes in the market shares of Ukraine's commodity groups in the EU market, we show its progress in penetrating this market compared to non-EU countries. On the one hand, the geographical structure of Ukraine's foreign

trade changed radically between 2010 and 2021. On the other hand, more minor changes in the commodity structure of exports and Ukraine's international specialisation were accompanied by an increased market share of Ukraine's exports in the EU market. It reflected an improvement in the ability of Ukrainian goods to compete, thus fulfilling one of Ukraine's accession criteria. Calculated on the basis of market shares, the increase in the ability of Ukrainian goods to compete is confirmed by estimates of export competitiveness indicators: the Balassa index of revealed comparative advantages and the Lafay index. Levels and changes in the three indicators varied between commodity groups. The increase in the market shares of three commodity groups (raw materials, so-called "other manufactured goods" (medium and low technology) and food products) was accompanied by significant and increasing levels of export competitiveness indicators. The decline in the market shares of other commodity groups was accompanied by low and declining levels of export specialisation indicators. Thus, Ukraine's integration into the EU has so far been based on the expansion of competitive and competitive-enhancing goods, in the production of which Ukraine specialises.

Keywords: Ukraine's foreign trade, Ukraine's integration into the EU, Ukraine's competitiveness, trade specialisation.

Zmiany handlu zagranicznego Ukrainy jako odzwierciedlenie jej postępu w integracji z Unią Europejską

Streszczenie

Celem pracy jest ocena zmian zdolności towarów ukraińskich do konkurowania na unijnym rynku. Odzwierciedla ona postęp Ukrainy w integracji z UE w okresie poprzedzającym napaść Rosji na Ukrainę. Wykorzystując mierniki handlu zagranicznego, w tym międzynarodowej specjalizacji, pokazujemy specyfikę integracji Ukrainy z UE. Szacując poziom oraz zmiany udziałów rynkowych grup towarowych Ukrainy na unijnym rynku, wskazujemy na jej postęp w penetracji tego rynku względem krajów nieunijnych. Z jednej strony, w latach 2010–2021 miały miejsce radykalne zmiany struktury geograficznej handlu zagranicznego Ukrainy. Z drugiej, mniejszym zmianom struktury towarowej eksportu i międzynarodowej specjalizacji Ukrainy, towarzyszył wzrost udziałów rynkowych eksportu Ukrainy na unijnym rynku. Odzwierciedlał on poprawę zdolności ukraińskich towarów do konkurowania, a więc spełnienia przez Ukrainę jednego z kryteriów akcesji. Obliczony, na podstawie udziałów rynkowych, wzrost zdolności do konkurowania ukraińskich towarów potwierdzają szacunki wskaźników konkurencyjności eksportu: ujawnionych przewag komparatywnych Balassa oraz Lafaya. Poziom i zmiany trzech wskaźników konkurencyjności były zróżnicowane między grupami towarowymi. Wzrostowi udziałów rynkowych trzech grup towarów: surowców, tzw. pozostałych wyrobów przemysłowych (o średnim i niskim poziomie technologii) i żywności towarzyszył znaczący i rosnący poziom wskaźników konkurencyjności eksportu. Spadkowi udziałów rynkowych pozostałych grup towarów towarzyszył niski i zmniejszający się poziom wskaźników specjalizacji eksportu. Tym samym dotychczasowa integracja Ukrainy z UE oparta jest na ekspansji towarów konkurencyjnych i zwiększających konkurencyjność, w produkcji których Ukraina się specjalizuje.

Słowa kluczowe: handel zagraniczny Ukrainy, integracja Ukrainy z UE, konkurencyjność Ukrainy, specjalizacja handlowa.

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