Application of Method of Systems Potential in Economics:

Hysteresis Loops and Business Cycle;
The Great Depression of 1930's as Mathematical Catastrophe
Of Economic System springing of Infringement of Collegiality.

Introduction

At the Conference in Systems Dynamics held in 2003 a Method of Systems Potential was proposed [22], according to which the development of some systems arising spontaneously in nature and in the society may be interpreted as a process of realisation of their "potential". We attempted to develop this system approach further and apply it to the Economic System.

In the *first part* of this essay we present the mathematical consequences ensuing from this method. The *second part* contains the application of this method to economy. The *fourth part* provides some factual data verifying the theoretical conclusions.

The most interesting result of the Method is the conclusion about the coordinate origination of irregular cyclical dynamics as a result of indefinitely small fluctuations of system parameters. The dynamics of "Realisation Ratio", R, the index of efficiency of system work, comprises two phases of continuous growth (2→3 and 4→1) and two jumps – up (3→4) and down (1→2) (Fig.1).

Realization Ratio is a function of variable z: $R = R(z)$, where $z \equiv \frac{U}{\Phi}$ is ratio of "conditions of realization", U to "potential", Φ of the system [22]. The cause of jumps lies in the properties of function $R(z)$. This function pictured in Figure 5 has only turn-point of maximum, z_0: $R(z_0) = 1$. Function $R(z)$ consists of two branches, *lower branch* ($z > z_0 \cdot R$) and *upper branch* ($z < z_0 \cdot R$). Function $R(z)$ is multivalent function within the left-hand neighbourhood of the point z_0 provided the systems parameter χ satisfies the following inequation: $\chi > 0$.

This case $\chi > 0$ is shown in the Figure 1. The jumps transfer the system from one branch of function $R(z)$ to another branch. These jumps take place at limiting points, z_0 and z_1 of domain within which function $R(z)$ is multivalent: $z_1 < z < z_0$. Every such jump is a mathematical catastrophe. The position of these limiting points depends on the values of system parameters. The direct cause of these jumps is fluctuation of system parameters. *For the jump to take place, indefinitely small fluctuation of limiting points z_0 and z_1 is enough.* The cycles made of jumps and stages of continuous change are well-known from the mathematical catastrophe theory. These are the so-called **hysteresis cycles (or loops)**.

We assumed that **the basis of business cycle of economic system is a hysteresis evolutional cycle (hysteresis loop)**. We suggest identifying the industrial crises that are regularly experienced by the economy with micro catastrophes of the economic system. These micro catastrophes are system jumps from the top branch of function $R(z)$ to the lower branch (Fig.1). Jump down **1→2 is a crisis phase of a cycle**; jump up **3→4 is a revival phase of one**; continuous growth along lower evolution branch **2→3 is a depression phase** and finally the continuous growth along top evolution branch **4→1 is a prosperous phase** of business cycle. This assumption is factually confirmed by analysis of data showing the change of the basic economic indexes during the cycle, some of these data are presented in the last, *fourth section* of this paper.

This method makes it possible to explain in quantitative terms the dynamics of the basic economic indices in the United States in 1920's and during the Great Depression. **From the point of view of Method of Systems Potential, the Great Depression of 1930's was a mathematical catastrophe of Economic System**. The profundity and duration of this catastrophe were expressly strengthened by the shift to the left (towards reduction) of the point z_0 in which function $R(z)$ has maximum value (Figure 2). This shift was a consequence of

considerable increase of long-term productivity of capital in the twenties. The reason why the shift was so rapid lies in infringements of collegiality principle. These infringements are briefly described in the *third part* of the essay.

I. Method of Systems Potential. Mathematical results.

The Method offers describing the state of systems using two terms, "potential of a system", Φ and "conditions of realization of potential", U. These quantities satisfy the following properties:

1. **Structure of potential.** "Potential", Φ consists of two parts: (1) the potential being realised, Φ_R which is used and shows itself through the system's activity; and (2) the non-realised potential, Φ_D which is not used by the system:

$$\Phi = \Phi_R + \Phi_D . \tag{1}$$

2. **Realization Ratio,** $R \equiv \frac{\Phi_R}{\Phi}$, is a function of variable $z \equiv \frac{U}{\Phi}$: (2)

$$R = R\left(\frac{U}{\Phi}\right) = R(z), \tag{3}$$

$$0 \le R(z) \le 1 . \tag{4}$$

3. **Entropy principle**. "Conditions", U and "non-realized potential", Φ_D decrease on the basis of radioactive decay law:

$$\Delta U_I = -\Lambda \cdot U \cdot \Delta t , \qquad \Lambda > 0 , \tag{5}$$
$$\Delta \Phi_D = -d \cdot \Phi_D \cdot \Delta t , \qquad d > 0 . \tag{6}$$

4. **The growth of "realized potential" and "conditions" is proportional to "activity" of a system.** Designating as A "activity" per unit of time, we get:

$$\Delta U_{II}(A) = r_U \cdot A \cdot \Delta t , \tag{7}$$
$$\Delta \Phi_R(A) = r_\Phi \cdot A \cdot \Delta t , \qquad r_\Phi > 0 . \tag{8}$$

5. **"Activity" of a system is a process of realization of its "potential".** Therefore the greater "realized potential"; Φ_R, the greater is "activity" of a system, A. We get in linear approximation:

$$A = \varepsilon \cdot \Phi_R , \quad \varepsilon > 0 . \tag{9}$$

6. **Evolution equations of a system** following from (1)-(9):

$$\dot{\Phi} + d \cdot \Phi = (a + d) \cdot R \cdot \Phi , \tag{10}$$
$$\dot{U} + \Lambda \cdot U = \nu \cdot R \cdot \Phi , \tag{11}$$

where

$$a \equiv r_\Phi \cdot \varepsilon , \qquad \nu \equiv r_U \cdot \varepsilon . \tag{12}$$

It is not difficulty to derive from formulas (2), (3), (6), (8) - (12) the following two equations respecting functions $R(t)$ and $R(z)$:

$$\dot{R} = (a + d) \cdot R \cdot (1 - R), \tag{13}$$
$$R'_z \cdot \left[(\nu - (a + d) \cdot z) \cdot R + (d - \Lambda) \cdot z \right] + (a + d) \cdot R^2 - (a + d) \cdot R = 0 . \tag{14}$$

These are principal equations of our research. Solution of equation (13) is a logistical function:

$$R(t)=\frac{1}{1+b\cdot e^{-(a+d)\cdot t}};\qquad b\equiv\frac{1-R(0)}{R(0)}. \tag{15}$$

Equation (14) is the first-order ordinary differential equation of Jacobi' type. This equation can be converted into linear differential equation by means of the following substitution of variables:

$$\xi=\frac{R-1}{z-z_0};\qquad \zeta=\frac{1}{z-z_0}; \tag{16}$$

where $$z_0\equiv\frac{\nu}{a+\Lambda}. \tag{17}$$

Function $\zeta(\xi)$ satisfies the following equation:

$$\zeta'_{\xi}\cdot\left\{b_1\cdot\xi^2+(a_1-B)\cdot\xi\right\}=(b_1\cdot\xi+a_1)\cdot\zeta+B\cdot\xi; \tag{18}$$

where $B\equiv-(a+d)$; $b_1=\nu-(a+d)\cdot z_0$; $a_1=-\frac{\nu}{z_0}=-(a+\Lambda)$. (18A)

Solution of equation (18) as a function of the initial variables, R and z, consists of two branches:

Upper branch: $z^{(-)}(R)$: $z=z_0\cdot R-C^{(-)}\cdot R^{-\chi}\cdot(1-R)^{1+\chi}$; (19)

subject to $z<z_0\cdot R$;

Lower branch: $z^{(+)}(R)$: $z=z_0\cdot R+C^{(+)}\cdot R^{-\chi}\cdot(1-R)^{1+\chi}$; (20)

subject to $z>z_0\cdot R$;

where $C^{(-)}>0$; $C^{(+)}>0$; and (21)

$$\chi\equiv\frac{\Lambda-d}{a+d},\qquad -1<\chi<\frac{\Lambda}{a}. \tag{22}$$

Three qualitatively different cases are possible: (1) $\chi>0$, (2) $\chi=0$ and (3) $-1<\chi<0$ (Fig.5). Function $R(z)$ is multivalent function within the domain $z_1<z<z_0$ provided $\chi>0$. Value z_1 satisfies the following condition:

$$\frac{dz^{(+)}(R)}{dR}=0. \tag{23}$$

The following rule of calculating z_1 can be derived from (20) and (23):

$$z_1=z_0\cdot\frac{1+\chi}{1+\frac{\chi}{R_1}}; \tag{24}$$

where value R_1 is the root of the following equation:

$$z_0\cdot\frac{R_1}{R_1+\chi}=C^{(+)}\cdot\left(\frac{1-R_1}{R_1}\right)^{\chi}. \tag{25}$$

Inequation $z_1 < z_0$ ($z_1 > z_0$) follows from inequation $\chi > 0$ ($-1 < \chi < 0$). In the case $z_1 > z_0$ function $R(z)$ is multifunction in the whole domain of the function (Fig. 5). When $\chi = 0$ the function is one-valued function, and its chart is broken line, which consists of two linear segments (Fig.5):

$$z = -C^{(-)} + \left(z_0 + C^{(-)}\right) \cdot R = z_0 - \tilde{C}^{(-)} \cdot (1 - R); \qquad \text{subject to } 0 < z < z_0; \tag{26}$$

$$z = C^{(+)} + \left(z_0 - C^{(+)}\right) \cdot R = z_0 + \tilde{C}^{(+)} \cdot (1 - R); \qquad \text{subject to } z_0 < z < C^{(+)}; \tag{27}$$

$$\tilde{C}^{(+)} = C^{(+)} - z_0; \qquad \tilde{C}^{(-)} = C^{(-)} + z_0. \tag{28}$$

The trajectory of a system $\left(z(t); R(t)\right)$ is drawing the curve $R(z)$ on the plane $(z; R)$. A system moves along top (19) or lower (20) branch of function $R(z)$.

Let us consider the case $\chi > 0$. If the *system parameters* ν, a, Λ, d are strictly constant, then the system will asymptotically approach the point in which the Realisation Ratio is equal to one: $\lim_{z \to z_0} R(z) = 1$ (formula (15)). It is evident, however, that in no real system the condition of permanency of these parameters is true. Fluctuations of these parameters will excite quasi-periodic oscillations in Realization Ratio of a System.

In this case the smooth gradual growth of the Realisation Ratio along top (4→1) or lower (2→3) branch will be interrupted by jumps (from one branch to another branch: 1→2 and 3→4) in the neighbourhood of points z_0 and z_1 respectively. These jumps will form the **evolutional hysteresis cycle** shown in Figure 1.

The duration of such cycle is random variable the mean value by which depends on the fluctuation value, δz_0 and δz_1 of bifurcation points z_0 and z_1 respectively. The smaller the fluctuations, the longer are the cycle.

According to formula (15) duration of phase of *continuous* growth of Realization Ratio from value $R(t_1)$ to value $R(t_2)$ is equal:

$$T_{12} = \frac{1}{a + d} \cdot Ln\left(\frac{\frac{1}{R(t_1)} - 1}{\frac{1}{R(t_2)} - 1}\right). \tag{29}$$

Let $R(t_2)$ be the maximum value of Realization Ratio if the fluctuation δz_0 takes place. Maximum value of function $R(t)$ depend on fluctuation of point z_0 by means of the following formula:

$$1 - \delta R \equiv R_{\max} = R(z_0 - \delta z_0) \approx R(z_0) - \frac{\delta z_0}{z'_R(1)}. \tag{30}$$

The following approximate estimations take place provided that the fluctuation is very small:

$$\delta R \equiv 1 - R_{\max} \approx \frac{\delta z_0}{z_0} \quad \text{subject to } \chi > 0; \tag{31}$$

$$\delta R \equiv 1 - R_{\max} \approx \frac{\delta z_0}{\tilde{C}^{(-)}} \quad \text{subject to } \chi = 0. \tag{32}$$

As far the value of fluctuations grows, the jumps become less and less regulated, and the cycle gradually degenerates becoming a random walk from one branch to another. The hysteresis

cycle and the jumps mean that the detailed description of system dynamics requires the use of methods of mathematical catastrophe theory. The surface of catastrophe is the surface $R\left(z,\chi,C^{(\pm)}\right)$. At fixed values of $C^{(+)}$ and $C^{(-)}$ we have a two-parameter catastrophe with limitations regarding the domain of function $R(z,\chi)$: $-1<\chi<\frac{\Lambda}{a}$ and $z>0$; and domain of values of this function: $0\le R(z)\le 1$ (catastrophe with boundaries). This is a much more complicated catastrophe than Whitney' "cusp". The fold line here consists of right line $z=z_0$ and line $z_1(\chi)$ defined by means of formulas (24)-(25). The surface having $z_0=1$, $C^{(+)}=C^{(-)}=0.3$ is shown in Figure 4.

II. Application of the Method to Economic System.

Realization Ratio characterizes the extent of using the potential of the system, that is, the useful output of the system or, talking in technical terms, its efficiency. In the economic system the use of economic potential means the output of production. Therefore the greater the "realized potential", Φ_R, the greater is the output in economic system, Y.

So we have supposed that the "**Realised Potential of Economic System", Φ_R can be measured by Output (that is by the Gross National Product) in it,** Y:

$$\Phi_R = Y\,. \tag{33}$$

The second assumption concerns the **"Total Potential" of Economic System".** The course of reasoning was like this. The economic potential characterizes the capacity of a system to manufacture a product. Therefore the economic potential includes all the factors that may be used for production: labor, capital, land, human capital and etc.

We supposed the following: (1) the "Total Potential of Economic System" is a sum of production factors "potentials" and (2) the "potential" of each factor is equal to quantity of the factor multiplied by the marginal productivity of one.

The marginal productivity of factor F is a partial derivative Y'_F. Thus:

$$\Phi \sim \sum_k Y'_{F_k}\cdot F_k\,. \tag{34}$$

It is known from microeconomics that the three tasks of the society of firms in terms of its behaviour on the competitive market are: 1) maximisation of profit, 2) maximisation of output subject to of stable costs, 3) minimisation of costs subject to of stable output yield the following first-order optimizing condition: the factor price, p_F of each factor is equal to the marginal productivity of this factor:

$$p_F = Y'_F\,. \tag{35}$$

Comparing the formulas (34) and (35), we come to the conclusion that the **"Total Potential of Economic System" is described by the "Cost-function" of Economy, or by "Costs of entrepreneurs",** C, if optimizing condition (35) fulfils approximately:

$$C=\sum_k p_{F_k}\cdot F_k \tag{36}$$

Let us consider economy with two production factors: the capital, K and labor, L. Let r be factor-price of the capital and w be a wage rate. We have:

$$C = r\cdot K + w\cdot L\,. \tag{37}$$

Realization Ratio in terms output-costs has the following form:

$$R = Const \cdot \frac{Y}{C}; \qquad Const = \left(\frac{C}{Y}\right)_{\min} \cdot R_{\max}; \tag{38}$$

where $R_{\max}$ depend on fluctuation δz_0 by means of the formulas (30) – (32).

$$\Phi = \frac{1}{Const} \cdot C. \tag{39}$$

The difference $\Pi \equiv Y - C$ is a net profit of economic system. Let us denotate net profit per output as:

$$\pi \equiv \frac{\Pi}{Y}. \tag{40}$$

The following formula takes place provided that cost-function, $C(Y)$, is a differentiable function in the point of maximum of function $R(z)$:

$$Const = \frac{C_m}{Y_m} \cdot R_{\max} = C'_Y(Y_m) \cdot R_{\max}; \tag{41}$$

where Y_m and C_m are output and costs in the point of maximum of function $R(z)$.

The formula (41) means that the right line $C = C'_Y(Y_m) \cdot Y$ is a tangent to the chart of cost-function $C(Y)$ in the point Y_m. In this point net profit per output, $\pi \equiv \frac{\Pi}{Y}$ gets the maximum value:

$$\pi_{\max} \equiv \left(\frac{\Pi}{Y}\right)_{\max} = \left(1 - \frac{C}{Y}\right)_{\max} = 1 - \left(\frac{C}{Y}\right)_{\min} = 1 - C'_Y(Y_m). \tag{42}$$

Consequently the value $\pi_{\max}$ depends on properties of cost-function. We can suppose that cost-function vary insignificantly if the reviewed period is not too lengthy. We get the first important result: values $\pi_{\max}$ must be identical in the all points of peak efficiency of the economic system, $R = R_{\max} \approx 1$. The maximum efficiency points are peaks of economic activity. We suppose that the **profit after taxes is the index of net profit of economic system.** Profits after taxes per output (= GNP) in three points of peak of economic activity in the United States, 1929, 1941 and 1948, are equal [Table 1]:

$\pi_{1929} \approx 8.3\%$; $\pi_{1941} \approx 8.2\%$; $\pi_{1947-48} \approx 8.8\%$.

Alvin H. Hansen in *"Business Cycles and National Income"* [10], giving the following figures $\pi_{\max} = \pi_{1929;\ 1947-48} \approx 8.1\%$ (Table XXXI, p.561), notes:

"Profits after taxes stood at the same level in relation to gross national product in 1947-48 as in the great boom of 1929". [p. 562]

"Probably something like this average ratio is necessary in a well-functioning private enterprise economy". [p. 569]

The reason of constancy of this correlation is stability of the cost-function of Economic System.

Entrepreneurs desire maximizing the total net profit and output having current costs, C. These "desired" levels of net profit, $\Pi^{(desired)}$ and of output, $Y^{(desired)}$ depend on maximum rate of profit, $q_{\max} = \left(\frac{\Pi}{C}\right)_{\max} = \frac{1}{C'_Y\left(Y_m\right)} - 1$ as follows:

$$\Pi^{(desired)} - \Pi + \xi \cdot Y^{(desired)} = Const_1 \cdot e^{-d \cdot t}. \tag{43}$$

This equation springs out of evolution equation (10) if we take into account the formulas (30) and (38) – (41). The constant $Const_1$ depends on initial conditions. Variable ξ depends on value δR as follows:

$$\xi = \frac{\delta R}{1 - \delta R}. \tag{44}$$

"Desired" profit, $\Pi^{(desired)}$ and "desired" output, $Y^{(desired)}$ is defined as follows:

$$\Pi^{(desired)} = q_{\max} \cdot C; \tag{45}$$

$$Y^{(desired)} = \left(1 + q_{\max}\right) \cdot C. \tag{46}$$

Equation (43) means that *parameter d is the Rate of Decrease of distance between "desired" and "actual" total net profit in Economic System* provided the fluctuations of parameters of this system are absent, $\xi = 0$.

All we have to do is define "conditions of realization" in economic system. For this purpose we shall substitute the definition (33) in evolution equation (11):

$$\dot{U} + \Lambda \cdot U = \nu \cdot Y. \tag{47}$$

This equation formally coincides with equation of capital accumulation if only we shall identify the parameter Λ with depreciation rate, and parameter ν with propensity to investment. However, the equation (47) has a more profound sense. It describes the process of accumulation of conditions in the system.

The value U may be identified with the fixed capital in a broad sense, including everything that constitutes the reach resources of the society, in this concept. This not is fixed capital in industries only, but also the funds of other non-economic structures: education, public health, state administration, and natural and social security systems.

The efficiency of using of production factors, of course, depends on all of the listed components; however, the main constituent is industrial fixed capital. Therefore, as a first approximation, one may conclude:

$$U \approx K. \tag{48}$$

Finally we can write the following formulas which connects "system" and "economic" variables:

$$z \equiv \frac{U}{\Phi} = Const \cdot \frac{K}{C}; \tag{49}$$

$$R = Const \cdot \frac{Y}{C}; \tag{50}$$

$$\mathrm{P} \equiv \frac{Y}{K} = \frac{R}{z}. \tag{51}$$

Consequently in geometric terms *productivity of the capital is equal to the tangent of angle of inclination of the radius-vector drawn in plane (z, R) from the coordinate origin to the point of the current state of the system*.

It can be seen from Figure 1 the drawing that when $\chi > 0$, the upper branch within some interval of point z_0 practically merges (coincides) with the right line $z = z_0 \cdot R$. Consequently the following approximate equality takes place:

$$\frac{Y}{K} = \frac{R}{z} \approx \frac{1}{z_0}. \tag{52}$$

It means that productivity of the capital in fact does not change at this section of top branch of evolution curve. This fact underlies in the basis of *acceleration mechanism.* The value of productivity of the capital on the upper section of evolution curve in the small left-hand neighbourhood of point z_0 is equal:

$$P_0 \equiv \left.\frac{Y}{K}\right|_0 = \frac{1}{z_0} = \frac{a + \Lambda}{\nu}. \tag{53}$$

According to data prepared by **Robert M. Solow** [26], this ratio in nonfarm industry in Economy of the United States was equal to ≈ 0.3 before the Great Crash of 1929 and it lifted by value ≈ 0.5 at the end of 1940's. We shall show below, that the formula (53) is really true if we shall identify parameters ν, a, Λ with the long-term rate of investment, rate of growth and depreciation rate respectively (with the mean values within very great time intervals) – Table 4.

The shift of point z_0 to the left from value $z_0\left(\text{before 1930}\right) \approx 3.3$ to value $z_0\left(\text{after 1930}\right) \approx 2$ corresponds to growth of long-term productivity of the capital P_0 from $P_0\left(\text{before 1930}\right) \approx 0.3$ to value $P_0\left(\text{since 1930}\right) \approx 0.5$. As a result of this shift, as can be seen from Figure 2 and Diagram 1, the crisis of 1930's proved to be much more durable and severe.

The shift of point z_0 is a clue to understanding of regularities of the Great Depression of 1930's. **Arvid Aulin** in book *"Origins of Economic Growth"* [2] is indicating at the logistic law of growth of short-term productivity of the capital during 1933-1948 years. Just such form of functional dependence directly follows from (8), (9), (12), (33), (47) and (48). This is the process of adjustment of Economic System with respect to new long-term level of productivity of the capital. So long as the long-term rate of growth of output is constant then productivity of the capital changes as logistical function:

$$\frac{\dot{P}}{P} \equiv \frac{\dot{Y}}{Y} - \frac{\dot{K}}{K} = a + \Lambda - \nu \cdot P = \nu \cdot \left(P_0 - P\right). \tag{54}$$

Hysteresis cycles, as applied with respect to the economic system, means the cyclic change of the following values:

$$\frac{Y}{C} = \frac{1}{1-\pi} \sim R; \tag{55}$$

$$\frac{K}{C} = \frac{1}{1-\pi} \cdot \frac{K}{Y} \sim z. \tag{56}$$

The phase of the system's falling from the top evolutional branch to the lower one is expressed, according to (55), in drastic drop of net profits per unit output, π. Therefore, the phase of catastrophic jump downwards of economic system, 1→2 (Fig.1) corresponds to the crisis phase of economic cycle. During the collapse of the system the value z varies much less than the value R (Table 1 and Diagram 1). Therefore the crisis means as well sharp reduction of short-term productivity of the capital, $\frac{Y}{K} = \frac{R}{z}$. After the fall of the system to the lower evolution branch short-term productivity of the capital grows initially, while the value z decreases 2→3 (Figures 1-2 and Diagram 1). Then this is followed by jump to the upper branch, 3→4. On the

upper branch, 4→1, short-run productivity of the capital gradually decreases in value, while the value z grows slowly, approaching z_0. Then a new jump downward, 1→2, takes place as consequence of fluctuation of the point z_0 and the cycle recur. Jumps upward and downward correspond to revival and recession (crisis) phases of the business cycle.

Wesley C. Mitchell in His book *"What Happens During Business Cycles?"* [19], gave detailed quantitative description of different phases and Stages of "typical" business cycle on the basis of analysis of major volume of statistical information. He established that Segment-by-Segment Average Rate of Change per Month in Reference Cycle changes very irregularly. This quantity changes quasi-gradually within Stages I-V and Stages VI-VIII but it leaps down within Stages V-VI and it leaps up within Stages VIII-I. According to our hypothesis these *jumps in Segment-by-Segment Average Rate of Change per Month in Reference Cycle correspond to jumps of Economic System from one evolution branch to another.* We consequently can consider this Mitchell' result as indirect confirmation of hypothesis of hysteresis cycles. Diagram 2 illustrates this conclusion.

The other our statement concerns the dynamics of Economic System during 1930's. We calculated values of quantities (55) and (56) in order to verify does the shift $z_0\left(\text{before 1930}\right) \approx 3.3 \Rightarrow z_0\left(\text{since 1930}\right) \approx 2$ exist or not actually? It is evident that Diagram 1 made on the basis of data in Table 1 confirms our supposition with respect to shift of long-term productivity of the capital since the Great Crash of 1929.

III. The Great Depression of 1930-ies as evolution catastrophe of Economic System. Brief Survey of historical events and its interpretations.

The striving to get maximum profit has always been a dominant factor of economic growth. Let us call this factor "economic egoism". If the economic entities are numerous, their egoisms, colliding, limit each other. The egoism in such system is not only a condition of personal welfare growth, but also a force retaining the personal egoism in certain limits.

The situation changes cardinally when each segment of the market appears under the influence of several strong economic entities that dictate particular rules of the game to all the remaining market participants. In such systems the selfish force becomes self-sufficing. The egoism of cross-influencing economic entities does not meet counteraction, and everything that lets one gain momentary profit is deemed to be "good" in this situation. *The principal fault of such system is near-sightedness. The violation of the collegiality principle becomes a norm here, even the condition to maintain high growth rate.*

The economy of the United States by early thirties was the economy of this type. The prosperity of the twenties was sustained by the measures being each in fact the violation of the collegiality principle. The core of this infringement lay in the fact that some economic entities got rich at the expense of the others, whereas the others hardly made ends meet. The economically strong units dictated their rules to economically weak units. This economic inequality let one make profit and grow rich at the expense of others. The "strong" did not show any willingness to seek compromise; they even had no understanding that they needed that compromise themselves.

We shall single out three basic forms of economic egoism:

1. **Pressure of large business upon individual small producers.** This pressure was especially noticeable for private farm economy.
2. **The pressure of the proprietors on the workers**, that resulted in considerable reduction of labour share in the national income in late twenties.
3. **The pressure exerted by the United States on other countries** that became their debtors after the First World War.

It is this infringement of collegiality principle that resulted finally in unprecedented depression that paralysed the national economy for nearly ten years. We do not mean to say that the violation of moral laws was the reason of crisis. There is not any direct relationship between morals and economy. *However, it was the reluctance to see, put forward and timely solve the problems of economic inequality of different constituents of the economic system that was the main cause of profundity and duration of the crisis of 30-ies.* Business is based on egoism and is beyond the sphere of morals; therefore it is the society that must see to observance of collegiality principle by means of laws or institutes. *In the twenties a new reality emerged – the economy controlled by large corporations. This new economy needed a new social system objectively, that would restrict the economic egoism of corporations and solve the problems of inequality in due time.* However, such system did not exist in the twenties. The problems were accumulating, got imposed on each other, without solution. Finally this accumulated burden of unsolved problems leads to crisis.

The high level of investments in the twenties created a new economy extensively using new technologies. This **new economy could provide the higher level of productivity of the capital, but to do that it was necessary to lower the propensity to investment (parameter ν).** This conclusion is the direct consequence of formula (53). *Therefore, the principle of long-term accumulation entered into conflict with the principle of short-term accumulation. It was a contradiction between the long-term interest of the whole society and the short-term interest of a small bunch of investors.* The high rate of investment negated itself.

Below we shall briefly list the factors that in the twenties accounted for the long-term excess of rate of investment over the level required for normal development. The underlying basis of these factors was economic egoism of different constitutes of economic system. The most relevant reason of the boom was infringement of collegiality principle in the twenties.

1. **Large business in the form of corporations dictated the price and conditions of sales to the other producers.** The corporations established ungrounded high prices and go super profits. The reverse side was that the companies selling their goods in the competitive market, but buying the required means of production from suppliers - monopolists lost part of their profit. **The monopolies and large corporations grew rich at the expense of dispersed individual manufacturers**.

Gardiner C. Means [16] at the annual meeting of the American Statistical Association in 1934 stated:

"…The last century has seen a steadily increasing shift from market coordination to administrative coordination… As a result of this shift from market to administration, the area of coordination remaining to the market has been greatly reduced while the increased bargaining power of the big administrative units has induced the counter concentration in the form of cooperative bargaining organizations, farm cooperatives, labor unions… thus reducing the number of separate units interacting though the market… Prices have become problems of administration" [**13**; p.30].

(In this part of the paper we refers to two collection of selections from different books devoted to the Great Depression: **Shannon, D. A., 1960**, *The Great Depression* [25] and **Himmelberg, R. F., 1968**, *The Great Depression and American capitalism* [13]. First figure in square brackets correspond to the number of collection in reference list.)

The prices fixed administratively mismatched the costs. These were rigidly fixed prices using which the corporations reduced the share of labour and expanded the share of profits. By the end of twenties these prices that lost the capacity to regulate the market started dominating in economy.

"Very many of our wholesale prices are administrated", **Gardiner C. Means says**, "administrated prices are to be found in a great many highly competitive industries… *Inflexible administrated prices are a major factor in our economy.* This is heightened when we add relative inflexibility of railroad and utility rates, or salaries and often of labor rates, of many commercial loan rates, and of

many government services…But ever in the … competitive industries such as automobiles, the rigidity of prices is evident while in the dispersed industries like farming… prices are extremely flexible…(1) Inflexible administrated prices are a major factor in our economy, (2) they constitute a serious impediment to balanced economic functioning, (3) they result primarily from and are inherent in economic concentration and modern industrial organization…" [**13**; p.29-30].

H.L. McCracken in 1938 in His paper [15] devoted to the influence of monopolies upon the crisis was noting:

"…We do not live in a frictionless world of free competition and flexible price… Our modern economy is marked by frictions of many types, by rigid prices administered by government or business organizations sufficiently unified and powerful to control supply and regulate prices" [**13**; p. 34-35].

"Whereas one of the major functions of competition is to keep price related to cost the major purpose of monopoly is to break the connection between cost and price… Monopolistic competition tends to achieve equilibrium by holding prices relatively rigid and restricting the output to the demand which will be effective at the pre-determined price". [**13**; p.35]

The pressure exerted by big business told especially acutely on economic situation of private farm economies. The price discrimination of farms is the most striking example of economic inequality. **Arthur A. Adams** in 1932 [1] was writing:

"The large business enterprises particularly in the fields of mining, manufacturing and trade through monopolies, cartels, and trade associations have been able in great measure to hold the prices of their products at relatively stable points in the face of an increasing output and lower costs… The farmers… partly because of the lack of joint ability to control output and the marketing of their products have little power to hold up the prices of their products. *Producers' control of the prices of one class of products and the lack of control by producers of another class of products have thrown the price system out of adjustment and have caused an unbalanced development of industry*". [**13**; p.18-19]

The farmers' position was disastrous in 1920-ies. **Bernhard Ostrolenk** in New York Times, September 25, 1932 [21] was writing:

"The Most Superficial study of the statistics reveals that while industry reached a new peak of prosperity between 1920 and 1929, the farmer met with one financial setback after another, that he was becoming poorer and poorer, that the disaster of 1920 was followed by an even greater financial catastrophe in 1930". [**25**; p.17]

The level of farm products prices was set too low as compared with the industrial products price level. This caused serious migration of the rural population. The industrialisation of America in the twenties took place to a great extent at the farmers' expense. It was based on the influx of cheap labour and low prices for raw materials and staple foodstuffs. In this sense the **city grew rich at the expense of agriculture**.

As **Arthur A. Adams** states:

"The small purchasing power of the farming population (due to relatively low prices of agricultural products) since 1920 has adversely affected the demand for consumers' goods in the United States. In spite of this fact, however, the *low prices of agricultural products were one of the forces upon which our great industrial expansion (1922-29) fed.* The relatively low prices of agricultural products gave manufacturers cheaper raw materials and relieved them of stronger pressure for increases in wages of workers. *Low agricultural prices also provided cheap food for the urban population, adding to their relative power to purchase other commodities*" [**13**; p.17-18].

Nearly all economists agree that it is the prices fixed in the administrative way, not able to regulate the market that proved to be one of the causes of the crisis of thirties.

"The most significance of these inflexible prices lies in their disruptive effect on the functioning of our economy", **Gardiner C. Means says,** "if all prices had been flexible it is doubtful if we would have had a serious depression after the stock crash of 1929. Instead of producing lower prices, the drop demand produces a drop in sales and in production. Workers and machines are thrown out of use and both owners and workers have less to spend, thus amplifying the original drop in demand. In this manner, *rigid prices can expand an initial small fluctuation of industrial activity into a cataclysmic depression*" [**13**; p.29].

"I agree", **Arthur Adams** writes**,** "with those who hold that both individual prices and the system of prices have lost some the elasticity they used to have, and that this change has contributed to our present difficulties… I believe that… if prices had generally followed the lead of declining costs, we should have had today only a very mild business depression, or, no at all, instead of the very severe one we now have" [**13**; p.18].

2. **The privileged position of the United States as compared with the other countries** that was established after the First World War let it for a considerable time to sustain the extremely favourable trade balance. The United States becomes a world creditor. This enabled it to get huge additional income. **The country on the whole grew rich at the expense of other countries.** The countries - debtors were either to expand their export or pay with gold or borrow new loans.

Such policy eventually disturbed the balance on the world financial and commodity markets that got established after the War. The change in the world prices distorted the price structure within the country. The first person that referred to interrelation between the crisis and the foreign policy pursued was **Ambrose W. Benkert**, prominent member of the New York State Chamber of Commerce. He was writing in 1933 in his pamphlet *"How to Restore Values…"* [3]:

"It is evident that the existing paralysis of business in the United States is due primarily to a break down of fair price interrelationships among commodities, raw materials, manufactured goods and services… The present price level of commodities and raw materials in contrast with the price level of essential services as expressed in taxes, interest and maturing debts, rents, transportation and utility rates… Many commodity and raw material prices… are at the lowest level in a century. Essential services depending on contract or government fixation still enjoy the peak price level of recent years… What has caused the present disparity in prices? …

During the war the United States had changed from a debtor to a preponderant creditor nation. During the past-war decade … most of the civilized nations of the world became our debtors… Foreign nations were therefore compelled to curtail imports and expand exports to provide funds for service charges on these external loans… In many of these countries programs were initiated to reduce the quantity of commodities used by their own populations in order to have a greater supply for export and at the same time their own manufactures were stimulated so as to reduce imports and provide additional exports to equalize their balance of payments… These policies initiated even before the crash of 1929, started a worldwide downward trend of commodity prices…" and "…compelled our foreign debtor nations to bid for gold… This procedure… broke down world price levels and flooded all markets with cheaper and cheaper goods… Our price level for commodities, raw materials and other goods in world competition… declined proportionately. Our domestic price levels for services and goods depending on contract, governmental fixation, usage, trade combinations, etc., remained where they were. Thus was brought about the disparity in price levels within our own country" [**13**; p.1-3].

This is how **Robert A. Gordon** in book *"Business Fluctuations",* 1952 [8] describes the crash of the "debt bondage" policy carried out in the twenties.

"During the First World War, the United States became a creditor of international account. In the decade following, the surplus of exports over imports had paid the interest and principal on loans from Europe continued. The high tariffs, which restricted imports and helped to create this surplus of exports, remained… Other countries, which were buying more than they sold, and had

debt payments to make in addition, had somehow to find the means for making up the deficit in their transactions with United States.

During most of the twenties the difference was covered by cash – i.e., gold payments to the United States – and by new private loans by the United States to other countries. Most of the loans were to governments… and a large proportion were to Germany and Central and South America… Countries could not cover their adverse trade balance with the United States with increased payments of gold… This meant that they had either to increase their exports to the United States or reduce their imports or default on their past loans… Accordingly, debts, including war debts, went into default and there was a precipitate fall in American exports… It contributed to the general distress and was especially hard on farmers" [**13**; p.92-93].

3. The redistribution of national income to the benefit of private property that took place in the twenties was the direct consequence of the administrative pricing policy. This eventually disrupted the demand for consumer goods artificially maintained by means of the crediting system (instalment buying). **Those who lived on income from property grew relatively rich at the expense of those who earned by their labour.**

Arthur A. Adams was writing:

"The pursuit of profits was the underlying incentive which brought into action the forces which increased our power of production. From the standpoint of production of economic goods and services, we have today, the most effective industrial system the world has been seen.

But in this system one outstanding weakness is now apparent. *We have failed to develop effective methods of the distribution of money income to the mass of consumers.* The money income received by consumers is not sufficiently large to enable them to purchase at prevailing prices the consumers' goods and services, which our economic system produces. *This outstanding weakness is a result largely of the desire for high profits on the part of managers*". [**13**; p.19]

"From 1923 to 1929 our economic system was trough out of balance. During this period we increased our power to produce goods, especially per worker, while at the same time the distribution of the current money income or power to purchase these goods became more unequal and maladjusted. This lack of balance was overcome temporarily through the unsound use of bank credit in creating buying power and therefore the demand for goods. The artificial prosperity thus generated could not last forever. The maladjustment between the production of goods and the distribution of income finally showed itself in the present depression" [**13**; p.15].

John Kenneth Galbraith in book *"The Great Crash, 1929",* [7] notes:

"In 1929… 5% of the population with the highest incomes received approximately one third of all personal income. The proportion of personal income received in the form of interest, dividends, and rent… was about twice as great as in the years following the Second World War. This highly unequal income distribution meant that the economy was depend on a high level of investment." [**13**; p.90]

The reason of growth of the share of property in the national income was not only excess profit of corporations backed by the system of administratively fixed prices, but also the speculative boom at the end of the twenties that generated a surge of frauds and swindles.

"American enterprise in the twenties", **John Galbraith** writes**,** "had opened its hospitable arms to an exceptional number of promoters, gaffers, swindlers, impostors, and frauds" [**13**; p.91]

The Banking Act of 1933; Securities Act of 1933; and Securities and Exchange Act of 1934 that drastically restricted the possibility of financial manipulations was the first step undertaken by the government as soon as it recovered from the crisis.

Summing up, we may agree with **John Kenneth Galbraith**:

"In 1929… the economy was fundamentally unsound". [**13**; p.90]

Let us list the principal items of this "disease" once again:

1. **The big business made profit at the expense of non-united dispersed manufacturers.**
2. **The city prospered at the expense of agriculture.**
3. **The country in general made profit for account of other countries.**
4. **The proprietary class appropriated the increasing part of national income by reducing the share paying for the labour.**

The economic system suffered from the excessive selfishness. The crisis of the 30-ies was the direct consequence of infringement of collegiality principle in the twenties. In this sense the catastrophe that took place was of religious and moral character. The respected priest **Nikolay Serbsky (Николай Сербский) [23]** characterizes the events of that time in one of his letters in the following way:

"**Crisis**" is a Greek word (χρισισ); it means "**court"** in translation… In earlier times the Europeans, if struck by misfortune, used the word "court"… Now the word court is substituted by the word "crisis"… You ask about the cause of the present crisis, or the God's judgement? The cause is always the same – … apostasy from God… Lord used modern instruments to bring contemporary people to reason. He struck a blow on banks, stock exchanges and the whole financial system. He overturned the tables of moneychangers all over the world, as He once did in the Jerusalem Temple. He spread unheard-of panic among the dealers and moneychangers. He disturbed everything, overthrew, confused, and aroused fear…" [p. 17].

Below we present the evidence of contemporaries of those events, the economists, well-known political figures and ordinary people. It was a catastrophe, and most contemporaries treated what was happening exactly as a catastrophe. Everything the people lived for collapsed. **David A. Shannon**, the editor of collected articles *"The Great Depression"* [25], in 1961, assesses the events of those years like this:

"…The Great Depression was a traumatic experience. It was all the more traumatic because the immediately preceding years had been quite comfortable once on the whole and the American mood had been, unusually optimistic. During the 1920' business and political leaders spoke of the New Era… An ever-expanding economy, full employment, and the elimination of poverty were permanent futures, many believed, of the New Era" [**25**; p. IX].

In the twenties the business was prospering, the incomes were growing, and nothing foreboded the thunderstorm. **John Kenneth Galbraith** characterizes the economic situation on the eve of the crisis this way:

"In 1929 the labor force was not tired, it could have continued to produce indefinitely at the best 1929 rate. The capital plant of the country was not depleted. In the proceeding years of prosperity, plant had been renewed and improved. In fact, depletion of the capital plant occurred during the ensuring years of idleness when new investment was sharply curtailed. Raw materials in 1929 were ample for the current rate of production. Entrepreneurs were never more eupeptic. Obviously if men, materials, plant and management were all capable of continued and even enlarged exertions a refreshing pause was not necessary" [**13**; p.88].

Robert A. Gordon in his detailed research [8] notes the following:

"From 1923 though 1929, business remained at a high level and tended to increase still further… We thus have a picture of a prolonged investment boom, which supported a steady expansion in incomes and consumers' demand and at same time provided the enlarged capacity necessary to meet the rising demand for goods and services" [**13**; p.104].

"There was overinvestment in the late 1920's in the sense that capacity... had been expanding at a rate that could not be indefinitely maintained… The chief immediate cause of the downturn, then, was probably the impact of "partial overinvestment" on business expectations. *This, however, is not sufficient to account for the length or severity of the depression…"* [**13**; p.108].

There is not so far a common opinion among the economists about the reasons that engendered this stagnation in economy, unheard-of before in terms of gravity and duration, which stagnation being unusual already by the fact that it took place without any visible external reasons: there was no drought or wars or any natural calamities or social cataclysms.

According to **Arthur B. Adams**:

"The economic conditions which led up to the depression were somewhat similar to those which have led up to other business depressions: were increase in production, increase in trade, and considerable inflation in bank credit" [**13**; p.15].

"But unlike these other occasions," **John Kenneth Galbraith** says, "in 1929 the recession continued and continued and got violently worse. This is unique feature of the 1929 experience. This is what we need really to understand" [**13**; p.90].

"What… are plausible causes of the depression," he asks, "the task of answering can be simplified somewhat by dividing the problem into two parts. First there is the question of why economic activity turned down in 1929. Second there is the *vastly more important question of why, having started down, on this unhappy occasion it went down and down and down and remained low for a full decade"* [**13**; p.89].

Calling the events of 1930-ies a "catastrophe that paralyzed America for more than a decade", **David A. Shannon** offers a mathematically precise definition of this phenomenon.

The crisis of 30-ies was in fact a catastrophe in mathematical terms, a jump of the system from the upper evolution branch to the lower evolution branch. However, this time the jump was accompanied by a rapid growth of long-term productivity of the capital. This resulted in a sharp left-shift of point z_0, following which the crisis became much more grave and lengthy (Fig.2).

The growth of long-term productivity of the capital was being prepared for a long time and was a direct consequence of industrialisation of the twenties. However, the adaptation of the system to new level of productivity of the capital supposing the reduction of long-term propensity to investment (formula (53)), contradicted to the interest of those who lived at the expense of that excessive of investment rate.

The impetuosity and pace of shift of the point z_0 after the "Black Tuesday" is the direct consequence of the situation when the force maintaining the position of that point lost its effect, and the system was able to realise the structural change that had matured for a long time.

Robert A. Gordon, expressing the widespread point of view of later economists regarding the events of those years, relates the depression directly with the preceding boom of the twenties:

"Investment opportunities (30^{th}) were restricted then because they had been so thoroughly exploited in the 1920's and because the severity of the financial liquidation after 1929 led businessmen and investors to view with a jaundiced eye the opportunities that were available" [**13**; p.110].

"Black Tuesday" changed the long-term expectations radically. The subjective source of excess of propensity to investment over the level that would match new, higher long-term productivity of the capital ceased to exist. There appeared a possibility to adjust the economic system to this new level of long-term productivity of the capital. However, to make this level working, it was necessary to eliminate the disproportion that emerged in the twenties, of distribution of the national income between the labour and property. Roosevelt's policy of New Deal was the system of measures that managed to solve this problem.

Joseph A. Schumpeter in His book *"Business Cycles",* 1939 [24] writes:

"Objectively" – i.e. irrespectively of intentions harbored by any individuals – they (investors) amounted to systematic attack on investment opportunity all round: it was frontally attacked by direct reduction of revenues – or the operative part of total net revenues – though taxation, which

would have been only the more effective if there really had been also an inherent tendency for investment opportunity to shrink; simultaneously, it was attacked in the rear by increasing costs; and both attacks were supplemented by a third – the attack on those traditional methods of management, pricing, and financing in the sphere of "big business", which were associated with the latter's emergence and successes" [**13**; p.67].

The crisis of the 30-ies started as a normal "jump off" of the system with the top evolution branch of the hysteresis cycle to the lower branch. Mathematically, such jumps underlying the business cycles, according to our hypothesis, represent regularly occurring micro-catastrophes by means of which the system is renewed and progresses. However *this time the jump downwards turned out to be a giddy drop, a catastrophe in full sense of this word*.

David A. Shannon [25] describes the events of that time as follows:

"After several months of depression America was indeed a place turned topsy-turvy. Even the surface appearance of the cites changed. Former bond salesmen were on the sidewalks trying to sell apples. Former clerks roamed the business districts in attempts to make a living by shining shoes. Unemployed and homeless men welcomed arrests for vagrancy and the warmth and food to be had in jail. Over a hundred thousand American workers applied for jobs in the Soviet Union. Shanty towns appeared in and around the industrial cities, and the inhabitants of these housing developments born desperation bitterly named them for the President of the United States" [**25**; p.1].

"It is difficult to say whether the unemployed urban worker or the farmer suffered the more from the depression" [**25**; p.16].

"Forlorn, down-and-out men shuffled hopeless through bread lines" [**25**; p. IX].

"Industrial workers and farmers dearly suffered more from want during the depression than other economic groups. Nevertheless, the deprivations of middle-class families were serious. Most people who made their living from their invested capital, from their business, or from their professional work did not go hungry – although some did – but many lost a considerable part of their fortune and took a major loss of income" [**25**; p.72]

New York Times, June 5, 1932 was writing:

"Darwin's theory that man can adopt himself to almost any new environment is being illustrated, in this days of economic change, by thousands of New Yorkers who have discovered new ways to live and new ways to earn a living since their formerly placid lives were thrown into chaos by unemployment or kindred exigencies" [**25**; p.10].

John Kenneth Galbraith characterizing the general atmosphere of 1930-ies as follows:

"When the misfortune had struck, the attitudes of the time kept anything from being done about it. This, perhaps, was the most disconcerting feature of all. Some people were hungry in 1930 and 1931 and 1932. Others were tortured by the fear that they might go hungry. Yet others suffered the agony of the descent from the honor and respectability that goes with income into poverty. And still others feared that they would be next. *Meanwhile everyone suffered from a sense of utter hopelessness"* [**13**; p.95]

"In 1931 and 1932, - **David A. Shannon** was writing – talk of social revolution become common. Surely though thousands of people the dispossessed and the hungry will revolt against the government and the economic system that had brought them to their desperate situation. But no revolution came. At least there was no revolution such as many anticipated, with rioting, blood in the gutters and violent overthrow of government. Instead a majority of the electorate switched its allegiance from the party of Herbert Hoover to the party of Franklin Delano Roosevelt" [**25**; p. X].

The striving to solve the problems by common efforts prevailed over the desire to find the culprits. Instead of revolution a change of power typical for a democratic country took place. Roosevelt' New Deal policies withdrew the economy from crisis. The economists assess the

importance of this policy in the recovery process in a different way. However, despite the shortcomings of specific acts, **New Deal policies objectively promoted withdrawal from crisis**.

It was a rigid policy of restricting of economic egoism: introduction of state control over the bond and real market activity (The Banking and Securities Acts of 1933 and Securities and Exchange Act of 1934), price and wage rates monitoring (National Industrial Recovery Act (June, 1933) – NIRA and latter, National Labor Relation Act (Jule, 1935); Public Utility Act of 1935), and raising taxes on corporate profit. **John Chamberlain**, a journalist and commentator on the economic and political scene, in his book *"The Enterprising Americans: A Business History of the United States"*, 1963 [4] was writing:

"The first important domestic creation the New Deal, the NRA, was a total abnegation of the competitive market economy… With its price-fixing and market-allocating codes the NRA was a denial of the free system… Businessmen came to ask themselves whether Roosevelt really understood a system where the hope of profit sparks expansion and investment" [**25**; p.96].

The policy of redistribution of national income pursued by the government made it possible to sharply increase the share of labor. **John Chamberlain** gives the following figures:

"… Money wage rates in manufacturing advanced some 43 per cent between 1933 and 1939 and real wages by an extraordinary 34 per cent… Some of this rise was no doubt to be expected in a period of partial recovery but much of it followed out of government-blessed wage boosts from an unprecedented surge of union organization" [**24**; p.97].

Relief, Housing and Social Security Programs (NIRA, Emergency Relief Act of 1932, National Housing Act of 1934; Social Security Act of 1935), Public Works, government intervention "for getting agriculture into better balance with the rest of the economy" (Soil Conservation and Domestic Allotment Act of 1936 and the Agricultural Adjustment Act of 1938) and other measures taken by the government made it possible to relax the social tension. It was a policy of moderate socialist reforms, mild expropriation of the share of income of the society's richest section.

Franklin D. Roosevelt in 1934 had explained the essence of New Deal as follows:

"What we seek is balance in our economic system – **balance between agriculture and industry and balance between the wage earner, the employer, and the consumer**" [**6**; p.199].

One may say that the basis of this wise policy was the collegiality principle.

It is understandable that the bourgeoisie did not like these measures, but it was compelled to agree to them, being afraid to lose everything otherwise. In judgement of **Joseph A. Schumpeter [24]**:

"… Behind these measures, administrative acts, and anticipations there is something much more fundamental, viz., an attitude hostile to the industrial bourgeoisie… They (businessmen) are not only, but they feel threatened" [**13**; p.68].

The willingness to find reasonable compromise that would suit all the parties, and the decisive government measures to restrict the economic egoism in society made it possible to stabilize the situation in the country.

The timely return to collegiality principle in politics helped to prevent the revolution and withdraw the country from chaos. According to **David A. Shannon**:

"Roosevelt and his party succeeded in partially alleviating the personal distress of the Great Depression and in effecting a partial economic recovery" [**25**; p. X].

Franklin D. Roosevelt in 1938 in his public speech on the radio expressed the close relationship of the politics pursued by him with collegiality principle this way:

"No doubt you will be told that the Government spending program of the past five years did not cause the increase in our national income… That is true in part, for the Government spent only a small part of the total. But Government spending acted as trigger to set off private activity…

The Government contribution of land that we once made to business was the land of all the people. And the Government contribution of money, which we now make to business ultimately, comes out of the labor of all the people. It is therefore, only sound morality, as well as a sound distribution of buying power, that the benefits of the prosperity coming from this use of the money of all the people should be distributed among all the people – at the bottom as well as at the top" [**25**; p.27].

The events after the Great Crash at the New York' Stock Exchange, the "Black Tuesday", as this unfortunate day will be called later, developed sweepingly. Let us note just some of the facts, illustrating them with statistical data.

The next day after the collapse a regular issue of **New York Times** was released with a bombastic title: "Worst Stock Crash stemmed by banks. 12,894,650 – Share Day Swamps Market Leaders Confer, Find Conditions Sound":

"The most disastrous decline in the biggest and broadest stock market at history… The total losses cannot be accurately calculated because of the large number of markets and the thousands of securities not listed on any exchange. However, they were staggering, running into billions of dollars" [**25**; p.2].

The landslide of shares monstrous in its scale was, naturally, a serious blow on the economy. However, some cases of large-scale share collapse are known to have happened before; this has always seriously affected the economic activity, but with time the real economy used to adjust to the changes in the stock market. Therefore no one could expect that the Wall Street collapse would cause such consequences.

On the day of crash, October 24, five most influential bankers after an emergency meeting at the office of J.P. Morgan & Co., made a statement:

"… That the market smash has been caused by technical rather than fundamental consideration and that many sound stocks are selling too low" [**25**; p.2].

And in 6 days **New York Times** informed that:

"Stock Prices virtually collapsed yesterday, swept downward with gigantic losses in the most disastrous trading day in the stock market's history" [**25**; p.4].

The economic indices of 1929 did not cause any serious anxiousness. Actually, there were some indicators of weakening of business activity, like **John Kenneth Galbraith** states, for instance:

"Federal Reserve indexes of industrial activity and of factory production… reached a peak in June. They then turned down and continued to decline throughout the rest of the year…The turning point in other indicators – factory payrolls, freight-car loadings and department store sales – came later, and it was October or after before the trend in all of them was clearly down… the summer of 1929 marked the beginning of the familiar inventory recession" [**13**; p.89].

However on the whole the economy seemed to be stable. **Broadus Mitchell**, a distinguished economic historian in book *"Depression Decade: From New Era through New Deal, 1929-1941"* [17] informs that shortly before the stock-exchange crash:

"The White House reported the President as considering "that business could look forward to the coming year with greater assurance". H. Booth, president of the Merchants' Association of New York, saw "no fundamental reason why business should not find itself again on the upgrade early in 1930…" [**25**; p.5].

The socially reputable persons did not believe in a possibility of a serious crisis and reassured the people claiming that nothing serious had taken place.

According to **Broadus Mitchell** [17]:

"The Guaranty Trust Company of New York expressed qualified hope: "Although there is no failure to appreciate the importance of the collapse of stock prices as an influence on general business or to ignore the historical fact that such a collapse has almost invariably been followed by a major business recession, emphasis has… been placed on certain fundamental differences between the conditions that exist at present and these that have usually been witnessed at similar times in past" [**25**; p.5].

However, contrary to all forecasts, this time events developed according to a different script. The economy not only recovered after a shock, but, despite all forecasts, assurance and conjuration kept on falling.

According to **David A. Shannon** [25]:

"The Wall Street debacle directly and immediately affected only a relatively small part of the American population, but a new and dismal era had began. Despite the assurance – or incantations – of business and political leaders that the stock market crash did not reflect upon the health of the economy in general, it was not long before almost every indication of the nation's economic welfare showed trouble" [**25**; p.1].

The people did not realise immediately that the share drop that happened this time was an event principally different from what took place ever before. They did not realise at once that **the downfall of the stock market was a "disturbance" of the economic system after which it could not return to its former state**.

John **Kenneth Galbraith** in His book [7] notes:

"On the whole, **the great stock market crash can be more readily explained than the depression that followed it.** And among the problems involved in assessing the causes of depression none is more intractable than the responsibility to be assigned to the stock market crash. Economics still does not allow final answers on these matters… After the Great Crash came the Great Depression which lasted, with varying severity, for ten years… It is easier to account for the boom and crash in the market than to explain their bearing on the depression, which followed. The causes of the Great Depression are still far from certain" [**13**; p.86-87].

Let us formulate once again our interpretation of the crisis of the 30-ies. Its main peculiarity lay in the fact that the normal recession was this time drastically strengthened by considerable and fast change of the system parameters, namely, sharp reduction of value z_0. *This considerable reduction was a consequence of two reasons: 1) growth of long-term productivity of the capital during the twenties and 2) excess of propensity to investment in this period over the level that would match this new, higher long-term productivity of the capital.*

The first to react to the events of the Tuesday was the banking system closely connected with the stock market.

According to **David A. Shannon** [25]:

"Banks began to fail at an alarming rate" [p. IX].
"…More than 5,000 banks closed their doors in the three years, 1930-1932" [p.72].

Harold U. Faulkner in His book "*Labor in America"* [6], informs:

"In the two years, 1930-31, 3,750 banks failed" [p.195].

William Greenleaf, in book *"American Economic Development Since 1860",* [9] describes the banking system collapse as follows:

"The real run on the American banks can be dated from the failure of the Bank of the United States in New York in December, 1930. From that time… failures continued at an increasing rate… The R.F.C. (Reconstruction Finance Corporation, based in January 1932) succeeded in slackening the

pace of failures, though they continued throughout 1932 at the average rate of 40 banks and $2 million of deposits every each… Towards the end of the year the final collapse began. The first state moratorium was declared on October 31st; the Detroit banks closed on February 14, 1933, and within three weeks the bank "holiday' had spread to every state in the Union" [p.193-194].

Default hit the real economy as well by sharp fall of demand for investment goods. According to **John Kenneth Galbraith** [7]:

"The collapse in securities values affected in the first instance the wealthy and the well-to-do. But… in the world of 1929 this was a vital group. The members disposed of a large proportion of the consumer income; they were the source of a lion's share of personal saving and investment. Anything that struck of the spending or investment by this group would of necessity have broad effects on expenditure and income in the economy at large. Precisely such a blow was struck by the stock market crash…" [**13**; p.95].

The strong dependence of economy on the demand for investment goods of the most well-to-do section of the population generated the first surge of reduction in the industrial output.

As **David A. Shannon [25]** notes:

"The Wall Street panic triggered a general collapse. Within only a few months unemployment becomes a serious problem" [p. IX].

The below data regarding unemployment were taken from the article by **Paul Webbink,** published in Proceedings of the American Economic Association, February, 1941 [28].

"Within a few months after the stock market collapse of October, 1929, unemployment had been catapulted from its status of a vague worry to be considered some future day into position of one of the country's foremost preoccupation. Unemployment increased steadily… from the fall of 1929 to the spring of 1933" [**25**; p.6].

According to **Paul Webbink**, the unemployment grew twofold from March 1930 to March 1931, and the next year - by 50 more percent. By March 1932 the unemployment reached by different estimates from 11,250,000 to 12,500,000. The peak of unemployment was in winter 1932-1933. Different sources give different figures. According to Robert Nathan, by March 1933 the country had 13,577,000 unemployed. According to National Industrial Conference Board, the number of unemployed at that moment was 14,586,000. American Federation of Labor and Congress of Industrial Organizations provide still greater values - 15,389,000 and 16,000,000 respectively.

According to **John Kenneth Galbraith** [7]:

"In 1933 nearly thirteen million were out of work, or about one in every four in the labor force" [**13**; p.86].

The drop in production reached catastrophic dimensions. The curtailment of production entailed the fall in prices, reduction of hourly wages of industrial workers and employees' salaries.

"In 1933," **John Kenneth Galbraith** states, "GNP… was nearly a third less than in 1929. Not until 1937 did the physical volume of production recover to the levels of 1929, and then it promptly slipped back again. Until 1941 the dollar value of production remained below 1929. Between 1930 and 1940 only once, in 1937, did the average number unemployed during the year drop below eight million" [**13**; p.86].

We could proceed with adducing another facts and figures describing the huge catastrophe that happened in America in the thirties. The scope of the tragedy may be evidenced by the figures of increment of population given by Alvin H. Hansen in book *"Business Cycles and National Income"* [**10**; p.76]:

Decade	Increase in population (Millions of persons).
1900-1909	16,0
1910-1919	13,7
1920-1929	17,0
1930-1939	8,9
1940-1949	18,0.

It is clear that the "Black Tuesday" engendered that catastrophe, but was not its cause. The cause, as we already mentioned, was infringement of the collegiality principle in the twenties. This infringement resulted in a gap between the potential and actual productivity of capital. In the twenties this gap was growing step-by-step. **To release this higher productivity of the capital, it was necessary to cut down the rate of investment existing in the twenties, which was sustained at a high level for a long time, ensuring welfare of the most prosperous section of the society.**

The collapse was the incitement that caused the drop of the system from the upper branch to the lower one. In this sense it was that very fluctuation that underlies the jumps of the hysteresis cycle. But the Collapse was a blow to expectations as well, which resulted in a sharp left-shift of the point z_0, which in its turn became the reason of as unusual depth and duration of this crisis.

The high rate of investment was sustained in the twenties by infringing collegiality principle that we have already spoke about: (1) privileged financial position of the country in the world, (2) low share of labour in the national income, (3) disproportion of prices for the products of big business and individual dispersed producer, (4) high prices for the products of big business, not matching the real costs.

If the investment rate had lowered smoothly in the twenties within several cycles, **no Great Depression would take place at all**. The economy would continuously shift to a new level of productivity of the capital. Each separate crisis would be somewhat more profound, but on the whole the transition would be less painful. However, such route demanded restriction of economic egoism on the part of the society. The social system that would take the role of such restricting executor was not yet built in the twenties.

Of course the given interpretation of events is only a hypothesis. But this hypothesis is in accord with the factual data, both in terms of quality and quantity. Now we proceed to the statistical verification of this hypothesis.

IV. Verification of hypothesis of hysteresis loops as applied to business cycles of Economic System.

The in-depth study of the factual data is beyond the frameworks of this article. So we shall cite just several results.

We have attempted to verify two statements: (1) hypothesis of evolution cycles as applied to *economic system,* and (2) hypothesis, which explains the Great Depression of 1930-ies as a result of sharp reduction of value z_0.

Hypothesis of evolution hysteresis cycles as applied to *economic system,* means:

(1) **Existence of jumps upward and downward in dynamics of a business cycle**. As we already mentioned (see part 2 of this paper), *Segment-by-Segment Average Rate of Change per Month in Reference Cycle* data prepared by **Wesley C. Mitchell** and represented in His book *"What Happens During Business Cycles"*, [19] confirm this property of hysteresis cycles (Diagram 2).

It is evident that sharp jumps from one evolution branch to another one must be shorter in general than the stages of continuous graduall evolution of a System along these branches. Consequently we can suppose that **duration of recession** (jump downward, 1→2) **and revival** (jump upward, 3→4), **less than duration of two other phases of business cycle:** depression **(**2→3) and prosperity (4→1). Mitchell' data (in particularly Diagram 2) confirm this property.

Yet in 1928, in His book *"Business Cycles. The Problems and Its Setting"*, **Wesley C. Mitchell** estimated the duration of the different phases of a business cycle as follows:

"…**The phases of recession and revival are relatively brief.** Put together, they account for only **one-quarter** of the duration of business cycles on the average. On the remaining three quarters, the **prosperous phase occupies a somewhat longer time, than the phase of depression.** But the ratio of months of prosperity to months of depression varies widely from country to country, and within any country it varies widely from cycle to cycle" [**18;** p.420].

Wesley Mitchell in this book refers to research of Willard L. Thorp, "Business Annals", 1926. Table 28 on page 408 contains figures based on Thorp' results. Relative duration of different phases of business cycles (as a percent of duration of a cycle) calculated on the basis of investigation of cycles in seventeen countries during 1890-1925 is equal: 39.3% - for prosperity phase, 23.9% - for both recession and revival phases and, 36.8% - for depression phase.

(2) The smaller fluctuations of quantities δz_0 and δz_1, the longer is hysteresis cycle. This prolongation of cycle takes place generally owing to prolongation of prosperous phase 4→1 since duration of the all other phases of hysteresis cycle is limited. Consequently we can suppose that **prosperous phase of typical business cycle (4→1) must be longer than depression phase of one (2→3) an average.** This conclusion is confirmed by researches of Willard L. Thorp and Wesley C. Mitchell (see last citation).

(3) The other very interesting result consists in **prolongation of depression phase** provided that the recession is accompanied by decreasing of value z_0 - the case analogous to the Great Depression of 1930's. It is evident that Great Depression is not only cycle in a history, which accompanied by sharp reduction of long-term capital coefficient, z_0. We can suppose that such cycles be among the long cycles. Consequently investigation of long cycles must reveal some prolongation of depression phase relatively of a prosperous phase.

Willard L. Thorp' investigation of long cycles, about which Wesley C. Mitchell mentions in His *"Business Cycles. The Problems and Its Setting"*, confirms this our supposition:

"Dr. Thorp", Wesley C. Mitchell writes, "has made a special examination of these long cycles… His results appear in Table 31… The average phase of depression in these long cycles is nearly a year longer than the average phase of prosperity" [**18**; p.411-412].

(4) Finally, let us mark yet one important property of hysteresis cycles with fluctuating limiting points. **Duration of hysteresis cycle is a random variable.** Consequently statistical analysis must give some frequency distribution function of durations of cycle. Wesley C. Mitchell in "Business Cycles" proved that such frequency distribution function exists actually. His Chart 24 illustrates this frequency distribution function by means of different selections of data. He supposed that it is lognormal distribution.

We resume. Wesley C. Mitchell' investigation of business cycles qualitatively confirms the hypothesis of hysteresis business cycles (that is identification of evolution hysteresis loops with business cycles).

Let us consider some quantitative results of Method of Systems Potential as applied to Economic System. Formulas (49) – (50) contain unknown constant, *Const* :

$$z = Const \cdot \frac{K}{C} = Const \cdot \frac{1}{1-\pi} \cdot \frac{K}{Y}. \qquad (49)$$

$$R = Const \cdot \frac{Y}{C} = Const \cdot \frac{1}{1-\pi}; \qquad (50)$$

$$\pi \equiv \frac{\Pi}{Y}. \qquad (40)$$

We supposed that Π is Profits after Taxes; K - is Employed Capital; Y - is the Gross National Product.

Four source of data were used:

1. *Summary National Income and Product Series: Annually, 1929-89* [27];

2. **Moore G. H., 1961,** *"Business Cycle Indicators"* [20];

3. **Kendrick J.W., 1961,** *"Productivity Trends in the United States"* [14]

4. **Solow, R.M., 1957**, *"Technical Change and production function"* [26].

Notes in our Tables 1-5 contain the all-necessary information with respect to sources of data and calculations. Data before 1929 in Table 1 was taken from Moore' manuscript [20]; data since 1928 in this Table – from Summary [27]. Productivity of Employed Capital in Nonfarm Industry was calculated on the basis of data from Solow' paper [26]. Table 1 contains the results of R and z calculations by means of the formulas (40), (49) and (50).

We supposed at first that $Const = 1$ (such supposition means that we do not take into account the presence of fluctuations) and calculated values, R and z. Regression analysis of these values on the basis of the theoretical formulas (15), (19) and (20) allows concluding that the following approximate equation takes place:

$$\chi \approx 0. \qquad (57)$$

It means that function $R(z)$ is a quasi-linear function (for each branch of this function), which consists of two linear segments:

$$z = z_0 + \tilde{C}^{(+)} \cdot (1 - R); \qquad \tilde{C}^{(+)} = C^{(+)} - z_0; \qquad \text{subject to } z > z_0; \qquad (27)$$

$$z = z_0 - \tilde{C}^{(-)} \cdot (1 - R); \qquad \tilde{C}^{(-)} = C^{(-)} + z_0; \qquad \text{subject to } z < z_0. \qquad (26)$$

Diagram 1 illustrates linearity of the function $R(z)$ within interval of z, which corresponds to period 1933-1941. The Linear Regression of these data, except for 1938, confirms with high extent of probability the assumption of linearity of function $R(z)$ ($R^{*2} \approx 0.98 \div 0.99$).

We used long-term average values of Depreciation Rate, Rate of Investment and Rate of Growth calculated on the basis of Kendrick' data (Tables 2 and 4) as statistical indexes of parameters of Economic System Λ, ν and a respectively. Since according to (57), $\Lambda \approx d$; we can find the *Const* by means of linear regression of data $\frac{C}{Y}(t)$ on the basis the following formula:

$$\frac{C}{Y} = 1 - \pi = Const + b \cdot Const \cdot e^{-(a+\Lambda)\cdot t}. \qquad (58)$$

Average value $a+\Lambda$ within interval 1933-1941, except for 1938, is equal to ≈ 0.1 (Table 4). Least-squares estimator of parameters of function (58) gives the following value:

$$Const \approx 0.863 . \qquad (59)$$

Table 1 contains values calculated on the basis of this value of the constant, $Const$. Diagram 1 confirms hypothesis, which explains the Great Depression as result of reduction of value z_0. The period 1922-29 corresponds to evolution of Economic System along the top evolution branch. In the period of crisis, 1929-33 a drop of the system to the lower branch takes place. This falling is accompanied by the left-shift of the point z_0. The further evolution of the system takes place along the lower evolutional branch, 1933-41. Consequently *hypothesis of long-term capital coefficient left-shift is confirmed.*

We verified also the theoretical formula (53), which we can rewrite as follows:

$$z_0\big|_{theor.} = \left.\frac{K}{Y}\right|_0 = \frac{\nu}{a+\Lambda} . \qquad (60)$$

Table1 and Diagram 1 indicate the sharp reduction of long-term capital coefficient, z_0 from value $z_0\big|_{\text{before 1929}} \approx 3.3$ to value $z_0\big|_{\text{since 1929}} \approx 2$.

Formula (60) gives us the following values:

$z_0\big|_{1909-1928} \approx 3.2$, $\qquad z_0\big|_{1933-1948} \approx 1.8$. (See Tables 2 and 4).

Finally let us show that theoretical formula (29) corresponds to the factual data also. The duration of phase of growth of quantity $R(t)$ from lower turn point, R_2, to the top turn point, R_1, is equal:

$$T_{2\to3\to4\to1} \approx \frac{1}{a+d} \cdot Ln\left(\frac{\frac{1}{R_2}-1}{\frac{1}{R_1}-1}\right). \qquad (61)$$

Denotations in this formula correspond to denotations in the Figure 1. Diagram 1 and Table 1 allow considering two such phases of growth: 1922-29 and 1933-41. Since $d \approx \Lambda$ we can verify the formula (61) using the average values within these intervals except last year (Tables 1, 2 and 4).

$a+\Lambda\big|_{1922-29} \approx 0.0784$; $\qquad R(1922) \approx 0.902$; $\qquad R(1929) \approx 0.941$;

$$T_{1922-29} = \left.\frac{1}{a+\Lambda}\right|_{1922-29} \cdot Ln\left(\frac{\frac{1}{R(1922)}-1}{\frac{1}{R(1929)}-1}\right) \approx 7.04 .$$

$a+\Lambda\big|_{1933-41} \approx 0.1107$; $\qquad R(1933) \approx 0.869$; $\qquad R(1941) \approx 0.940$;

$$T_{1933-41} = \left.\frac{1}{a+\Lambda}\right|_{1933-41} \cdot Ln\left(\frac{\frac{1}{R(1933)}-1}{\frac{1}{R(1941)}-1}\right) \approx 7.77 .$$

Factual values of duration are equal ≈ 7.75 and ≈ 8 years respectively. This result can be interpreted as yet one confirmation of Method of Systems Potential.

Table 3 contains the results of calculation of factor-price of the Capital in nonfarm industry by means of the following formula:

$$r = \frac{Const \cdot \frac{y}{R} - w}{k}; \qquad (62)$$

where w is wage rate, $k = \frac{K}{L}$; and $y = \frac{Y}{L}$.

Well-known that sum of Depreciation Rate and Interest Rate is the lower limit of cost of the capital. Factor-price of the capital (= cost of the capital) approaches to this level on the eve of a crisis. Comparison of columns (12) and (13) in Table 3 during 1922-29 years confirms this theoretical conclusion of economic theory.

V. Conclusion.

We have considered only the simplest option of application of the Method of System Potential with respect to the economy.

Connecting efficiency of economic system and net profits, we simplified the real situation. However, this simplification is justified if we talk of economy in which decision-making depends primarily on the value of net profit of the enterprise. It is surprising that even such a simplified model allows us to essentially advance our understanding of the economic system work.

The hysteresis cycles are a method of qualitative refreshment of the system. The renewal of economy after each crisis is a well-established fact.

As applied to *social systems,* the cyclic dynamics is known as a theory of social metamorphoses, according to which the forms of ownership and institutes of administration in the society vary from time to time significantly. The very change lies in a global social reform that under certain circumstances may develop into a social revolution. Marx, one of the founders of the theory of social metamorphoses, was sceptical towards the ideas of reforming. He believed that the contradiction between the “productive forces” and “productive relations” underlying the crisis of the old management system could be solved only through a social revolution. He compared the revolution to child-delivery in the course of which a new social organism emerges. And though, by Hegel’s keen remark, the “experience and history teaches that nations and governments had taught nothing” [12], the lessons of social revolutions at least make people aware of the fact that the peaceful settlement of a conflict is always more preferable than war.

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Figures

Figure 1. Realization Ratio, $R(z)$ and Evolution Cycle.

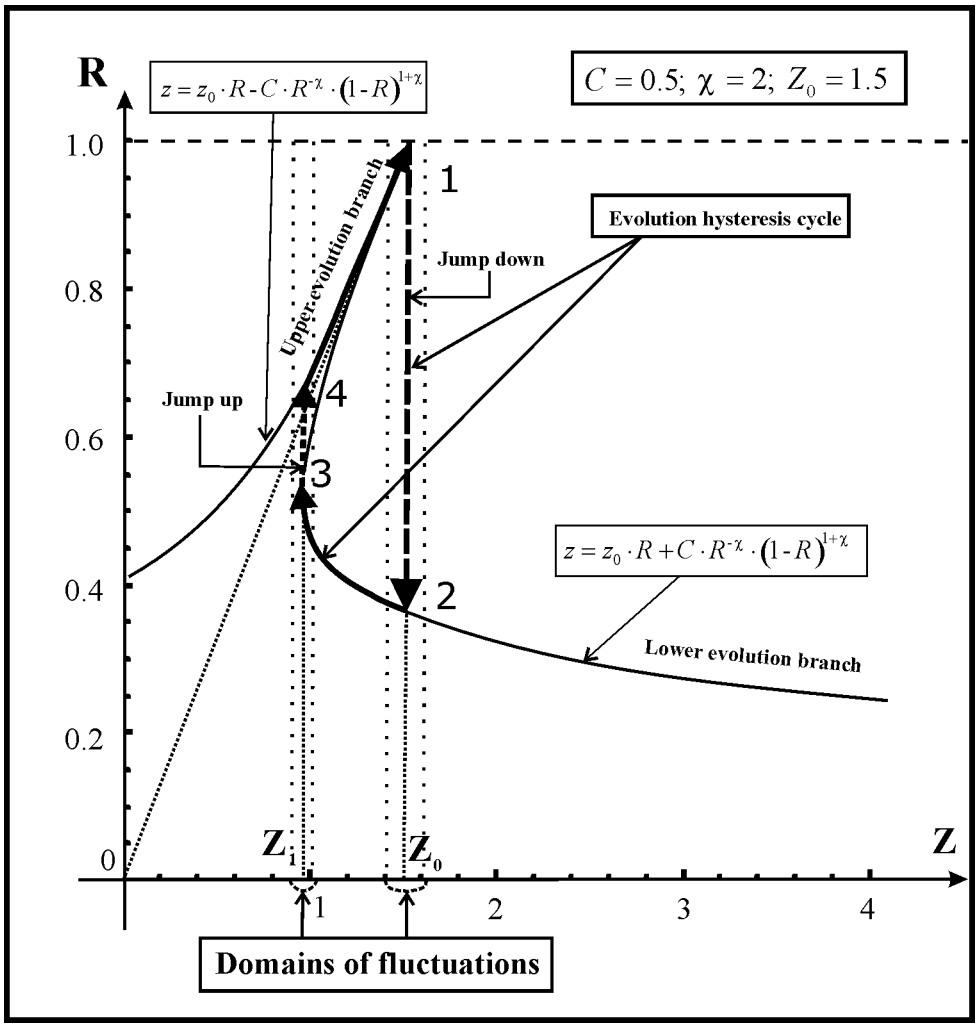


Figure 2. The Great Depression as catastrophe of Economic System and left-shift of the capital coefficient, z_0.

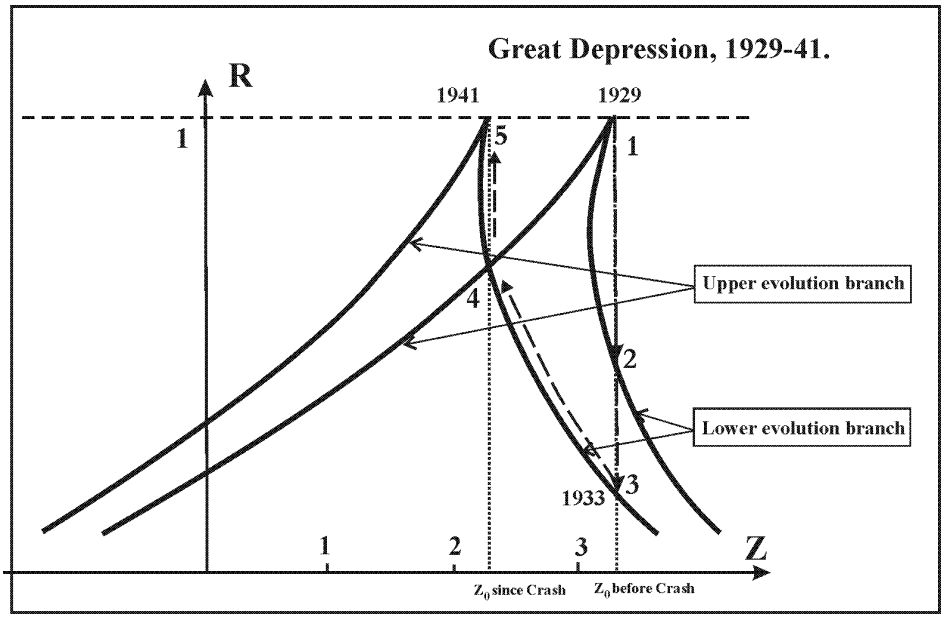


Figure 3. The Surface of Evolution Catastrophe, $R(z,\chi)$: $z = z_0 \cdot R \pm C \cdot R^{-\chi} \cdot (1-R)^{1+\chi}$

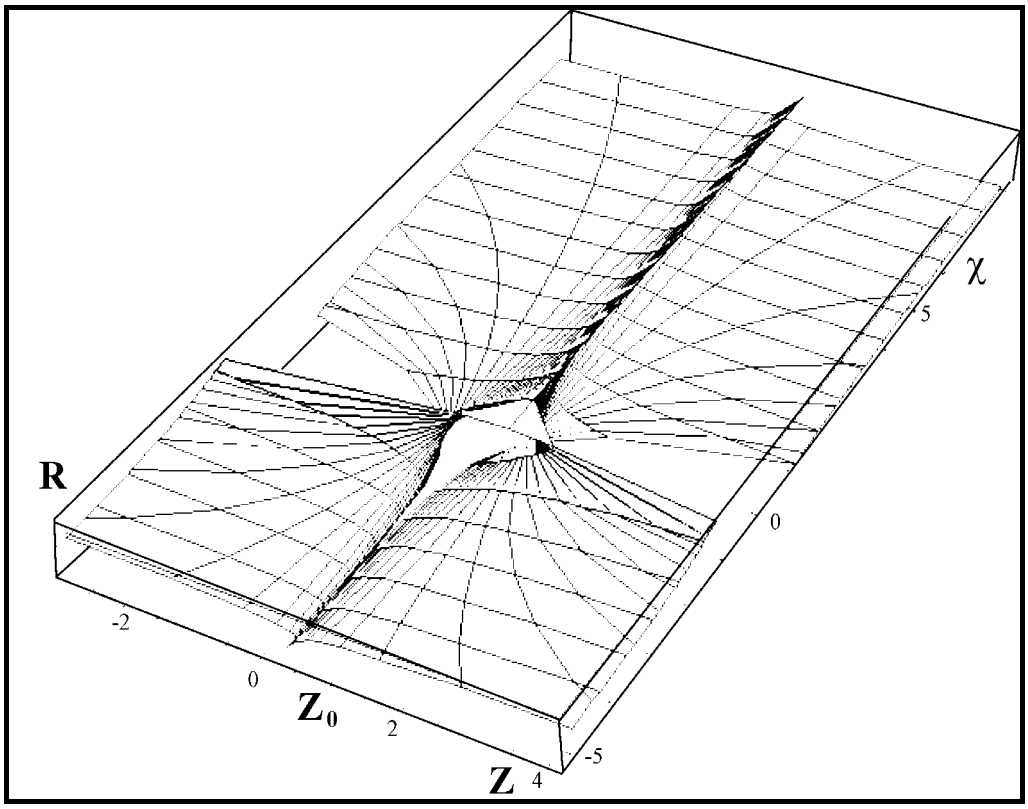


Figure 4. The Surface of Evolution Catastrophe for $z_0 = 1$, $C = 0.3$;

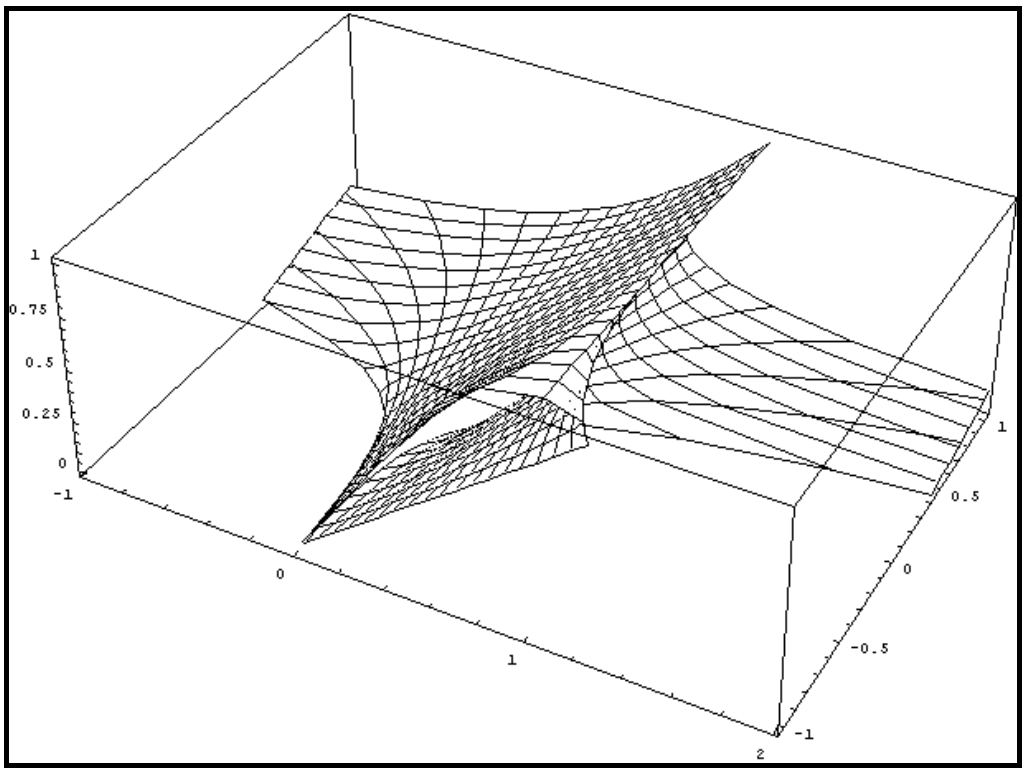
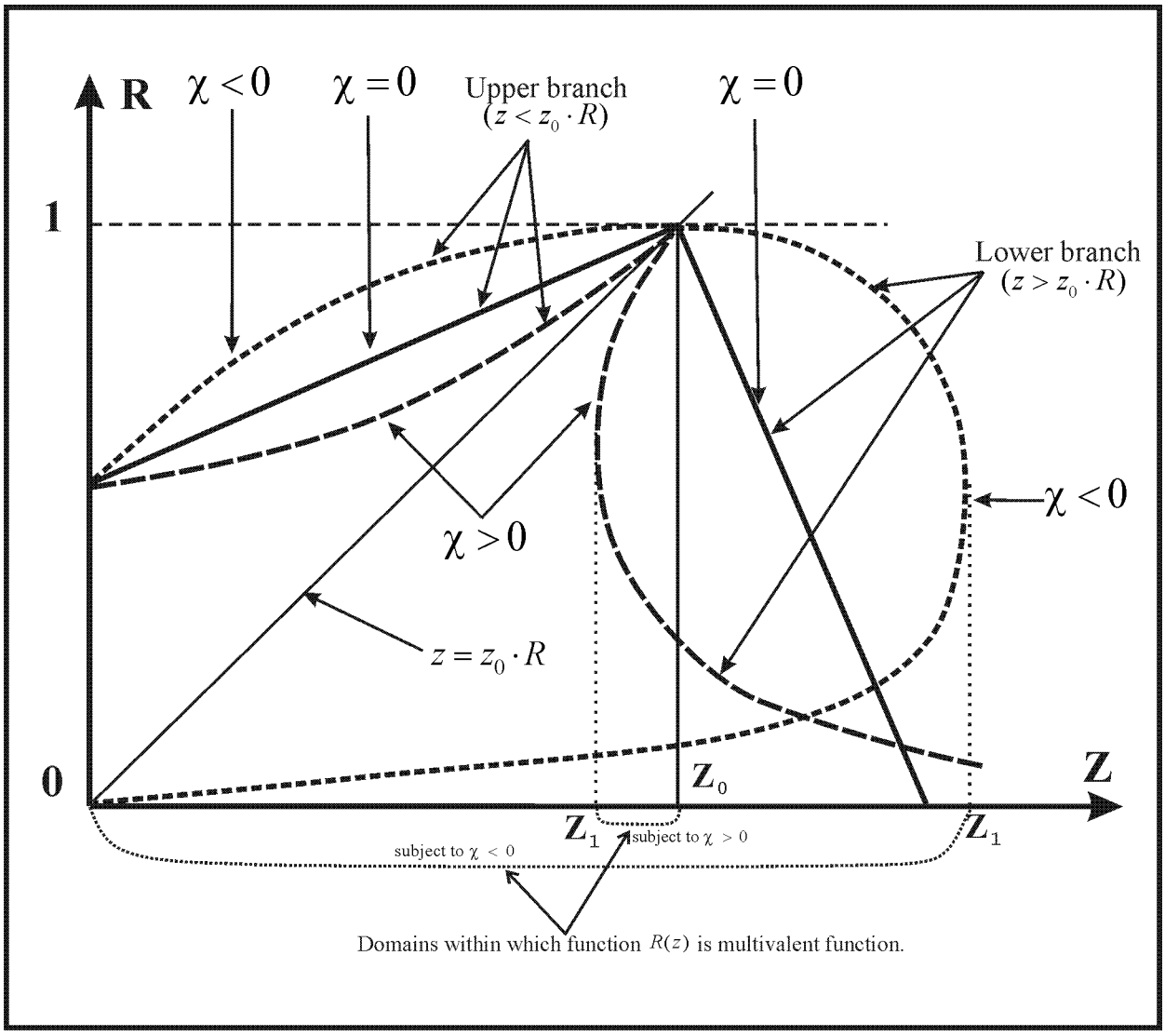


Figure 5. Realization ratio $R(z)$: $z = z_0 \cdot R \pm C \cdot R^{-\chi} \cdot (1-R)^{1+\chi}$ for different χ.



Diagrams.

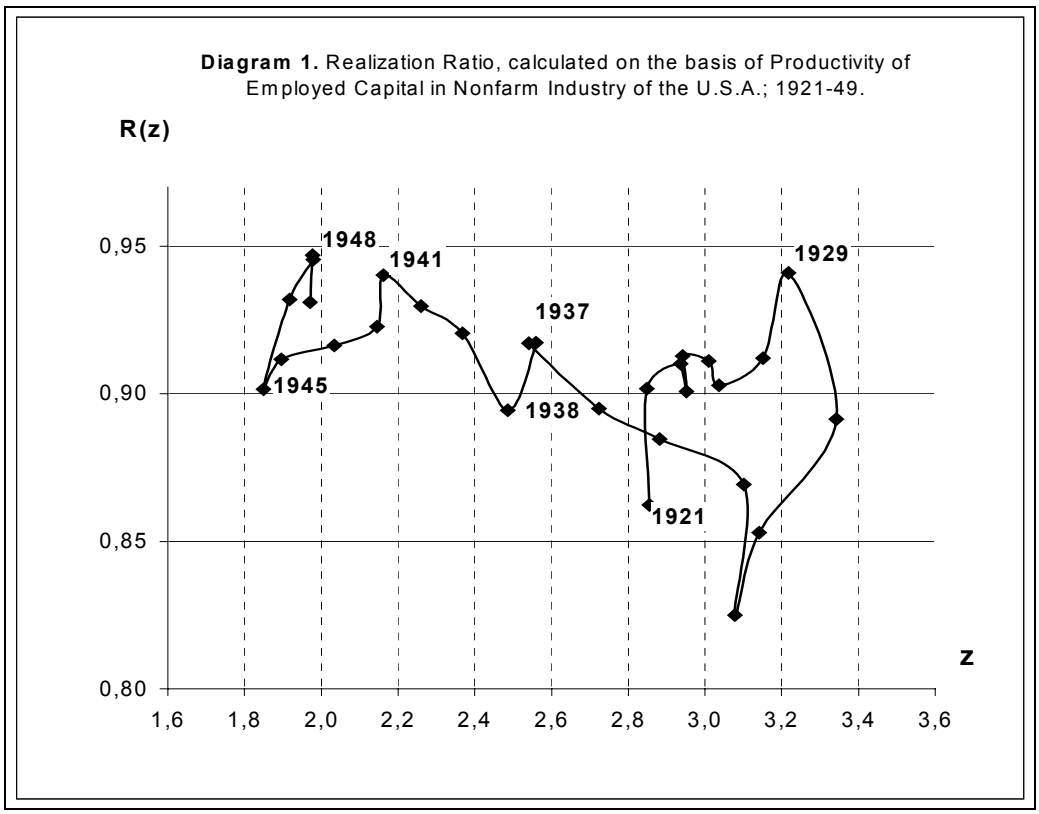


Diagram 1. Realization Ratio, calculated on the basis of Productivity of Employed Capital in Nonfarm Industry of the U.S.A.; 1921-49.
R(z)
0,95
0,90
0,85
0,80
1948
1941
1929
1937
1945
1938
1921
z
1,6
1,8
2,0
2,2
2,4
2,6
2,8
3,0
3,2
3,4
3,6

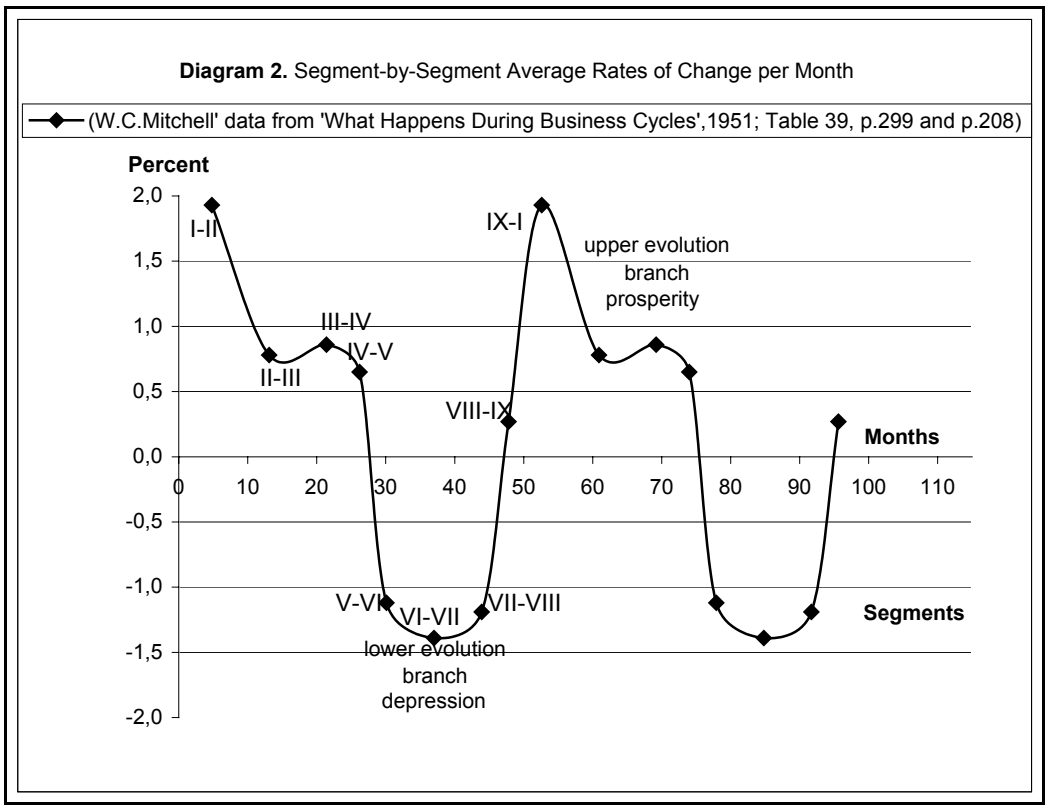


Diagram 2. Segment-by-Segment Average Rates of Change per Month
(W.C.Mitchell' data from 'What Happens During Business Cycles',1951; Table 39, p.299 and p.208)
Percent
2,0
1,5
1,0
0,5
0,0
-0,5
-1,0
-1,5
-2,0
I-II
II-III
III-IV
IV-V
V-VI
VI-VII
VII-VIII
VIII-IX
IX-I
upper evolution branch prosperity
lower evolution branch depression
Months
Segments
0
10
20
30
40
50
60
70
80
90
100
110

Tables.

Table 1. Realization Ratio, calculated on the basis of Productivity of Employed Capital in Nonfarm Industry; 1921-49.

(Gross National Product and Profits are given in billions of current dollars).

Year	Output; GNP, Y	Profits after Taxes, П	Costs, C	Profits/Output Ratio	Output/Costs Ratio	Realization Ratio = Const * Output/Costs, R	Productivity of Employed Capital in Nonfarm Industry	Conditions/Potential Ratio, (K/C)*Const
	Current dollars					**R**	**Y/K**	**Z = R/ (Y/K)**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Source or Calculation:	[20], [27]	[20], [27]	**Y-П**	**П/Y**	**Y/C**	**Y/C * Const**	From Table 3.	(7):(8)
	Current dollars					**Const = 0.863**		**Const = 0.863**
1921	67,48	-0,060	67,54	-0,0009	0,999	0,862	0,302	2,855
1922	69,46	2,977	66,48	0,0429	1,045	0,902	0,316	2,849
1923	81,32	4,213	77,11	0,0518	1,055	0,910	0,310	2,936
1924	83,35	3,492	79,86	0,0419	1,044	0,901	0,305	2,952
1925	89,40	4,872	84,53	0,0545	1,058	0,913	0,310	2,941
1926	94,39	4,990	89,40	0,0529	1,056	0,911	0,303	3,009
1927	93,60	4,120	89,48	0,0440	1,046	0,903	0,297	3,037
1928	97,82	5,258	92,56	0,0538	1,057	0,912	0,289	3,151
1929	103,90	8,60	95,30	**0,0828**	**1,090**	**0,941**	0,292	**3,217**
1930	91,10	2,90	88,20	0,0318	1,033	0,891	0,267	3,343
1931	76,40	-0,90	77,30	-0,0118	0,988	0,853	0,271	3,142
1932	58,50	-2,70	61,20	-0,0462	0,956	0,825	0,268	3,078
1933	56,00	0,40	55,60	0,0071	1,007	0,869	0,280	3,101
1934	65,60	1,60	64,00	0,0244	1,025	0,885	0,307	2,881
1935	72,80	2,60	70,20	0,0357	1,037	0,895	0,329	2,724
1936	83,10	4,90	78,20	0,0590	1,063	0,917	0,361	2,540
1937	91,30	5,40	85,90	0,0591	1,063	0,917	0,358	2,560
1938	85,40	3,00	82,40	0,0351	1,036	0,894	0,360	2,486
1939	91,30	5,70	85,60	0,0624	1,067	0,920	0,389	2,368
1940	100,40	7,20	93,20	0,0717	1,077	0,930	0,411	2,260
1941	125,50	10,30	115,20	**0,0821**	1,089	**0,940**	0,435	**2,162**
1942	159,00	10,30	148,70	0,0648	1,069	0,923	0,430	2,144
1943	192,70	11,20	181,50	0,0581	1,062	0,916	0,450	2,034
1944	211,40	11,30	200,10	0,0535	1,056	0,912	0,481	1,896
1945	213,40	9,10	204,30	0,0426	1,045	0,901	0,487	1,850
1946	212,40	15,70	196,70	0,0739	1,080	0,932	0,486	1,917
1947	235,20	20,50	214,70	0,0872	1,095	0,945	0,478	1,979
1948	261,60	23,20	238,40	**0,0887**	**1,097**	**0,947**	0,479	**1,978**
1949	260,40	19,00	241,40	0,0730	1,079	0,931	0,472	1,971

Notes: (2) - Gross National Product for 1921-28 from Moore [20], Table 16.1, p.133; for 1929-49 from Summary [27], p.20;

(3) - Profits After Taxes for 1921-28 from Moore [20], Table 9.1, p.106; for 1929-49 - from Summary [27]; p.26;

(7) - **Const** is found by linear regression on the basis of formula: C/Y = **Const** + b*__Const__ * Exp [-0.1 * t]; See Text.

(8) - Productivity of Employed Capital in Nonfarm Industry calculated from Solow [26];

Table 2. Depreciation Rate, Rate of Investment; and Rate of Growth of Output in Economy of the U.S.A., 1909-49.

(Gross National Product, Investment, Capital Consumption Allowances and Real Capital Stock are given in billions of 1929 dollars.

Adjusted Kuznets' Concepts from Kendrick' manuscript [14]).

Year	Output, GNP	Rate of Growth	Gross Domestic Investment, GDI			Capital Consumption Allowances	Real Capital Stock in Domestic Economy	Depreciation Rate	Rate of Investment
			Total	New Construction and Equipment	Change in Business Inventories				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	[14]	From (2)	(5) + (6)	[14]	[14]	[14]	[14]	(7): (8)	(4): (2)
1909	53,615	0,012	12,624	11,229	1,395	5,920	221,809	0,0267	0,2355
1910	54,263	0,020	12,470	11,595	0,875	6,158	228,359	0,0270	0,2298
1911	55,341	0,051	11,206	10,500	0,706	6,403	235,136	0,0272	0,2025
1912	58,171	0,046	12,900	11,741	1,159	6,637	240,387	0,0276	0,2218
1913	60,828	-0,083	13,842	12,684	1,158	6,886	247,125	0,0279	0,2276
1914	55,755	0,030	9,813	9,786	0,027	7,109	253,657	0,0280	0,1760
1915	57,434	0,155	9,635	9,406	0,229	7,285	259,727	0,0280	0,1678
1916	66,356	-0,025	12,893	11,226	1,667	7,489	264,460	0,0283	0,1943
1917	64,692	-0,016	11,914	11,428	0,486	7,754	269,779	0,0287	0,1842
1918	63,640	0,104	11,994	11,465	0,529	8,019	274,337	0,0292	0,1885
1919	70,271	0,016	14,614	11,749	2,865	8,650	278,121	0,0311	0,2080
1920	71,383	-0,042	15,039	10,726	4,313	8,603	282,540	0,0304	0,2107
1921	68,355	0,070	9,769	9,891	-0,122	8,183	286,280	0,0286	0,1429
1922	73,150	0,135	13,197	12,944	0,253	8,663	290,436	0,0298	0,1804
1923	82,994	0,027	18,210	15,435	2,775	8,905	298,526	0,0298	0,2194
1924	85,222	0,025	15,209	16,193	-0,984	9,043	308,547	0,0293	0,1785
1925	87,359	0,070	19,624	18,022	1,602	9,407	319,226	0,0295	0,2246
1926	93,438	0,008	20,469	19,312	1,157	10,086	332,064	0,0304	0,2191
1927	94,161	0,017	19,163	18,785	0,378	10,163	344,133	0,0295	0,2035
1928	95,715	0,060	18,346	18,763	-0,417	10,592	354,809	0,0299	0,1917
1929	101,444	-0,098	20,352	18,678	1,674	10,994	365,089	0,0301	0,2006
1930	91,513	-0,079	14,870	15,428	-0,558	10,902	373,097	0,0292	0,1625
1931	84,300	-0,162	10,862	11,579	-0,717	10,662	376,298	0,0283	0,1288
1932	70,682	-0,033	4,050	7,318	-3,268	10,246	373,175	0,0275	0,0573
1933	68,337	0,092	3,022	6,370	-3,348	9,960	365,427	0,0273	0,0442
1934	74,609	0,150	5,306	8,096	-2,790	9,995	358,425	0,0279	0,0711
1935	85,806	0,116	12,432	9,881	2,551	10,188	356,808	0,0286	0,1449
1936	95,798	0,085	14,840	14,123	0,717	10,563	358,540	0,0295	0,1549
1937	103,917	-0,070	19,261	14,717	4,544	10,884	364,078	0,0299	0,1853
1938	96,670	0,073	12,006	12,963	-0,957	10,923	368,057	0,0297	0,1242
1939	103,736	0,089	15,426	14,788	0,638	11,086	370,930	0,0299	0,1487
1940	112,961	0,118	19,310	16,201	3,109	11,401	379,162	0,0301	0,1709
1941	126,237	-0,029	26,826	21,007	5,819	12,457	389,744	0,0320	0,2125
1942	122,571	-0,005	26,548	24,157	2,391	13,934	396,616	0,0351	0,2166
1943	121,918	0,039	25,049	26,006	-0,957	14,785	396,195	0,0373	0,2055
1944	126,633	0,028	26,077	27,113	-1,036	15,907	391,997	0,0406	0,2059
1945	130,218	0,166	22,256	23,531	-1,275	16,217	387,229	0,0419	0,1709
1946	151,895	0,011	25,923	19,705	6,218	14,658	390,267	0,0376	0,1707
1947	153,515	0,035	22,321	23,118	-0,797	16,558	400,991	0,0413	0,1454
1948	158,828	-0,031	29,944	25,879	4,065	18,012	415,492	0,0434	0,1885
1949	153,970		22,877	25,667	-2,790	19,014	430,424	0,0442	0,1486

Notes: (2) - Gross National Product and (7) - Capital Consumption Allowances from Table A-I, p. 290-92;

(5) and (6) - Investment from Table A-IIa, p.293-95;

(8) – Real Capital Stock from Table A-XV; p.320-322.

Table 3. Productivity of the Capital and Factor-price of the Capital in Nonfarm Industry, calculated on the basis of Solow' data [26]; 1909-49.

Year	% labor force employed, **f**	Share of property in income, **v**	Private nonfarm GNP per man-hour, **y**	Wage Rate, **w**	Employed capital per man-hour, **ke**	Productivity of Employed Capital, **pec**	Capital stock per man-hour, **ks**	Realization Ratio	Factor-price of the Capital	Depreciation Rate, **DR**	Factor-price of the Capital minus Depreciation Rate	Interest Rate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Source or Calculation:	[26]	[26]	[26]	**w = y * (1 - v)**	[26]	**pec = y/ke**	**ks = ke * 100/f**	From Table 1.	**r = (0.863 * y/R - w)/ke**	From Table 2	**(10) - (11)**	From Moore [20]; Tables 25.0 and 26.0
1909	91,1	0,335	0,623	0,414	2,06	0,302	2,26			0,0267		
1910	92,8	0,330	0,616	0,413	2,10	0,293	2,26			0,0270		
1911	90,6	0,335	0,647	0,430	2,17	0,298	2,40			0,0272		
1912	93,0	0,330	0,652	0,437	2,21	0,295	2,38			0,0276		
1913	91,8	0,334	0,680	0,453	2,23	0,305	2,43			0,0279		
1914	83,6	0,325	0,682	0,460	2,20	0,310	2,63			0,0280		
1915	84,5	0,344	0,669	0,439	2,26	0,296	2,67			0,0280		
1916	93,7	0,358	0,700	0,449	2,34	0,299	2,50			0,0283		
1917	94,0	0,370	0,679	0,428	2,21	0,307	2,35			0,0287		
1918	94,5	0,342	0,729	0,480	2,22	0,328	2,35			0,0292		
1919	93,1	0,354	0,767	0,495	2,47	0,311	2,65			0,0311		
1920	92,8	0,319	0,721	0,491	2,58	0,279	2,78			0,0304		
1921	76,9	0,369	0,770	0,486	2,55	0,302	3,32	0,862	0,112	0,0286	0,083	0,067
1922	81,7	0,339	0,788	0,521	2,49	0,316	3,05	0,902	0,094	0,0298	0,064	0,055
1923	92,1	0,337	0,809	0,536	2,61	0,310	2,83	0,910	0,088	0,0298	0,059	0,055
1924	88,0	0,330	0,836	0,560	2,74	0,305	3,11	0,901	0,088	0,0293	0,059	0,051
1925	91,1	0,336	0,872	0,579	2,81	0,310	3,08	0,913	0,087	0,0295	0,058	0,050
1926	92,5	0,327	0,869	0,585	2,87	0,303	3,10	0,911	0,083	0,0304	0,053	0,051
1927	90,0	0,323	0,871	0,590	2,93	0,297	3,26	0,903	0,083	0,0295	0,053	0,050
1928	90,0	0,338	0,874	0,579	3,02	0,289	3,36	0,912	0,082	0,0299	0,052	0,054
1929	92,5	0,332	0,895	0,598	3,06	0,292	3,31	0,941	0,073	0,0301	0,043	0,060
1930	88,1	0,347	0,880	0,575	3,30	0,267	3,75	0,891	0,084	0,0292	0,055	0,051
1931	78,2	0,325	0,904	0,610	3,33	0,271	4,26	0,853	0,091	0,0283	0,063	0,047
1932	67,9	0,397	0,879	0,530	3,28	0,268	4,83	0,825	0,119	0,0275	0,091	0,050
1933	66,5	0,362	0,869	0,554	3,10	0,280	4,66	0,869	0,099	0,0273	0,072	0,048
1934	70,9	0,355	0,921	0,594	3,00	0,307	4,23	0,885	0,101	0,0279	0,074	0,042
1935	73,0	0,351	0,943	0,612	2,87	0,329	3,93	0,895	0,104	0,0286	0,075	0,037
1936	77,3	0,357	0,982	0,631	2,72	0,361	3,52	0,917	0,108	0,0295	0,078	0,034
1937	81,0	0,340	0,971	0,641	2,71	0,358	3,35	0,917	0,101	0,0299	0,071	0,033
1938	74,7	0,331	1,000	0,669	2,78	0,360	3,72	0,894	0,106	0,0297	0,077	0,032
1939	77,2	0,347	1,034	0,675	2,66	0,389	3,45	0,920	0,111	0,0299	0,081	0,021
1940	80,6	0,357	1,082	0,696	2,63	0,411	3,26	0,930	0,117	0,0301	0,087	0,021
1941	86,8	0,377	1,122	0,699	2,58	0,435	2,97	0,940	0,128	0,0320	0,096	0,020
1942	93,6	0,356	1,136	0,732	2,64	0,430	2,82	0,923	0,125	0,0351	0,090	0,022
1943	97,4	0,342	1,180	0,776	2,62	0,450	2,69	0,916	0,128	0,0373	0,091	0,026
1944	98,4	0,332	1,265	0,845	2,63	0,481	2,67	0,912	0,134	0,0406	0,093	0,025
1945	96,5	0,314	1,296	0,889	2,66	0,487	2,76	0,901	0,132	0,0419	0,090	0,022
1946	94,8	0,312	1,215	0,836	2,50	0,486	2,64	0,932	0,116	0,0376	0,078	0,021
1947	95,4	0,327	1,194	0,804	2,50	0,478	2,62	0,945	0,115	0,0413	0,073	0,021
1948	95,7	0,332	1,221	0,816	2,55	0,479	2,66	0,947	0,117	0,0434	0,073	0,025
1949	93,0	0,326	1,275	0,859	2,70	0,472	2,90	0,931	0,119	0,0442	0,075	0,027

Table 4. Long-term values of parameters of Economic System, calculated on the basis of Kendrick' data [14].

(See Table 2)

Number of Period	Period	Rate of Growth	Propensity to Investment	Depreciation Rate	Sum of Depreciation Rate and Rate of Growth	$z_0 = \frac{\nu}{a+\Lambda}$
		a	ν	Λ	$a+\Lambda$	
1	Average, 1909-22	0,0337	0,1978	0,0285	0,0622	3,1818
2	Average, 1909-23	0,0332	0,1993	0,0286	0,0618	3,2239
3	Average, 1909-24	0,0327	0,1980	0,0286	0,0613	3,2271
4	Average, 1909-25	0,0349	0,1995	0,0287	0,0636	3,1392
5	Average, 1909-26	0,0334	0,2006	0,0288	0,0622	3,2281
6	Average, 1909-27	0,0325	0,2008	0,0288	0,0613	3,2752
7	Average, 1909-28	0,0339	0,2003	0,0289	0,0627	3,1938
	Average for 1-7 periods:	**0,0335**	**0,1995**	**0,0287**	**0,0622**	**3,2099**
1	Average, 1933-34	0,1209	0,0577	0,0276	0,1485	0,3884
2	Average, 1933-35	0,1194	0,0867	0,0279	0,1473	0,5887
3	Average, 1933-36	0,1108	0,1038	0,0283	0,1391	0,7464
4	Average, 1933-37	0,0747	0,1201	0,0286	0,1033	1,1629
5	Average, 1933-38	0,0744	0,1208	0,0288	0,1032	1,1705
6	Average, 1933-39	0,0765	0,1248	0,0289	0,1054	1,1835
7	Average, 1933-40	0,0816	0,1305	0,0291	0,1107	1,1793
8	Average, 1933-41	0,0693	0,1396	0,0294	0,0987	1,4146
9	Average, 1933-42	0,0618	0,1473	0,0300	0,0918	1,6046
10	Average, 1933-43	0,0597	0,1526	0,0306	0,0904	1,6886
11	Average, 1933-44	0,0571	0,1571	0,0315	0,0886	1,7728
12	Average, 1933-45	0,0655	0,1581	0,0323	0,0978	1,6168
13	Average, 1933-46	0,0616	0,1590	0,0327	0,0943	1,6870
14	Average, 1933-47	0,0598	0,1581	0,0332	0,0930	1,6994
15	Average, 1933-48	0,0542	0,1600	0,0339	0,0880	1,8179
	Average for 13-15 periods:	**0,0585**	**0,1591**	**0,0332**	**0,0918**	**1,7348**

Sources: **[14]** - **Kendrick, J.W.; 1961, "Productivity Trends in the United States"**, The Nat. Bureau of Econ. Res.; General Series, No.71, Princeton;

[20] - **Moore, Geoffrey H.; 1961, "Business Cycle Indicators",** The Nat. Bureau of Econ. Res.; Studies in Business Cycles, No.11, Princeton;

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