THE THERMODYNAMIC NATURE OF TIME

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> 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.
> Sir Arthur Eddington

Abstract

The definition of time formulated by Isaac Newton was created in the 17th century, so naturally it could not refer to thermodynamics, which significantly influences thinking about time. The essential content of the definition is the statement that time is absolute and flows uniformly independent of all events. This paper modifies this definition of time by pointing out that time is a manifestation of a thermodynamic process, it flows uniformly, at a rate determined by a suitable natural constant. The constant has a value of 0.08 [1/year] and indicates the natural, mathematical connection of the passage of time with the cyclic motion of the planet Earth, and therefore with the calendar. The thermodynamic process involves the transformation of the primary energy of modern man's life into his human capital, i.e., his ability to act and perform useful work. The term presented is conciliatory to the natural and social sciences.

1. Time and the passage of time constant

J.T. Fraser (1979), 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 recognized 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.

Long and numerous inquiries into the nature of time have led David Park to the view that "*The passage of time does not need to be explained by physics*" (Park, 1972, p. 111). Perhaps this view is the result of the belief that physical paradigms narrow the issues and hinder a comprehensive view of the nature of time. In our considerations, where necessary for substantive reasons, we do not respect the orthodox materialist scientific creed, as discussed by R. Sheldrake (2015, pp. 14-15). Since the Creator decided that humans would only be able to live up to 120 years, and scientific research confirms this, the information in Genesis (6, 1-3) is a relevant source that should be fairly cited.

Acclaimed physicist and original thinker R. Feynman begins his lecture on time with a speech:

> What is time? It would be nice if we could find a good definition of time. (…) Perhaps we should say: "Time is what happens when nothing else happens." Which also doesn't get us very far. Maybe it is just as well if we face the fact that time is one of the things we probably cannot define (in the dictionary sense), and just say that it is what we already know it to be: it is how long we wait!

This eminent scientist and man of action must have experienced the frustration of being forced to wait idly, which caused him to feel that his time was being wasted. Like everyone else, he was not interested in the fact that something was always happening; namely, changes were constantly taking place in his body and in everything around him. Although he was well aware that entropy was constantly or almost constantly increasing, in his youth he did not relate this to himself. Later in life, the sensation of aging in the body is an everyday experience. And naturally, reflection on the reasons for this occurs and the path to deciphering the nature of time opens up.

The modified formulation of time takes into account this constant transformation taking place in the human organism (and every animate being). 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 vital 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 vital energy (PVE) of modern man, personal human capital, 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, it 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.

How the transformation of PVE into what is generally called human capital works is illustrated by the three photographs posted; of an infant, a one year old child and a two year old child. The fact that 1 - 0.9231 = 0.0769 PVE is lost after the first year results in the fastest growth of the child. In the second year, the smaller loss of PVE calculated from the remaining 92.31% also results in rapid growth, but slightly slower growth. Thus, if PVE = 1.0000 at birth, a rapidly declining sequence is produced at a constant value of 8%; after one year there will be $e^{-0.08}$ = 0.9231 remaining, after the second year there is $e^{-2\times0.08}$ = 0.8521, after the third year 0.7866, and so on. Thus, the function showing the passage of time Z_t is revealed; $Z_t = e^{-at}$, where: a – constant of time passage, t - number of calendar years.

Fhotos 1. Photographs* showing the transformation of primary life energy into human capital

* Photographs of my daughter Emilia Renkas are posted with my spouse’s joint permission solely for use within this article. Any copying or publishing by third parties requires each time written consent of the parents.

Gerontologists (Vijg Jan and Eric Le Bourg, 2017) clearly indicate that the end of human life is 120 years, so at that time PVE reaches biological zero. We say biological and not mathematical zero as the e-at function is always positive. At 120 years, we have a value of $e^{-120\times0.08}$ = 0.000067729, or, 0.00% of the initial PVE. This is a rough estimate of this natural constant, otherwise already known and tested for at least two decades (Dobija, Renkas, 2021b).

The primordial resource of vital energy has been known since ancient times. In China it was and is known as *qi* energy. Huai-Chin-Nan (1984, p. 45) writing about the essence of *qi* describes it as: "the primary energy of the body is like a hidden treasure that comes with life". This knowledge is clarified by P. Pitchford (2010, pp. 82-83), who points to three sources of *qi* energy. The first source called Yuan Qi is the primordial energy found in the determination of time. According to ancient knowledge, it is inherited from parents and passed on to offspring. The energy resource is limited and is used up over time. An unfavorable lifestyle leads to additional loss of this energy. The energy of life is known as: Qi - China, Prana - India, Mana - Polynesia, Ki- Japan, Fire of the spirit - Tibet.

The following passage from Shakespeare's sonnet is seen by J. Barbour (2021, p. 20) as a poetic sense of the causal effect of the second principle. But this interpretation can be mainly referred to the passage of time, that is, the vanishing of that fire that animates a person until it finally goes out.

In me thou see'st the twilight of such day
As after sunset fadeth in the west,
Which by and by black night doth take away,
Death's second self, that seals up all in rest.
In me thou see'st the glowing of such fire
That on the ashes of his youth doth lie,
As the death-bed whereon it must expire,
Consum'd with that which it was nourish'd by.
Sonnet 73: That time of year thou mayst in me behold

2. The accelerated metabolism of modern man

Defining time requires clarifying the category of "modern man." This difficult task is facilitated by Aeschylus, for whom knowledge in this matter seems to be vivid and uncontaminated, connected with the achievements of Prometheus, which he described in the work "Prometheus Bound". We recognize Aeschylus as an important source of historical knowledge about contemporary man, as he gives voice to Prometheus, who in his exquisite poetic form (a fragment from Episodion 2) tells about his deed that "turned the stupid into the intelligent and awakened the spirit within them":

Prometheus
You must not think it is my stubbornness
that keeps me quiet, or a sense of pride,
for bitter thoughts keep gnawing at my heart
to see how foully I am being abused.
And yet who else but I assigned clear rights
and privileges to these new deities?*
But I make no complaint about such things,
for if I spoke, I would be telling you
what you already know. So listen now
to all the miseries of mortal men -
how they were simple fools in earlier days,
until I gave them sense and intellect.
I will not speak of them to criticize,
but in a spirit of goodwill to show
I did them many favours.
First of all, they noticed things, but did not really see
and listened, too, but did not really hear.
They spent their lives confusing everything,
like random shapes in dreams. They knew nothing
of brick-built houses turned towards the sun
or making things with wood. Instead, they dug
their dwelling places underneath the earth,
like airy ants in cracks of sunless caves.
They had no signs on which they could rely
to show when winter came or flowery spring
or fruitful summer. Everything they did
betrayed their total lack of understanding,
until I taught them all about the stars
and pointed out the way they rise and set,
which is not something easy to discern.
Then I invented arithmetic for them,
the most ingenious acquired skill,
and joining letters to write down words,
so they could store all things in Memory,
the working mother of the Muses' arts.*
I was the first to set wild animals
beneath the yoke, and I made them submit

to collars and to packs, so mortal men
would find relief from bearing heavy loads.
I took horses trained to obey the reins
and harnessed them to chariots, a sign
of luxurious wealth and opulence.
And I was the one who designed their ships,
those mariners' vessels which sail on wings
across the open sea.
Yes, those are the things
which I produced for mortal men, and yet,
as I now suffer here, I cannot find
a way to free myself from this distress.

Translated by Ian Johnston, Vancouver Island University, Nanaimo, BC, Canada, 2012

More knowledge about the accomplishments of Prometheus and his subordinates is gained from the Book of Enoch, which also serves as a link to the content contained in Genesis. From the Book of Enoch we learn quite a bit about some of the members of the team led by Samyaza Prometheus who decided to marry earthly women, which was not a biologically safe venture. The following short text of an excerpt from this book depicts a familiar event from Genesis and in doing so reveals the first name of the commander.

1. It happened after the sons of men had multiplied in those days, that daughters were born to them, elegant and beautiful.
2. And when the angels, the sons of heaven, beheld them, they became enamoured of them, saying to each other, Come, let us select for ourselves wives from the progeny of men, and let us beget children.
3. Then their leader Samyaza said to them; I fear that you may perhaps be indisposed to the performance of this enterprise;
4. And that I alone shall suffer for so grievous a crime.
5. But they answered him and said; We all swear;
6. And bind ourselves by mutual execrations, that we will not change our intention, but execute our projected undertaking.
7. Then they swore all together, and all bound themselves by mutual execrations. Their whole number was two hundred, who descended upon Ardis, which is the top of mount Armon.
8. That mountain therefore was called Armon, because they had sworn upon it, and bound themselves by mutual execrations.
9. These are the names of their chiefs: Samyaza, who was their leader, Urakabarameel, Akibeel, Tamiel, Ramuel, Danel, Azkeel, Saraknyal, Asael, Armers, Batraal, Anane, Zavebe, Samsaveel, Ertael, Turel, Yomyael, Arazyal. These were the prefects of the two hundred angels, and the remainder were all with them.
10. Then they took wives, each choosing for himself; whom they began to approach, and with whom they cohabited; teaching them sorcery, incantations, and the dividing of roots and trees.
11. And the women conceiving brought forth giants,
12. Whose stature was each three hundred cubits. These devoured all which the labour of men produced; until it became impossible to feed them;

Book of Enoch Chapter 7, Section 2, Library of Princeton, Theological Seminary

As is well known, Enoch belongs to the long-lived line of Adam, being the seventh patriarch about whom Genesis (5:1-32) contains significant data on the number of years of life and the conception of the first offspring. Adam and his progenitors thus constitute the last long-lived lineage in which important civilizing events occurred, such as the activity of Prometheus contemporary to Enoch and the beginning of the process of shortening human life to at most 120 years beginning with Noah, his father Lamech, and his mother Bat-Enoch.

The data on the number of years of life of the members of Adam's line allow us to calculate the characteristics for those people, so vividly described in the quoted passage from Aeschylus' work. Given that Adam lived 930 years, then from the equation $Z_{930} = e^{-930\times b} = 0.000067$ (biological zero) we get an estimate that b = 0.01, or b = 1% per year. Thus, the metabolism of the members of Adam's lineage was much slower than it is today, for them the time lapse constant was equal to b = 0.01 [1/year]. On the other hand, Adam had his first offspring (Seth) at the age of 130, i.e., at the level of PVE; $Z_{130} = e^{-0.01\times130} = 0.27$. If the mother had a similar number of years, she still had a large body power. A modern 18-year-old has a PVE = $e^{-0.08\times18}$ = 0.24, so the mother at that age has a similar power; the magnitudes of 0.27 and 0.24 are similar. In those days there were also births to very young women of about 70 years of age.

Modern man arose as a result of some specific need. It was serious if there was an expedition of the titan Prometheus acting probably to sustain life on the planet and ensure its continuation and accelerate the creation of civilization. These needs are indicated by mythological stories about Phaethon, Icarus and the planet known as Mulge in the Sumerian language. The meaning of the term "titan" is derived according to Z. Sichin (1985, p. 95) from the Sumerian language (TI.TA.AN) which means "Those who dwell in heaven". And it is a very accurate term that makes it possible to distinguish Prometheus from the cluster of nature gods, to whom, by the way, he assigned a place in the order of earthly civilization.

The changes that necessitated the earthly activities of Prometheus' team did not just affect humans, but all of nature. Roman poet Ovid writes of the appearance of the seasons, which previously, in the happy golden age, did not exist. The seasons appeared in the age referred to as the silver age.

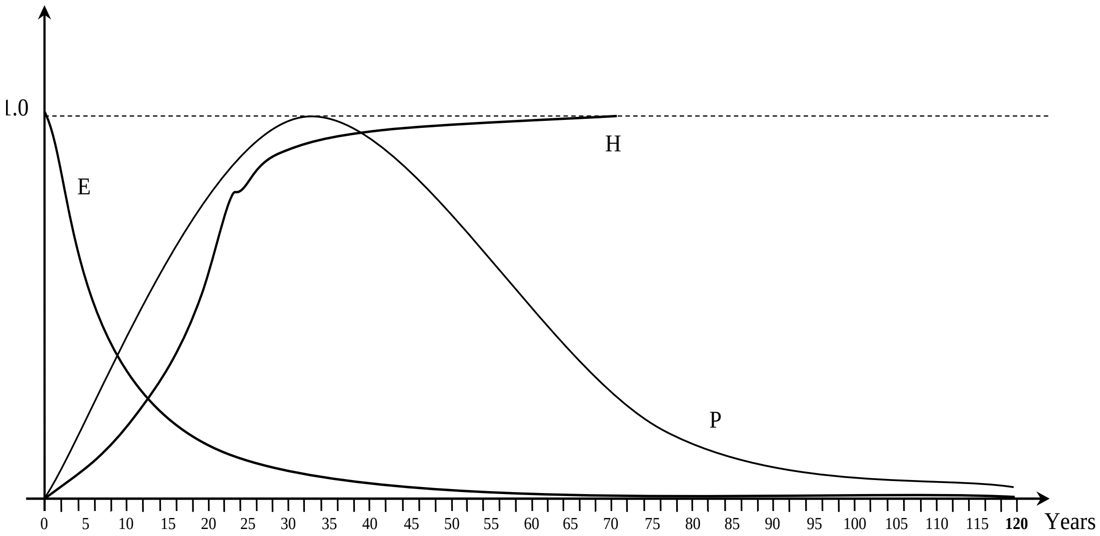
So to the rapid change on the planet Earth adapted the life of man, who had to become more active and enterprising in order to survive and work for the development of civilization. As we can see these actions have been successful, but the problems to be solved still exist and even pile up. Here a thought arises; if it was possible that Prometheus "gave man fire", that is, activated his organism by speeding up the metabolism and setting a greater pace for the course of time, then such a situation can be repeated for the benefit of man.

The Silver Age
But when good Saturn, banish'd from above,
Was driv'n to Hell, the world was under Jove.
Succeeding times a silver age behold,
Excelling brass, but more excell'd by gold.
Then summer, autumn, winter did appear:
And spring was but a season of the year.
The sun his annual course obliquely made,
Good days contracted, and enlarg'd the bad.
Then air with sultry heats began to glow;
The wings of winds were clogg'd with ice and snow;
And shivering mortals, into houses driv'n,
Sought shelter from th' inclemency of Heav'n.
Those houses, then, were caves, or homely sheds;
With twining oziers fenc'd; and moss their beds.
Then ploughs, for seed, the fruitful furrows broke,
And oxen labour'd first beneath the yoke.
Metamorphoses by Ovid. Translated by Sir Samuel Garth, John Dryden, et al

When the civilization reaches the appropriate level of development and the devices will be autonomous controlled by the procedures of artificial intelligence, then perhaps the time will come that the Authority, which once ordered "let a man live 120 years ", will decide on a longer human life, more peaceful and dignified, for example 320 years. In this state of affairs from the equation $Z_{320} = e^{-320 \times c} = 0.000067$, one gets c = 0.03[1/year]. And the offspring will be born when the mother reaches about 45 years of age. The slowing down of human reaction time will be replaced by automatic algorithms that control devices.

In order to graphically illustrate the dynamics of modern man, figure 1 was drawn, where three curves characterize the changes of human energy over the time of its existence: the line of the disappearance of the initial stock of PVE (E), the line representing the changes of the organism's power (P) and the line of the increase of personal human capital (H). Line P is a graph of disposable power defined by M. Mazur (1976, pp. 224-234) as physiological power minus idle power. Line H illustrates the economic value of personal human capital and its relationship to the constant will be explained later. Line E is the natural graph of the Z_t function. The P and H curves are adjusted to the scale of the figure and are shown as a percentage of the maximum magnitude.

Figure 1. The disappearance of primary vital energy and the course of dispositional power in the human body



Source: Dobija, Renkas, (2021a)

The figure shows that initially the P line runs similarly to line 1 - E. Then the increasing idle power decreases the rate of increase of reachable power. The same reason causes the P-line to reach its flat maximum, to start a slow decline at more than 30 years. M. Mazur used physiological data to determine the maximum power of the average body, in period 27-35 years.

The H line represents the growth of personal human capital, that visible effect of the transformation of life energy into the ability to do work in the material world. In a physically and mentally healthy person, personal human capital increases, despite the passage of time. People work, start families, settle homes, raise descendants and create various works. All this determines the development of the ability to perform work, the ability to do it, that is, transfers to the created objects. In the economic account of human capital, the constant a = 0.08[1/year] plays the role of the rate of capitalization of the expenditures incurred in maintaining a descendant to adulthood and taking up work. This issue is subject to ongoing empirical research presented in the next section. Thus, the rate of decline in PVE affects the rate of increase in human capital growth expenditures.

From the course of the E-line it can be seen that at least from the age of 40, in order to prolong one's life, one should take conscious steps to obtain additional life energy from available sources. A human with knowledge and will to last can use two more sources of life energy other than PVE. Source two Gu Qi is energy extracted from consumed food, and source three Zong Qi is energy from the air, extracted through the lungs and skin. Maoshing Ni (2012, pp. 22-23) in the book "The Yellow Emperor's Classic of Medicine" discusses the successive 8-year stages of human development in terms of kidney energy (synonymous with PVE) and states that by the sixty-fourth year of life, kidney exhaustion, fatigue, and weakness occur. This low state of PVE can be clearly seen in Figure 1. As we know, this is the period of reaching retirement age.

There are considerable possibilities for extending productive life. This issue was raised in the famous essay by E. Schrödinger (1967) asking a perverse question why man lives so long? He states that an organism can keep itself alive only by taking negative entropy from its environment, which is something positive for it. Thus, he pointed to the use of "order" existing in nature or consciously created by man in drugs, vitamins and various supplements. These products significantly benefit the elderly, whose organisms have to some extent lost the ability to absorb these compounds from food.

It should be noted, however, that this sipping of order, as described by E. Schrödinger, was reasonably practiced already in ancient times and to a greater extent than in the West today. Flavors were seen as types of energy and the main idea of correct nutrition was the balance, order and completeness of the elements in daily meals (Maoshing Ni, 2012, pp. 28-32). There are many examples indicating that reaching an age close to 120 is not something absolutely extraordinary. For example, R. Taylor (1970) describes the long and happy lives of members of the Hunza tribe, where living to nearly 120 was common until recently. There is no shortage of examples of longevity.

3. The manifestation of the constant in the issues of capital growth

In the economic sciences, categories are distinguished: resources, assets and capital. Resources are natural and are not assigned an economic value expressed in monetary units. They are estimated in natural units. Assets are heterogeneous objects that contain the abstract ability to do more useful work and their value is valued in monetary units. Capital is this abstract and potential ability to perform labor embodied in assets, while labor is the transfer of capital to products. Capital, assets and labor processes determine the essence of the commodity-money economy, as explained in the article (Dobija, 2015). As can be seen, just as in nature there is a "matter-energy" dualism, so in economics there is an "asset-capital" dualism. From the definition of capital "the ability to perform work", that is, also the ability to live and exist, follows the primary importance of the category of capital, as well as profit, that is, the periodic increase in capital.

Therefore, the category of human capital, that is, the ability of a person to perform competent work, is very important, as highlighted in the article (Dobija, 2004). To proceed with the measurement of human capital, it is important to note that an infant, although priceless, as a gift of nature has no attribute of economic value. Therefore, we estimate the value of human capital by taking into account the stream of inputs for the cost of living and professional education. Here it is important to note that the infant takes in little simple food, yet it develops rapidly, as shown in the posted pictures. Thus, the value of human capital H(a,t) is a function of the stream of inputs N and life energy, the level of which is quantified by a constant. The empirically verified formula for measuring capital H(t,a) is:

$$H(a,t) = N \times U(a,t) = N\frac{e^{at}-1}{a}, \quad a = 0.08 \text{ [1/rok]} \quad (1)$$

Where t is the number of years until adulthood, N is the annual cost-of-living outlay, U(a,t) is the coefficient (annuity) of summing the capitalized outlays.

Capital H(a,t), on the other hand, represents the potential of a person's ability to do work, which naturally dissipates. This is clear because the human organism can be treated unambiguously as a heat engine that must lose some energy in order to work. This is explained in an interesting way by P. Atkins (2003, p 157-159) pointing to the role of ATP and ADP molecules. It follows, therefore, that for economic equilibrium, i.e. not allowing for depreciation of human capital of an employee, it is necessary to balance this random and spontaneous loss of capital (s) with appropriate remuneration for work. This leads to the equation that defines the variable of equivalent remuneration (W).

$$W = s \times H(a, t) \qquad (2)$$

Where: s - the rate of spontaneous and random dissipation, W - annual equivalent labor compensation. The above equation provides the basis for performing empirical tests of both the size of the constant "a" and the size of existing wages when examining whether actual wages preserve worker capital.

Taking as a basis the cost of living in countries where wages are known to be close to fair values, in particular the USA and Western Europe, we can estimate the value of the random variable “s”, based on the formula $s = W_r/H(a,t)$, where W_r - real wages. In the case of the teenagers under consideration, there are no costs of professional education, so the human capital model is: $H(a,t) = K(a,t)$, where $K(a,t) = k(e^{at} - 1)/a$, and k - annual cost of living for a person in a family of 4.

Table 2 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 standardize 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 or the US states the estimation leads to similar results.

Table 2. 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)* [1]	$s = W_r/K(a,t)$
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

[1] *Eurostat, Monthly minimum wages*, https://ec.europa.eu/eurostat/databrowser/view/earn_mw_cur/default/table?lang=en (access date: 21.02.2022 r.)

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
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 a percentage of Employer Social Security Tax[2] (UK – 13.8%, France – 45%, Germany – 19.98%, Belgium – 25%, Switzerland – 6.4%, Sweden – 31.42%). Cost of living data was taken from (Cost of living, 2022).

The important relation suggested by Table 2 is the equality E(s) = a, or the weak inequality E(s) ≤ a. What does this mean? By the definition of time the constant can be looked at as the rate at which human labor resources are supplied from external sources; from Nature. In turn, labor transfers human capital to labor objects, which then become products and assets, subject to entropy growth. Thus, if the random variable s that 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 emphasized that this opinion can be made under the natural assumption of openness of the system called 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 wage in highly developed countries of Europe and states of the USA is determined by the constant a = 0.08 [1/year]. This fact is associated with correspondingly high labor productivity, as highlighted in (Dobija, 2011).

Given the relation a = E(s), equation (2) transforms to the form:

$$W(a) = a \times H(a,t) \tag{3}$$

Where: W(a) - the fair wage that offsets the natural spontaneous loss of human capital.

In order to provide independent evidence that the estimated wages are fair and to give scientific weight to this category, Table 3 is presented, which contains an account made 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 Social Security Tax and 1,45% of Medicare Tax, which is the basis for the

[2] *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 (access date: 21.02.2022 r.)

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[3].

According to formula (3), the theoretical minimum wage W(a) for a teenager (t = 17 years old) is calculated: W(a,t) = W(0.08, 17) = 0.08 × (12 × 585) × [$e^{0.08×17}$- 1] / 0.08 = $1,694.00/month. On the other hand, the statutory monthly minimum wage is: $9.00 (average minimum wage per hour from 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 capitalization 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 3. 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 × $1,694)	3,388.0
6	Pension fund contribution including Social Security Tax paid by the employee (20%)	677.6
7	Health care contribution including Medicare Tax paid by the employee (10%)	338.8
8	Amount remaining for cost of living disbursement	2,371.6
9	Amount per person (2 adults + 2 children)	592.9
10	Average cost of living	585.0
11	Pension funds per one 333,8 x12x [$(1 + 0,03)^{48}$ – 1)/0.03] =	418,218.0
12	Monthly pension after 65 year of work	1,742.0

As the calculations in Table 3 show, the amount to cover of living costs per person remaining 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 two descendants up to the level of human capital they have achieved, i.e.,

[3] Cost of living in USA. https://www.expatistan.com/cost-of-living (dostęp: 24.02.2022 r.).

this wage guarantees the preservation of human capital. In addition, after 48 years of work, the pension fund calculated at a capitalization rate of 3% is $418,218. Hence, the monthly pension amount can reach 1,742. Personal capital of 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 in Section 3 and further in Sections 4 and 5 show the contribution of the constant to the solved cognitive problems of human capital measurement and the appropriate labor 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 the US. This has been confirmed by calculations with repeated use of a constant, unambiguously indicating 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 disturbed by various factors occurring in social and economic reality. People have their own characters and are not always industrious, thrifty, reasonable, there are serious illnesses. There are economic crises caused by not respecting the correct theories, as well as all kinds of negative political influences, which threaten pension funds.

4. The manifestation of a constant in wage expectations

The general model for measuring the personal capital of the employed includes several more variables. These are: the cost of professional education; the number of years of professional work; the learning parameter, which allows to use a modified learning curve to measure capital gains through experience. Empirical studies conducted over the last two decades (Dobija, 2004, 2015; Jedrzejczyk, Koziol & Renkas, 2021; Koziol, 2011; Koziol, Mikos, 2020; Kurek, Gorowski, 2020a, 2020b, 2020c; Kurek, 2021; Renkas, 2018, 2021) using the general model confirm all the conclusions obtained in the previous section on teenage minimum wages. One application of the general model is to study wage expectations and verify the hypothesis of whether there reveals a constant. An example research was done on data from Ukraine, which does not belong to a country with a decent minimum wage.

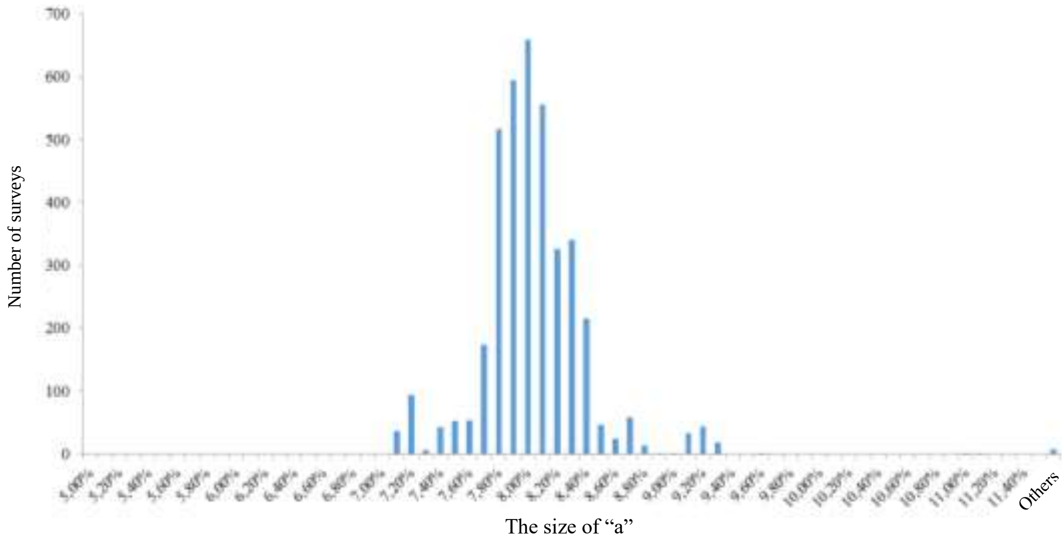
In poorer countries, such as Ukraine, minimum wages are usually far from decent. However, it is possible to study wage expectations in relation to their possible dependence on the constant. This type of research was conducted using data provided by questionnaires from Labour Offices in five different regions of Ukraine. 3,920 job seekers were surveyed asking for the data necessary to calculate the value of their human capital (age, education, work experience, etc.) and their expected wage if hired. The choice of the survey location is dictated by the fact that the job seeker does not manifest excessive expectations, but counts the cost of living for the whole family. By comparing the theoretical wages with the expected wages indicated by the respondents, the percentage of compliance of these wages and the value of the constant were estimated. Basic statistics of the set of determined values for the constant and the obtained average value of the compliance percentage for 3,920 respondents are presented in Table 4.

Table 4. Descriptive statistics for constant and the average percentage of agreement between expected and set wages based on human capital theory

Statistical quantities	Obtained values
Sample size (number of surveys)	3,920
Average value of the percentage of congruence between expected and theoretical wages	100.3%
The average value of constant "a"	0.0799
Standard deviation	0.0052
Q_1	0.0780
Median	0.0797
Q_3	0.0814
Kurtosis	208.49

Figure 2 shows a histogram of the frequency of the corresponding magnitude “a” in the overall dataset of 3,920 surveys from 5 regions.

Figure 2. Frequency histogram of the corresponding magnitude “a” in a dataset of 3,920 survey



The statistics presented in Table 4 indicate a very high level of agreement between the wages expected and those determined on the basis of the theoretical model, which includes in the calculations the constant a = 0.08 [1/year]. Thus, it is shown that job seekers' wage expectations are a function of the economic constant, confirming its value and at the same time indicating its economic significance. This demonstrates the profound impact of this constant on the economic reality of human capital growth and equivalent wages. Among 3,920 respondents, the mean value of "a" in light of salary expectations, with a very small standard deviation (0.005237), is close to the magnitude of 0.08 which confirms the hypothetical value. Additionally, the probability distribution is leptokurtic, indicating a high clustering of the magnitude "a" around the value of 8% (Figure 2). Thus, the study of expected wages as a percentage of the human capital value of job seekers, confirmed the presence of a constant size "a" at a level significantly close to 0.08 [1/year].

Another study example concerns the wage expectations of economics graduates in Poland. B. Kurek and I. Gorowski (2020a, 2020b, 2020c; Kurek, 2021) presented a cross-sectional study of wage expectations in terms of a constant a = 0.08 [1/year] and the impact of various variables on its magnitude. The empirical study confirmed the hypothesis that a constant "a" is manifested in wage expectations of graduates.

5. Disclosures of a constant in empirical studies of rates of return

As expected from the time determination, the constant also appears in the measurement of human capital as an important variable; the rate of capitalization of inputs. In addition, the constant was also found to determine the rate of dissipation of human capital (the buildup of its entropy) and thus was used to create a fair wage model. 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 labor, that is, transfers of human capital to products.

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 US is a component of the CAMP model (Goetzmann, Ibbotson, 2006), which has strongly lost its values in the current time. 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 recognize 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 5).

Table 5. 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 apriori: 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, 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%.

6. Entropy and the constant in the model of capital

Albert Einstein reportedly said that the compound interest formula is the greatest mathematical achievement of mankind[4]. Whether a joke or not, the formula $C_t = C_0e^{rt}$ is the nucleus of the general model of capital. Ch. Bliss (1975, p VII) has 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 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 recognize 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 - the rate of disappearance of capital, m - capital inflow by labor. Thus, the general model of capital after the period $\Delta t = 1$ is presented:

$$C_t = C_0 \times e^{-st} \times e^{mt} \times e^{at} = C_0 \times e^{(a - s + m)t},\ a = E(s) = 0{,}08[1/\text{year}] \quad (4)$$

An example interpretation of model (4) 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

[4] 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”. http://www.ruleof72.net/rule-of-72-einstein.asp.

second principle) could die (variable e^{-st}). The work of 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 PVE, which is quantified by the constant (variable e^{at}). It should be emphasized that the inflow of capital through the work of 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. Labor does not increase capital; labor is merely a transfer of capital, but competent labor counteracts entropy.

The economic processes in which capital gains, or income, are sought are interpreted similarly. By definition, income = $\Delta C = C_1 - C_0 = C_0 \times e^{(a - s + m)t} - C_0 \approx C_0(a - s + m)\,\Delta t$, 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), 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 knowledge contained in sections 4 through 6 shows 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 labor, 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 labor that has coagulated. The source of labor is human capital, which, as the definition of time reveals arises after the PVE conversion. 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 PVE life energy. Economic processes generating GDP take place with the help of a 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.

7. Thermodynamics enriches Newton's and Kant's concepts of time

The arguments presented about the nature of time and the role of the time constant in economics enrich the knowledge left by Newton and Kant without compromising its coherence. The difficult question is whether time is absolute and what does that mean? Probably Newton did not connect the passage of time with the consciousness of man, possibly he thought of a higher being, according to the times in which he lived. This opinion indicates the utter harmlessness of this adjective in relation to the concept of time, and its use intelligently replaces the lack of knowledge of thermodynamics. Nor is time mathematical, but it takes mathematics to describe it, as it does for any abstract scientific category. And not just arithmetic, when you factor in the knowledge contained in the calendar.

Through the work of Kant (1724-1804), time gained a philosophical basis and a connection to human consciousness. Kant explains (1871, p 48) that:

> Time is not something which subsists of itself, or which inheres in things as an objective determination, and therefore remains, when abstraction is made of the subjective conditions of the intuition of things. For in the former case, it would be something real, yet without presenting to any power of perception any real object. In the latter case, as an order or determination inherent in things themselves, it could not be antecedent to things, as their condition, nor discerned or intuited by means of synthetical propositions a priori. But all this is quite possible when we regard time as merely the subjective condition under which all our intuitions take place. For in that case, this form of the inward intuition can be represented prior to the objects, and consequently a priori.

This term contains the essence of Kant's concept of time. As we know, Kant regarded senses as important tools of cognition that are necessary to supplement the knowledge provided by intellect. Time is empirically real thanks to sensory cognition, which reflects the states and order of succession of real objects. However, it is not an absolute reality, it is not a self-contained entity existing without the senses and human consciousness. But the meaning of time is important, without it human being would lose its full ability to know the world through experience. The essence of Kant's concept is well defined by his statements. *"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. Time is the form of our sensuality, it is the form of the inner sense."*

When talking about important concepts of time, one cannot leave out Albert Einstein. Although it was said (William Shakespeare) "Woe to inferior beings when they come between the blades of mighty swordsmen" but the situation forces us to take a stand, which is significantly facilitated by the power of J. Barbour's intellect. According to our definition, time is not what clocks measure, but they are needed for various purposes, especially the organization of social life and the conduct of scientific research. A factual argument on this issue is presented by J. Barbour (1999, p. 225):

> The theory of relativity is not at all concerned with the abstract concept of time: it describes physical devices called clocks. There is nothing implausible about the idea that clocks moving past us at high speed should appear to go slower than the watch we wear on our hand. The movement of a clock could change the rate at which it ticks.

For example, can one agree with the statement of F. Capra (1976, p. 187) who writes:

> What is true for lengths is also true for time internals. They, too, depend on the frame of reference, but contrary to special distances they become longer as the velocity relative to the observer increases. This means that clocks in motion run slower; time slow down. This

clock can be of ranging types: mechanical clocks, atomic clocks or even a human heart beat.

So let's calculate how kinetic energy changes the total energy of a mechanical clock. Assuming that the formula $E = m_0c^2$ is true, the rest energy of the clock m_0c^2 is summed with the kinetic energy $m_0v^2/2$ resulting in the total energy E_c:

$$E_c = m_0c^2 + \frac{m_0v^2}{2} = m_0c^2\left(1 + \frac{v^2}{2c^2}\right) \quad (5)$$

Where: m_0 - rest mass, v - velocity of the object. So as velocity increases, the total energy of the clock increases, so a clock scaled earlier at mass m_0 is likely to lag. This has nothing to do with time, which flows at its own pace, but not for a clock, but for a conscious human. The title of Einstein's main article introducing the theory of relativity indicates that the author is dealing with the electrodynamics of objects in motion (Einstein, 2005, p 121-160) and not the theory of abstract time.

Concluding the considerations about Newton's conception, we state that it is mainly the historical conditions that can distort the judgments about the substantial value and civilizational meaning of the definition of time introduced by this scientist. When one lives in an age of universal admiration of the works of the Creator and creates the mechanics of the heavens oneself by discovering divine intentions and laws, it is natural to attribute the creation of time to a higher being (the Creator) and not to human consciousness. In a sense this is correct, since the disposition that man is to live up to 120 years is equivalent to the existence of a time lapse constant of 0.08 [1/year].

Kant, on the other hand, related time to human sensuality and intellect, which is apt because we feel the passage of time physically and mentally, so we also need an explanation of its nature. This paper explains that the nature of time is thermodynamic and points to the corresponding process of energy transformation in the human body. As a result of this transformation, human capital is created which drives economic processes. The natural constant discovered in this process regulates socio-economic processes, such as: determines the fairness of wages, interest rates and profits, determines the appropriate period of retirement. Thus, it can be concluded that Newton's definition of time was developed and updated in accordance with the development of scientific knowledge and the state of ongoing evolutionary processes.

Concluding the defense of Isaac Newton's formula of time, it is necessary to refer to the claim that time does not exist, which is treated in the works of J. Barbour (2018, 2021) and other authors. The point is that there is actually no clear controversy. This modern scholar emphasizes the existence of arrows of time, including the most important one, which is the universal process of balancing (Barbour, 2020, p 15-16). In the accepted definition of time, there is the category of the modern human, in whose body there is a disappearance of PEW and an increase in entropy, which is a distinct arrow giving the direction of the passage of time (Barbour, 2020, p 20). The compensatory process and the increase of entropy in the body is illustrated by the power waveform curve (P) in Figure 1. Thus, the definition of abstract time also includes the existence of a thermodynamic arrow of time.

With agreement on the arrow of time, the matter of the existence of abstract time is settled by the very existence of humanity. If there was no human civilization on the planet Earth, there would be no concept of time. On the other hand, traces of the existence of arrows would accumulate in the structures of the planet and would form time capsules. On the other hand, if in the Universe, outside the planet Earth there would be no civilization, then the terrestrial time can even be considered absolute. It is only the constant of the passage of time that would have to be adjusted to the astronomical calendar on other planets in case of their settlement.

Ending words

The role of the knowledge of thermodynamics is, as can be seen from the presented investigations, very helpful in explaining the issues of time and the effects of economic processes taking place in time. The influence of this science is comprehensive because where the concept of energy operating in isolated objects and autonomous systems of the living world appears, there thermodynamics is indispensable for the construction of theory. There is no exaggeration in the terms coined by P. Atkins (2007), such as "four laws that drive the universe", "entropy the engine of change" and others. 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. 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 planet Earth.

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