Inequality and economic efficiency of society through the prism of thermodynamics

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Abstract

Economy is driven by energy flows. It functions as an energy-transforming system producing work at the expense of dissipation of consumed energy. Money play the role of virtual energy that circulates in economic cycles and provides conversion of various other forms of energy into work. The behavior of money as virtual energy, along with all other kinds of energy, is subjected to the fundamental Laws of Thermodynamics. The potential capability of money to produce work depends not only on its amount but also on its entropy, which, in its turn, depends on its concentration. More concentrated money is more efficient than dispersed one. Considering the economic processes from the viewpoint of thermodynamics, one can see in somewhat unusual light some economic and social phenomena. It becomes clear, for example, that the inequality of income distribution in society is a natural consequence and simultaneously a necessary condition of its development. The extent of inequality defines, on the one hand, the economic efficiency of society and, on the other hand, the level of social tension, the gap between riches and poverty, the distribution of economic activity between different social strata, etc. Even the very structure of society may depend upon the extent of inequality and vice versa.

Keywords: Money, Inequality, Entropy, Virtual energy, Economic efficiency, Competition gradient

1 Introduction

Inequality, when it refers to social problems, is a word which rather readily excites passions. During at least two centuries it remains a permanent matter of a great number of economic, sociological, and in some cases even political works [1-3]. The phenomenon of inequality is perceived often almost as a synonym of "injustice". That is unjust, however, because since Adam Smith it is clear that inequality plays really the dual role. On the one hand, inequality is a mechanism of development, and on the other a standing source of poverty and social tensions. An ever-growing degree of inequality that accompanies rapid development of contemporary economy excites both the general public and experts in sociology and economy. Inequality in society has indeed two aspects: social and economic one. The former manifests itself in the difference of living standards of various social strata of society: the real disparity in housing conditions, in the accessibility of education, adequate medical care, legal protection, and the like. On the economic plane, inequality is expressed in the disparity of incomes.

Though inequality in social system is perceived most often as something wrong, it is indeed neither good nor evil. Moreover, inequality of some kind is an innate feature of evolving systems of any nature. All processes of evolution in biology, culture, or technology certainly produce diversity. The diversity that emerges in social systems manifests itself in the inequality in incomes first of all. Thus, inequality as a phenomenon should be considered not as a kind of flaw but as a natural inseparable attribute of social life. The matter may concern the extent of inequality in a society and its influence on social and economic processes.

One may endeavor to examine the question from the positions of thermodynamics. This branch of science is rather distant from economics and sociology on the knowledge tree, nevertheless there are deep reasons for their rapprochement. The existence of an innate bond between economic processes and consumption of energy was evident long since, at least on the level of philosophy and physics [4,5]. However, the penetration of rational ideas from outside into the area of economics has occurred with much ado. So, the notion of entropy, a fundamental concept of thermodynamics, was first introduced into economics about 35 years ago by Georgescu-Roegen [6]. Since

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then the area of usage of the methods and ideas of natural sciences in the domain of social sciences, the economics first of all, expands gradually [7,8], perhaps even too gradually. Thermodynamics defines the universal laws of energy conversion. Economy is driven by the flows of energy. The present-day trends of world development manifest the linkage between the economy and consumption of energy more obviously than ever. Functioning of the economy consists finally in performing work at the expense of dissipation of energy consumed. All such processes, including the economic ones, obey the fundamental Laws of Thermodynamics. Examination of economic processes on the basis of general thermodynamic concepts may reveal some new facets of habitual notions and facts of economics and sociology. Among other points, there are the problems of inequality and competition, of riches and poverty, of distribution of economic power between different social strata, of the efficiency of money, etc.

The most obvious parameter defining the measure of inequality is the distribution of the aggregate income of a society among its members. To conceive the mechanism that engenders inequality in social system more visually, one has to comprehend some peculiarities of the substance that is the main acting factor of economic processes, namely, the money. This specific substance functions as the working medium that circulates in economic cycles. Examining closely the "behavior" of this working medium, one may come to a conclusion that there is a reason to consider money as a certain specific form of energy.

2 Money: virtual energy

Money has many properties that are homologous to those of various forms of physical energy. The list that follows shows some of them:

- Money, just as energy, determines the capability to do work;
- Money, just as energy, is a conserved entity;
- Similarly to energy, money can exist in a variety of mutually convertible forms;
- The "behavior" of money is similar to that of energy. Money as any form of energy flows "spontaneously", without external efforts, in the direction of decline in intensity factor: money loses in concentration when is being spent, hot teakettle cools down, a battery discharges. All spontaneous processes are irreversible. They are accompanied by dissipation of energy, and, correspondingly, by the loss of its quality.

The listed set of properties of money gives a reason to consider it as "virtual energy" [9], a specific form of energy that circulates in social system and makes possible mutual coupling of energy flows distinct in their nature. Money exists and manifests itself as virtual energy in the only medium the human society. Mutual conversions of the virtual energy into other forms of energy or vice versa, other forms of energy into money, occur only with the assistance of people. The general laws governing the processes of energy conversion apply to those with participation of money entirely.

Money, as other forms of energy (as heat, for example) is characterized by two features: an extensive one (the amount of money) and an intensive one (defining its quality). The ability of money to do work is determined both by its amount and its quality. The quality of money depends on its concentration. For example, one million dollars in a "condensed" state give to its owner manifold opportunities to do something essential. The same one million dollars scattered by $1 among one million "owners" may allow each of them at best to drink a bottle of beer - not too impressive an event. Thus, in defiance of simple arithmetic: $\$1,000,000 > 1,000x\$1,000 > 1,000,000x\$1$.

The quality of energy is characterized by a function termed entropy [10]. This function is, in a very general sense, a measure of disorderliness of a system. The more entropy is associated with a given quantity of energy, the lesser is its capability to do work. A more chaotic system is less productive such an idea seems quite natural. The notion of entropy can be attributed to virtual energy, the money, as well. The more ordered, in other words, more "concentrated", is money, the lesser is its specific entropy and greater its potential productivity.

We must emphasize that the question whether we have the right to attribute the notion of entropy to money is crucial. In our opinion, the answer is positive without doubts. Money as virtual energy obeys the laws of thermodynamics invariably, as well as all other forms of energy. The limitations that these laws impose on all processes of energy conversion are to be taken into account with respect to economic processes. This may contribute to more adequate understanding of their general mechanisms. It should be noted that many economists consider money as a certain pure essence of zero entropy and actively oppose to any infringement on the inviolability of money, this sacred cow of habitual conceptions of economics. Some others are, however, more susceptible and the number of them increases.

The entropy of money can be defined as the logarithm of a ratio of the total amount of money functioning in a given society (M), to the amount of money (m) that is in disposal of a certain owner, either a person or an organization [9]:

$$s = \log \frac{M}{1+m}. \quad (1)$$

Here s is the specific entropy referred to a monetary unit, in which the values m and M are estimated. The complete quantity of entropy associated with a given sum of money (m) equals the product of the specific entropy of money (s) and its quantity: $S = m \cdot s$.

It is easy to see that the more ”dispersed” money is, the greater its specific entropy. The highest value of the specific entropy of money, $s_{\max} = \log(M/2)$, corresponds to the case when m equals the basic monetary unit used in a given society, say, one dollar. On the contrary, specific entropy tends to zero if all the money in society is concentrated in the hands of a single owner ($m = M$). That is certainly a hypothetical case only. The specific entropy of any real sum of money can take a value between these extremes. It also follows from the equation shown above, that the increase of the total amount of money in a society (M), no matter due to its economic growth or inflation, increases the specific entropy of any fixed sum of money.

3 Efficiency of money

Considering money as virtual energy, one has the right to put a question about its efficiency, i.e. its capability to produce work. As applied to physical systems, efficiency is a non-dimensional ratio of the work done to the energy consumed. The efficiency of money as virtual energy can be defined in a quite similar way, at least in principle. A difficulty emerges, however, because of the infinite variety of the kinds of work performing by humans. To build a house, to sow a field, to deliver exotic goods from overseas, to write a book or to preach a sermon - all these activities are different kinds of work. The common feature of all of them is that the execution of any kind of work always implies ordering of something, either bricks, or goods, or words, or thoughts, or anything else. The degree of ordering of a system may be characterized with the value of entropy. Correspondingly, the amount of necessary work, with no regard to its specific matter, may be defined through the amount of entropy that is to be taken from the object. The real amount of work needed is, of course, greater because of unavoidable imperfection of the methods and means of work.

Creation of an order within a system requires the diminishing of its entropy but this is possible only under condition that equal (ideal case) or greater (real case) amount of entropy is generating simultaneously by the very process of doing work as a result of the loss of quality of the energy used. Processes in economy are driven by the flows of virtual energy, money, that run from the high-quality (low-entropy) levels down to the lower, high-entropy levels, thus, they are accompanied by generation of entropy. The amount of entropy generated always exceeds its local decrease in the object of work. One may state undoubtedly that the transformation of virtual energy occurs in conformity with the same fundamental laws of thermodynamics, which are common to all other forms of energy. According to these laws, the possible efficiency of the transformation of money in any operation depends on the concomitant change of entropy. If the specific entropy of money in the initial, more ”concentrated” state is s_1, and in the final, more ”dispersed” state, when the money has been paid to the executor of work, is s_2, then the maximum efficiency of the operation can be estimated as the ratio of the increase of entropy ($s_2 - s_1$) to its maximum value:

$$\eta_{\max} = \frac{s_2 - s_1}{s_2} = 1 - \frac{s_1}{s_2}. \quad (2)$$

This expression is quite similar to the well-known equation of Sadi Carnot that determines the highest theoretically attainable efficiency of an ideal heat engine:

$$\eta_{\max} = 1 - \frac{T_1}{T_2}. \quad (3)$$

Equations (2) and (5) are identical since entropy of heat energy is inversely proportional to temperature: ($s \sim 1/T$), thus, $s_1/s_2 = T_2/T_1$.

It should be noted that equation (2) refers to an ideal conversion system, free from internal resistance and losses. All real systems, both for the conversion of heat or for operations with money, are not ideal. A certain fraction of energy (or money) is inevitably consumed by the mechanism of transformation. Thus, the real efficiency of conversion is always lower than that predicted by the equations given above. A more realistic expression, in which

Table 1: Dependence of the specific entropy and of the possible efficiency of money on the degree of its integrity and on the total amount of money in a society.

	Total amount of money used by a society (arbitrary units)			
Concrete sum of money	$M = 10^9$ (1 billion)		$M = 10^{12}$ (1000 billion)	
m	entropy s	efficiency η %	entropy s	efficiency η %
10^6	3	42.3	6	29.3
10^3	6	18.3	9	13.4
10	8	6	11	4.4
1	8.7	1.7	11.7	1.3
Zero level	9	0	12	0

the inevitable internal losses of energy are considered, was also derived [9]:

$$\eta = 1 - \left(\frac{s_1}{s_2}\right)^{1/2}. \tag{4}$$

As one may see, it differs from (2) in the exponent of power ($1/2$ instead of 1).

The considerations concerning the entropy and efficiency of money as virtual energy can be illustrated with a brief table shown below.

As seen from the table, the dispersion of money diminishes its potential efficiency. Comparing the values in the third column of the table, one can see that a million monetary units taken as a whole can provide more than twice as much work as a million divided into a thousand of separate thousands (correspondingly, $0.423 \cdot 10^6$ and $0.183 \cdot 10^6$ arbitrary units of work). A significant generalization that follows is that rich people have not only greater amount of money than others but their money is more efficient in economic processes because of higher concentration.

The fully dispersed money at the lowest level of concentration cannot be used for doing work, since its efficiency in such a state is zero. It can only be used in exchange for food, thus, for getting biological energy.

Naturally, the concrete values represented in the table can be considered as rough estimates only. The real processes in which money plays the basic role are usually so complicated by a variety of factors that it would be hardly reasonable to count on getting quite precise results. Nevertheless, the qualitative dependence seems to be quite well-formed.

One more conclusion can be drawn at closer examination of the table. As one may see, the calculated value of the efficiency of a given sum of money in an economically weak society (small M) is greater than in a mighty one (large M). Anyone from a developed country who has ever visited a less developed nation, has discovered that the purchasing power of his currency turned out higher there than in his motherland. The opposite effect is well known to those who have ever traveled in the reverse direction.

4 Distribution of income

As cooling of a heated object is a spontaneous process accompanied by generation of entropy, so spending (dispersion) of money is a spontaneous process in economy. Such a process is also accompanied by generation of entropy and, as it is usually desirable, by performing work. Of course, such a process to go on, money at different levels of concentration and, accordingly, with different values of entropy, should be available. Thus, an inequality of distribution of money in a system is an indispensable precondition for the very possibility of performing work. In other words, at least two levels are needed, an "employer" - a possessor of comparatively "concentrated" (low-entropy) money - and a person (or persons) that agree to do certain work for a fee offered.

The inequality of distribution of money between members of a society can be represented visually with an income distribution function. Taking into account that the population of any country, except the most minor ones, consists of millions or even hundreds of millions, it is reasonable to plot this function in double-logarithmic coordinates. In this way even a very wide range of values, both of order numbers of persons in the ranking after their incomes, and, correspondingly, of the incomes, can be depicted without loss of information. As an illustration, the income distribution function in the US in the year 2004 is shown below in Fig. 1.

As one can see, the main part of the distribution function is a straight line of constant inclination. The income distribution functions for most countries have in general a similar shape varying to some extent in the value of inclination. The straight-line portion of the curve obeys the Pareto distribution [1], according to which the value

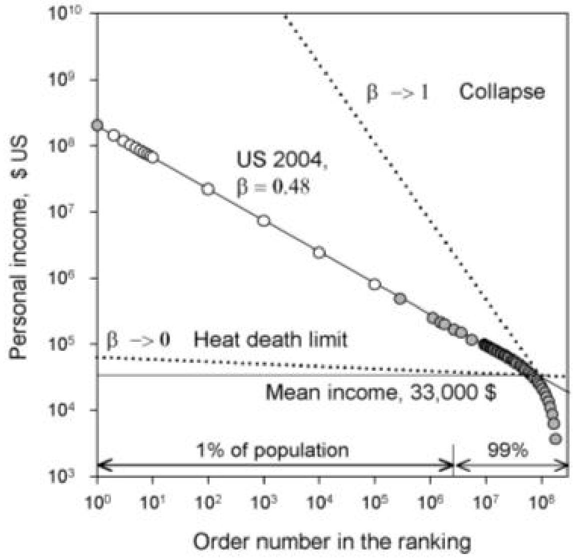

Figure 1: The income distribution function in the US in the year 2004. Source: data of the US Census Bureau [11]. Dotted lines the limiting cases of "collapse" and "heat death limit". The latter is shown tentatively as slightly deflecting from horizontal.

of the income of the n^{th} member of a sequence (P_n) is inversely proportional to a certain power (β) of its order number (n) in the sequence:

$$P_n \approx 1/n^{\beta}. \tag{5}$$

The exponent β in this formula defines the slope of the line of distribution on a logarithmic plot. The greater β is, the steeper goes the line and, correspondingly, the higher is the degree of inequality in a society.

In all cases, the tail part of the distribution function deviates from the straight line and bends downward. Such an effect emerges because official statistics considers only the recorded monetary payments received by people. However, official monetary income, such as regular wages, is not the only or even the main source of subsistence for poor people. They find other ways of increasing their actual income by taking advantage of all existing opportunities, such as various forms of relief, non-cash benefits from governmental, public, and religious organizations, chance income, and, finally, alms. In any case, the actual income including not only money as such but also the monetary equivalent of all the means of sustenance received in kind, cannot be less than a certain minimum necessary for maintaining life in a given society. Thus, the actual income, in contrast to the official one, cannot be zero. The share of the unrecorded component in the actual income of the poorest households increases as their official income diminishes. The distribution function plotted on the basis of the values of actual income, be they available, would be less curved or even straight near its right end.

The slope of the distribution function (its linear part) exerts a significant effect on the economic and social processes in society. If the slope of the distribution line is steep, any shift "leftward", to the positions of lesser order numbers, may give a significant advantage to an individual, and thus is worthy of the corresponding efforts. For example, if the slope $\beta = 0.7$, the expected effect of the displacement, say, from the millionth position in the ranking to the ten thousandth position, is a 25-fold increase in income. This implies, in its turn, a qualitative change of social status and life standard. The like displacement in the case of a less sloping function, say at $\beta = 0.1$, promises an increase in income by only about 60%. It stands to reason that the motivation to make efforts to achieve success is much more significant in the former case than in the latter.

Thus, the slope of the distribution line (β) characterizes the level of competitive tension in society. It seems reasonable to call this factor the "competition gradient" [12]. One should emphasize the dual sense of this factor: the competition gradient is at the same time the gradient of concentration of money. It causes simultaneously two conjunct thermodynamic flows, the flow of money in a "natural" direction from the higher concentration to the lower one, and oppositely directed "migration" of the members of society, who strive to climb to a higher position in the ranking. The former process is spontaneous, whereas the latter needs a certain consumption of energy, which is supplied by the first, spontaneous process. Thus, the competition gradient acts as a driving force that prompts the whole society to evolve in the direction of higher economic efficiency.

Table 2: Dependence of some characteristics of inequality upon the value of the competition gradient

Competition gradient (β)	0.1	0.3	0.5	0.6	0.7	0.9
Highest income* P_1	5.7	176	$5 \cdot 10^3$	$2.5 \cdot 10^4$	$1.2 \cdot 10^5$	$1.9 \cdot 10^6$
Lowest income* P_N	0.9	0.7	0.5	0.4	0.3	0.118
% of total income of a nation received by top 1% of population**	1.6	4	10	15.8	25.1	63
Share of population with income below average, %	66	71	77	81	84	94

*With respect to the average income taken as a unit.
**The total population of income-gaining individuals (N) is taken as 100 millions.

The dual role of the competition gradient should be considered in two aspects: as a factor that exerts influence on the social conditions in society and as a factor defining its economic efficiency. As to the former aspect, one can gain some insight of the matter from the table that follows:

As one can see, as the slope of the distribution function increases, the highest income rises drastically up to extreme values exceeding the average for hundreds thousand times. In contrast, the lowest income diminishes moderately. Along with the increase of the competition gradient, the repartition of the overall national income in favor of a narrow stratum of the richest people occurs. The portion of the total national income that falls to the share of people whose incomes are below the average level correspondingly diminishes, whereas their part in the total population increases. It is worthy of note that even in the most egalitarian societies with a very flat distribution function, no less than 66% of the population have incomes below the average. The most staunch upholders of total equality may be unaware of this mathematical fact.

5 Economic efficiency of society

The economy of a society is not a simple sum of individual efforts of its members but the process and the aggregate result of functioning of a very complex system, in which all individuals are involved for performing some or other role. In spite of a great complexity of contemporary economy and its very significant role in humans life, the society is a system of the higher rank with respect to its economy. Thus, an economy is a specialized subsystem of a society, which provides the latter with means of subsistence. Contemporary industry-based economy, provided that energy resources are in abundance, has an inherent tendency to unlimited growth. This tendency becomes balanced with the totality of real potentialities and the multifarious needs of society as a whole. It stands to reason that the interaction of the economic subsystem with the main system, a society, limits to a certain extent the level of economic efficiency in comparison with that allowable by thermodynamics. This loss in efficiency is, however, an unavoidable charge for stability. As a result of coadaptation of different subsystems of a society, a certain distribution of the ”fruits” of its economic activity - its total income - becomes settled.

Any society is stratified and arranged into a hierarchy of strata graded with respect to the income of their members, their social status, life standards, political influence, and finally their role in the economy. Just the latter point, the economic role of different strata of society, we have in mind to discuss here with an aim to clear up the correlation between the character of the income distribution function and the overall economic efficiency of society. One should note, by the way, that the very notion economic efficiency of society is not defined unambiguously. The value of Gross National Income per capita (GNI p/c) seems to be, probably, the most appropriate measure for this purpose.

As we have seen above, the distribution of income in society is characterized by a pronounced inequality. The incomes of people, which take top numbers in the ranking, and, correspondingly, belong to the highest strata of society, may be several orders of magnitude greater than the average values. Let us consider, however, the distribution of the total income of society not among the individuals, as above, but among social strata. For this purpose, the whole interval of the ranking of income receivers from the first order number to the last one can be divided into a series of an arbitrary number of strata of equal width in logarithmic scale. This may be, for example, such a series: the first stratum - top ten income receivers from No 1 to No 10, the next stratum those included into top tens from No 11 to No 100, then into top hundreds from No 101 to No 1000, and so on. At such a choice of the width of the strata, a society with 100 million (10^8) of income receivers will be divided into 8 strata. One may divide mentally a society into a greater number of strata taking them more narrow. No matter what the number

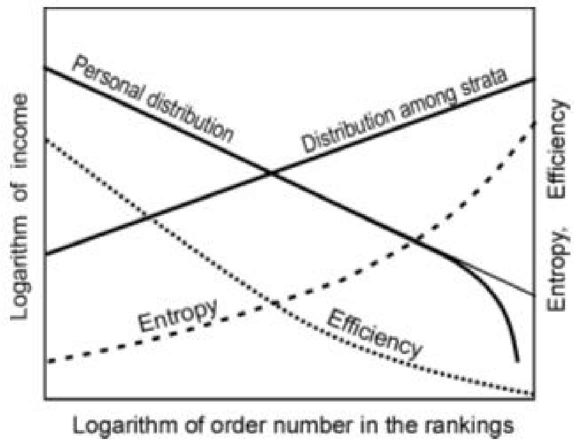

Figure 2: A schematic picture of the personal income distribution and that of the aggregate income of social strata. Personal income goes down whereas the aggregate income of strata increases as the order number in appropriate ranking increases. Specific entropy of money grows and its efficiency goes down as the level of income decreases.

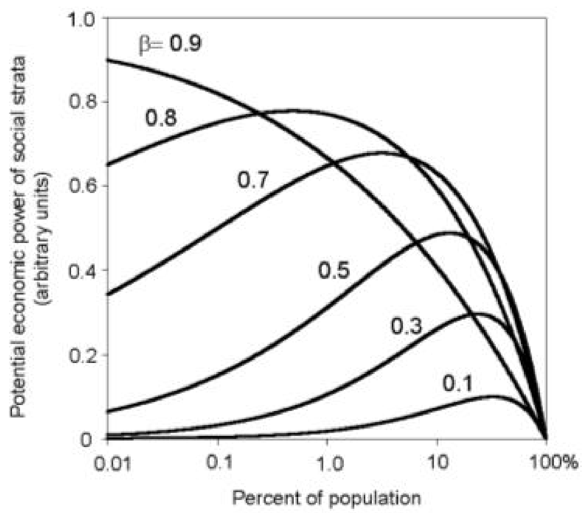

Figure 3: The distribution of potential economic power between the strata of society at different values of the competition gradient.

of strata is taken, each next stratum in a sequence will include a greater number of people with a lower level of income than the preceding stratum. The aggregate income of a stratum will be the total of the incomes of all its members. The function of income distribution among persons and the function of distribution of aggregate income among social strata (of equal width in logarithmic scale) have opposite slopes, negative in the former case and positive in the latter. More rich but less numerous strata of society possess smaller aggregate income than more numerous but less rich ones. The steeper is the distribution function of income among individuals, the more even is the distribution function of the aggregate income among strata.

It is significant that money owned by people belonging to the rich strata is more "concentrated" and therefore has low specific entropy and, correspondingly, high potential efficiency. The money of less rich strata has higher specific entropy, whereas its efficiency is lower. All this is shown schematically in Fig. 2.

The aggregate economic power of a certain social stratum may be calculated as the product of an extensive factor (the aggregate amount of money in possession of the stratum) and the factor of efficiency of money, which depends upon an intensive factor (the concentration of money). The factor of efficiency can be computed by equation (4). Inasmuch as one of the factors is a descending function of the order number, whereas the other is an ascending one, the resulting dependence is a function with a maximum [12-14]. A series of such curves for different values of the competition gradient is depicted in Fig. 3:

Table 3: Potential economic power of society

Competition gradient (β)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic power (arbitrary units)	0.11	0.25	0.42	0.66	1	1.5	2.3	3.7	6.1

As one can see, the economic power of different social strata depends upon the value of the competition gradient rather strongly. The steeper the distribution line is, the greater the economic role of the higher strata of society. As the competition gradient goes down, the maximum of the curve shifts rightward. This denotes that the leading position in economics shifts to the less rich strata. At the same time, the overall potential economic power of society goes down, too. In the table below, the data that show the dependence of the total economic efficiency of society upon the value of the competition gradient are represented.

The dependence is rather sharp: as the competition gradient grows from 0.1 to 0.9, the total potential economic power increases by about sixty times. One should note, however, that the figures shown are obtained on the basis of purely thermodynamic calculations. Meanwhile, the thermodynamics has quite definite limits of applicability. It is unable to take into account the totality of concomitant social processes in all their complexity. The factors of such a kind are beyond the scope of thermodynamics. They are, however, of great significance in social systems and become an obstacle in attaining the level of economic efficiency admissible from the point of view of thermodynamics. So, at a very great steepness of the distribution function a crucial disproportion may arise between the growing productive power of society and the limited purchasing capacity of its greater part. That may cause a rupture of continuity of the economic cycle, a phenomenon known as an overproduction crisis.

At a very high value of the competition gradient (β above 0.8), the total potential power of society is great and concentrated mainly in the hands of a very thin top social stratum, consisting of some tenths of a percent of the whole population. The situation of such a kind could probably have taken place in some countries in the time of the monopolistic control of the economy by steel, oil, automobile, and other "kings". At somewhat lower values of the competition gradient (0.8-0.7), the overall economic power of society diminishes, and the region of maximum power shifts to more numerous social strata amounting to a few percents of population. One may suppose that under such conditions the role of economic structures of joint-stock type should grow. At still lesser value of the competition gradient, the overall economic power of society goes down even greater, and the maximum of economic activity shifts to the region represented with the broad strata of population with incomes of about the average level and lower. In such a case, however, there arises a rather complex problem of involving into the economic cycle very dispersed resources of the most numerous but least rich strata of society. To all appearance, there are no universal and efficient ways of solving this problem. In most cases, the government or mass organizations such as trade-unions take upon themselves such a mission. Ultimately, this leads to the inevitable transformation of the income distribution function: those who succeed in mobilization of dispersed resources of the broad low-income social strata promptly change their own positions in the ranking closer to its top, forming there a region characterized by high level of incomes and high value of the competition gradient. Thus, the initially egalitarian society with flat distribution function turns into two-phase society with the distribution function steep in its initial part and flat in its tail.

6 Competition gradient and the structure of society

The value of the competition gradient is determined to a great extent by the structure of society, and vice versa, the very structure of a society depends strongly upon the value of the competition gradient. This dependence is manifested in a variety of respects, not only economical but social and political also [12].

Let us consider first an extreme case of a society with very steep distribution function characterized by the inclination close to unity or greater. The society of such a type can be of limited size only. This follows from the mathematical properties of the Pareto function (5). The sum of its terms at the condition $\beta > 1$ converges to a finite limit. Therefore the "incomes" of all people beyond a certain order number in the ranking (the smaller, the greater is β) would be below the level of survival. Such an extreme case ($\beta \geq 1$) can be defined as "collapse".

One should note that the limitation that the slope of the distribution function must be less than unity ($\beta < 1$) refers to societies sufficiently numerous, amounting to many millions of individuals. The limitation is not obligatory, however, in comparatively small structures, for example, the companies, which function as the subsystems of lower level with respect to society. The competition gradient in such structures may exceed unity.

The limitation may be disregarded also in the case of "nonequilibrium" (nonlinear on the logarithmic plot) distribution function, for example, more steep in the initial section and more flat farther, closer to the tail. In such a case, the competition gradient β within a narrow initial segment of the distribution may exceed unity. In society with a very high competition gradient approaching unity, nevertheless below it, the gap in incomes between the richest and the poorest strata of the population would be so excessive (see Table 2) that social conflicts are inevitable. The society should spend a significant portion of its total income to smother such conflicts. And again, only a very limited share of the population can be socially active in such a society. It is hardly probable that it can have a democratic form of government, rather an authoritarian or an oligarchic. Though theoretically the overall economic efficiency of a society with a very steep distribution function could be high (see Table 3), this hypothetical opportunity cannot be realized in fact because of the thinness of its socially active stratum and of enormous expenses a society of this type should pay to maintain social stability.

A society characterized by a more gently sloping, but not too flat distribution function, is likely to be more dynamic in its development and, in fact, more economically efficient. The competition gradient remains large enough to induce individual activity, and, at the same time, the share of economically active population increases in comparison with the previously revised case. One could suppose that social tensions in such a society should not constitute a menace to its stability. Democratic forms of government are usual in societies of this type. Most of developed countries belong just to this group. The values of the competition gradient peculiar to such countries vary usually within a range about 0.3 0.6, greater values in more "capitalist" countries as the US, for example, (see Fig. 1), lesser ones in more "socialist" ones, as Sweden. This range may be considered as the domain of "acceptable normality". In the case of a flat distribution function with the values of β about 0.2-0.1 or less, the society becomes very homogeneous in economic and social respect. There are neither the rich nor the poor in such a society, and a universal equality, a feature so desired by the originators of various models of ideal communities, reigns throughout it. On closer examination, however, it is revealed that the outlook for societies with a very small value of the competition gradient turns out to be not quite as brilliant as one could suppose. Above all, it would be significant to realize that a society of total equality cannot exist in principle, even as an abstract model. The supposed absence of causes for social tensions in such a society seems attractive at first glance, but this implies simultaneously the absence, or at least a very low level of motivation for economic activity.

Since the range of incomes of the inhabitants of a society with too flat distribution function is rather narrow, these incomes are associated with high entropy content, and therefore they can serve mainly for the satisfaction of current vital needs and cannot be used for accomplishing any large-scale tasks. Thus, the members of a society of total equality are practically deprived of the opportunity to display personal initiative in the economic sphere. Because of the low level of motivation for individual activity, collectivist tendencies come to dominate public consciousness. In a hypothetical society with a very small competition gradient, no complicated hierarchical structure can be formed, thus, the level of organization will be primitive.

Summarizing all these circumstances, one may conclude that a society of total equality should be extremely inefficient economically and incapable of development. Most likely, it could not exist at all, at least for a long time. It is no more than a speculative chimera that is at variance with the fundamental laws of evolution. Moreover, even if originated by some miracle, such a society would soon lose its initial uniformity and increase its competition gradient spontaneously, or cease to exist. Borrowing the term from cosmology, one can call the hypothetical case of zero competition gradient the "heat death limit".

Thus, the value of the competition gradient in any real society should be between zero and unity, but not too close to either of these limits. These limits are shown in Fig. 1 with dotted lines. Approaching to the upper limit is fraught with a catastrophic growth of social tension in a society, while the approaching to the lower one leads to the loss of stimulus to development. The range of high values of the competition gradient is the area of aspirations of the adherents of lassez-fair capitalism, whose only aim is, generally speaking, the maximization of the efficiency of conversion of all kinds of energy into virtual energy, money, taking little account of the concerns of the low-income majority of population. The range of very low values of the competition gradient is the domain of various communist and socialist utopias. In both cases some or other noneconomic means become necessary to maintain the economy of a society functioning. The approaching to either of the limits should result in decreasing or loss of stability of a society. The both cases, that of too high or, on the contrary, of too low competition gradient, are, evidently, unstable and in pure form unrealizable. The possible trajectories of the evolution of such societies may lead, strange though at first sight, to similar results, to the formation of two-phase systems with the income distribution function of variable slope, very steep in the initial part and flat in the tail. The "equilibrium" distribution function neither too steep nor too flat, satisfying the condition of "acceptable normality", specific to a given society, is being settled as a result of attaining of a certain dynamic balance of a multitude of various factors, not only economic ones but political, historical, sociological, and others. The factors defined by the fundamental laws of thermodynamics are among them. One should emphasize that unlike economics and other social sciences, the thermodynamics is by its nature absolutely neutral with respect to human values. One may say that while economics or sociology can discriminate "good" from "bad" in a certain humanistic sense, the thermodynamics can distinguish ”possible” from ”wishful” on the base of abstract physical principles. Therefore the thermodynamics enables one to have a look on some economic processes from outside the frame of habitual Economics, avoiding thus any influence of philosophical preconceptions and ideological biases. This may contribute to more objective insight of complicated social and economic phenomena.

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