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ECOLOGICAL AND SOCIAL EFFICIENCY: FUNCTIONS OF AGENTS' BEHAVIOUR

Summary. The problem of social and ecological efficiency correlation is considered in the paper. The device describing "ecological" efficiency of various systems, such as macroeconomics, a firm or any system from the point of view of economic theory is worked out. It is shown how ecological efficiency and the problem of market economy regulation, external effects in particular, correlate. The author introduces correlations which allow defining ecological efficiency and ecological programs costs quantitatively. Besides, the basic idea is that modern economic theory does not consider ecological development problems as an integral condition of economic growth. The classical theoretical paradigm describing the issues of ecological and social efficiency separately demands changes including aspects of interconnection between these types of efficiency that is shown in the paper.

Keywords: ecological efficiency, social efficiency, externality, ecological programs costs, function of health reserve and agents' qualification
JEL: D01, D61, D 62, Q57.

1. Social and Ecological Efficiency

Social efficiency requires multicriterion estimation. It concerns the problems of quantitative measuring of living standard and availability of the major social functions for various population levels, allocation of resources and incomes and quality assessment. Comparison of "life burden" in different countries is very important here. It matters at social conditions estimation of certain economic system development and it affects social satisfaction of economic agents. The so-called economic and "ecological" efficiencies are important parameters here. And "ecological" efficiency or efficiency of agents' "ecological" behaviors is undoubtedly a component of economic efficiency. Modern economic theories, especially "mainstream", neglect this concept and consider it as the aspect reducing economic efficiency. "Ecological" effects are often presented as externalities or negative externalities. Thus, the following variants of the problem solution are suggested: either A.Pigu's tax eliminating the consequences of negative externality, or the market of pollution rights sale according to R. Coase, or joint use of public resource according to vague enough approach of E.Ostrom. Let's logically consider the problem of general economic efficiency and discuss the problem of ecological efficiency separately. [3].

Economic efficiency is a complex (integrated) estimation of development (functioning) success of economic system of any level and is defined by a set of quantitative and qualitative indicators. (It assumes the use of commercial, budgetary, social, technological, industrial and other kinds of efficiency).

Thereby economic efficiency is a certain aggregated indicator. Hence, there are two possible ways of defining such efficiency, deep down. Either it is necessary to designate efficiency integrated criterion and to solve the search problem of this criterion optimum, for example, with the use of numerical methods (optimization methods). Or it is necessary to single out some kinds of efficiency, that is, private criteria, and to calculate each criterion in a simpler way. However, then it will be necessary somehow to consider the importance of each criterion and its contribution to the system's general efficiency. This contribution may be positive and negative. However, the major difficulty is to define the quantity of criteria and evaluate their importance, contribution and the sign. As a result, the search problem of system's economic efficiency is reduced to the following mathematical task:

1. $E = E_s / Z \rightarrow \max$, where E - of economic system efficiency, E_s - economic effect, Z - system functioning costs. Certainly, the efficiency maximum is reached at minimum costs and maximum effect.

2. $E = \sum_{i=1}^{n} K_i q_i \rightarrow \max$, where E - economic system efficiency, K_i - efficiency criterion of i^{th} efficiency kind (factor), q_i – importance of efficiency criterion at general efficiency estimation.

The problem of extremum defining can be solved in case of efficiency criteria (kinds) independence and in case when they are dependent. Using empirical material it is possible to define the function of such dependence and examine it on the extremum. However, it is important to notice, that efficiency maximum for economic system can be achieved, but only not for the account of degradation of separate system's elements. In other words, we come to some axioms which are important in the efficiency theory and which are necessary to take into consideration analyzing functioning efficiency of complex systems and comparing the development results of such systems. Let's formulate the basic axioms of the efficiency theory. These axioms are also important at efficiency estimation of "ecological" behaviour.

Axiom №1. Efficiency of economic system is not equal to the sum of efficiencies of the elements making it. The system effectiveness may be more or less than the total efficiency of system's elements.

Axiom № 2. If all the elements of the system are inefficient, the system cannot be effective.

Axiom №3. If all the elements of the system are effective, then, under certain conditions, the system may be inefficient (for example, one of workshops with general efficiency of its work lag behind high efficiency of others, so general assembly and equipment fitting become inefficient).

Axiom №4. Efficiency cannot be increased considerably in a short period of time, if special factors and conditions allowing it to do, do not work. However, other things being equal, it is impossible to increase efficiency in a short run without changes of qualitative correlation of system's elements.

Axiom №5. Efficiency can be quickly reduced because of any errors or fast change of the situation in the system or its environment.

Axiom №6. If an element of the system is inefficient, it does not mean that the system as a whole is inefficient. The system can be effective when one or several elements are inefficient (one or two centres of profit are unprofitable, but their activity is compensated by profitability of other profit centres of a corporation).

Axiom № 7. Efficiency of various system elements can be connected, and each pair of elements may have special characteristic of interconnection. Therefore, it is impossible either to sum up, or to multiply efficiency of various system elements for defining general efficiency, if only it is a private simplified (training) case where such operations are acceptable.

Axiom №8. Economic system can be effective, but unreliable.

Axiom №9. Economic system can be effective, but unstable.

Axiom №10. Economic system with any efficiency can be reliable and unstable and, vice versa, it can be steady, but unreliable.

Axiom № 11. Inefficient economic system can be reliable and/or steady. It makes great difference, that reliability potential of such system is quickly reduced, but it can be steady long enough (the existence effect of inefficient institutional systems and structures is a good example).

Axiom №12. It is possible to consider the state when economic system is effective, steady and reliable to be the property of system optimality (global system optimum).

Axiom №13. The state of the system characterized by inefficiency, unreliability and instability is the property of its nonoptimality (dysfunction peak).

Efficiency estimation of economic policy and administrative decisions is, certainly, a special problem.

Within the framework of economic science a great number of aggregated efficiency indicators has been developed for specific systems. Sensitivity coefficient λ (elasticity coefficient) can be one of such indicators which is applicable in different variants and with reference to different objects. It is a relation of relative increment of the basic indicator to a relative increment of an unknown indicator, provided that there is a relationship between these indicators.

$$\lambda = \frac{\Delta Fx}{\Delta Xf},$$

where: λ - sensitivity coefficient, ΔF - increment of the basic parametre, ΔX - increment of unknown parametre, x, f - rate of parametres change (growth).

This aggregated indicator can be successfully applied when economic efficiency is reduced to allocation (resource) efficiency. Combination and recombination of production factors define such efficiency. K. Marx began to divide factors of the extended production into extensive and intensive ones. Types of economic growth (labour-saving, capital saving, overall intensification) were singled out on the analogy. Unlike extensive, intensive reproduction is known to be based not only on the expansion of production means on the existing tehnical-technological base at the same labour qualification and labour structure, but for the account of expansion of tehnical-technological base and manpower training, their advanced training (investment into human capital).

Production function Cobb-Douglas was applied as a successful model for economic efficiency measuring for many years. Its classical view is: $Y = A\ L^a\ K^b$, where L, K – labour and capital factors, coefficients a, b - elasticity of factors according to production volume. This kind of function was changed by many researchers and additional factors, such as, technologies, technical progress, person investments, information factor, and etc. were introduced. However, it did not change a conceptual framework of Cobb-Douglas function. The idea is in setting a correlation of factors which actually change. Besides, elasticity is constantly and dynamically changing. Furthermore, the type of factors multiplication set a priori is poorly reasoned and is not often corroborated empirically, even in spite of the fact that this model was quite satisfactory for the researchers mathematically and till now it has been actively used at creating various models.

Both approaches are factorial, that is, they assume interaction of various production factors defining output and consumption. However, the first approach assumes allocation of factors at once according to relative efficiency criterion (extensive and intensive factors). It is equivalent to conventional ranging, and production function approach leaves this question unclear, until elasticity coefficients for each factor are not empirically estimated. At the same time, factors interaction is absolutely out of model, as well as changes of factors elasticity as a result of the action of other factors (replacement).

In other words, the so-called economic efficiency can be defined as production intensification, which almost automatically defines consumption possibilities, because production function and consumption function should be connected.

With reference to economic system, it is expedient to use the following aggregated indicators:

- return correlation of intensive and extensive factors;
- return correlation for each factor of production (capital/labour, technology/labour, technology (information)/capital, and etc.);
- correlation of norms of social and private return [2].

In my opinion, estimation of general economic efficiency on the basis of wealth category is the most interesting. Having singled out the elements of national wealth, it is necessary to consider efficiency both from the point of view of productive (target) use, and economical consumption, especially of non-renewable part of wealth. Financial macroeconomic stability of the system should thus be provided. The parametre of productive use of national wealth, which is defined both for each element of wealth, and for its amount, can become the aggregated indicator of estimation

Ecological efficiency is a special kind of efficiency which can be defined in several ways: as costs for restoration of ecological systems damaged by pollution (negative externalities) to the general amount of created product (income) and as the relation of negative externalities (pollution) damage to benefits which the system obtains as a result of positive externalities. Besides, ecological efficiency can be estimated according to technological productivity of resources extraction, storage and recycling, comparing the general size of pollution of various environments with the parametres of their assimilation potential.

In my opinion, ecological efficiency can be estimated as follows. To estimate the general damage from pollution and costs of measures which decrease pollution indicators of each kind and each measure intended for the given kind of pollution. It is possible to estimate years of life without functional infringements and pollution of ecosystems as augmentation of agents' well-being and the losses connected with life under polluted conditions, including increased probability of arising diseases.

On the one hand, ecological programs promote new technologies, improve means of production, and, on the other hand, increase indicators of life quality. But their main mission together with the development of medical sector is life prolongation and creation of favorable life conditions. Efficiency in this case is defined as achievement of necessary result with the least expenses. Here comparative analysis of various techniques efficiency of pollution liquidation is important. Costs (cost price) of ecological program may be defined in such a way:

$$Z_e = \sum_{i=1}^{n} z_i + P - \sum_{j=1}^{m} s_j \ ,$$

where:

Z_e - costs for program realization;

z_i - costs for i^{th} action of the program according to the number of n - actions;

P - cumulative side effect from program realization, connected with possible damage at pollution liquidation;

s - costs (expenses) of preventive measures of possible adverse consequence according to the number of consequences – m, which could have occurred in the case of ecological program failure.

Social value of ecological program or certain ecological measure, as I see it, is conveniently defined as follows:

$$V_S = \frac{Z_e - B}{T_a},$$

where: V_S - social value of ecological program/measure; Z_e - general costs of the program/measure; B – common advantage; T_a - period of time before restoration of assimilation barrier of ecosystem, or T_a = T, where T - time for the measure implementation.

Certainly, estimation of benefits and expenses should be carried out subject to money value at different time, that is, subject to discounting.

Negative external effect arises when production costs are transferred on environment, which can't but accept them. Other things being equal, it allows providing greater production volume, but the gain connected with this great volume can hardly compensate the losses of life quality caused by pollution. Besides, benefit of large output does not mean greater income as this parametre depends on demand elasticity. If the agent had not accepted negative externality (nature, in this case) then the output would have been obviously lower. But at inelastic demand the total revenue could have been larger than at negative externality. In other words, at inelastic aggregate demand ecological programs become profitable for economic system. The costs connected with avoidance of negative externality reduce production volume according to this model, but at inelastic aggregate demand the total revenue (income) does not decrease, but increases. Hence, production ecologization is more effective at a certain monopolization level of the market.

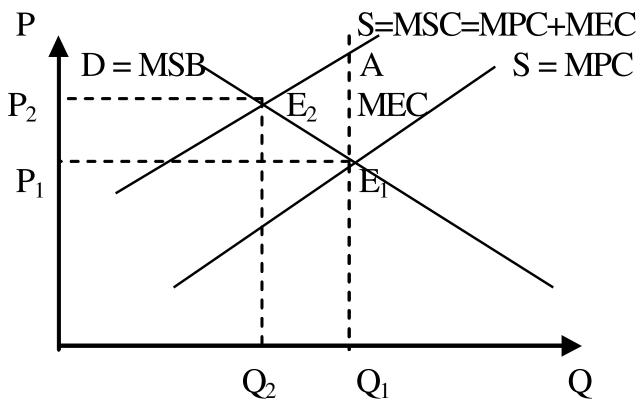

Figure 1. Ecological Efficiency through Estimation of Negative External Effect
Note: the author´s own processing [3].

As it is shown in Figure 1 in the equilibrium point E_1 marginal private costs and marginal social benefits are equal MSB=MPC. Thus, marginal social costs are higher than marginal private costs as a certain amount of costs is transferred to the third agent (nature), which provides high enough output Q_1. Really marginal social costs are more than marginal private costs on the amount of external negative externality MEC (marginal external costs). If we include these costs into production then output in equilibrium point E_2 will be Q_2, and marginal social benefits will be equal to marginal social costs. The loss of efficiency is measured by the triangle AE_1E_2. Taking into account these costs, purely production efficiency will go down, but general efficiency of production processes and ecological efficiency will increase. To preserve the output at level Q_1 it is required to move the demand curve upwards to the right, that is, to increase demand. This will move the equilibrium to point A at essentially higher prices.

If demand is elastic, then the triangle of efficiency losses AE_1E_2 will be obviously greater in area than in case of inelastic demand, and loss in aggregate return will be defined by the difference P_1Q_1 and P_2Q_2, at $P_1 = P_2$. To bridge a "gap" in efficiency provided by negative externality, it is necessary either to move to equilibrium E_2, that is, lower output which will not be compensated by demand inelasticity which allows preserving the return and revenue position.

Or other possible variant is to move the demand curve parallel to itself so that it passes through point A. Then a new balance E_3 = A will be established at the same output Q1, but at higher price level P_3. However, negative externality will be compensated and marginal social costs will be equal to marginal social benefit MSC = MSB = MPC+MEC (Figure 2)

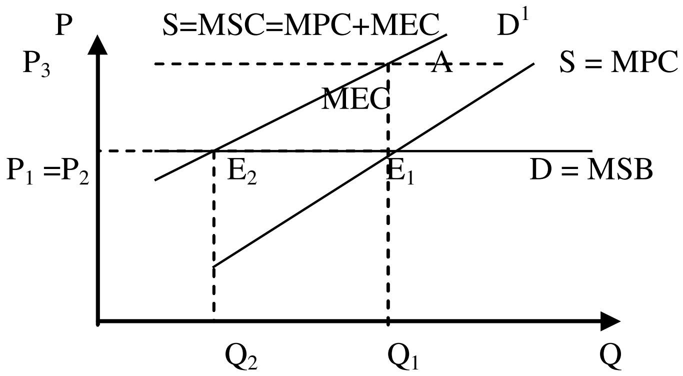

Figure 2. Negative Effect at Absolutely Elastic Demand
Note: the author´s own processing [3].

In Figure 3 the change of ecological efficiency depending on the dynamics of external costs (marginal external costs are shown as shares of marginal private costs) is presented.

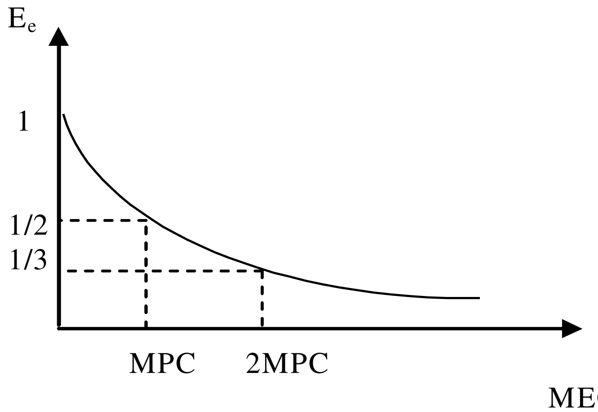

Figure 3. Dynamics of Ecological Efficiency Indicator Depending on the Amount of External Costs
Note: the author´s own processing [3].

It is suggested to define the indicator of ecological efficiency as follows:

$$E_e = \frac{MPC}{MSC} = \frac{MPC}{MPC + MEC} = \frac{1}{1 + \frac{MEC}{MPC}}$$

$$E_e = \frac{PC}{SC} = \frac{PC}{PC + EC} = \frac{1}{1 + \frac{EC}{PC}} = \frac{1}{1 + a},$$

where: MEC, MPC - marginal external and private costs accordingly; EC, PC - external and private aggregate costs, a - relation coefficient of the external and private costs.

At MEC = 0, we have maximum ecological effectiveness of the system equal to $E_e = 1$. At infinite increase of MEC efficiency tends to zero. At MEC = MPC, E_e = l, at MEC = 2MPC, $E_e = 1/3$.

External costs growth (marginal and general) will operate in the direction of ecological efficiency decrease. The aggregate increase of such costs also reduces efficiency of economic system.

We consider the method connected with introduction of external costs into marginal private costs to be a productive enough way to struggle against ecological pollution. Thus, marginal social costs are higher at the expense of this addition at simultaneous expansion of demand. Under condition of its inelasticity the impact on consumption and production will not be appreciable. It will require the change of costs accounting rules. To be more precise, when the measures of ecological and macroeconomic policy are effectively organized, the idea of impact on ecology is irrelevant as production and consumption become the function of non-prejudice to the third agents. And that is an expedient and adequate approach to the problem.

Planning of outstripping development should consider “ecological burden” of economic system. It is possible to present ecological burden of i^{th} country with such aggregated indicator: I_i = Pi x Ai x Ti, where Pi – population size, Ai - standard of well-being, Ti - technological development level [1]. But such indicator and especially its minimization are hardly practically pertinent and possible. To achieve this goal is possible at the expense of control of population increase (P), and higher cleanliness of modern technologies (T), that is, reduction of dirty technologies. And this problem minimization should be solved at well-being growth, especially in the poorest countries - (A). Though, certainly, if human society hopes to survive and develop, it should use the idea of “limitation” and “abstention” as the main motivation principle. If we introduce a certain norm of ecological costs $n_e = R_e/Y$, $n_n = R_n/Y$ where n_e - actual norm of ecological costs, n_n - needful norm of ecological costs, R_e - actual size of costs for ecological measures, R_n - necessary costs corresponding to real pollution, Y - gross product of the country, then the difference $n_e - n_n \to \min$ can be subject to minimization.

Let's introduce the relation indicator of gross national product to cost estimation of national wealth of the country. Then, it is possible to consider this coefficient an integrated value showing how effective the economy is, that is, whether it uses the available riches and creates national product productively. Mathematically it is possible to present this indicator as the relation $K_E = Y_t / W$, where: Y - national product of the year t, W - national wealth in estimation of the current year [3]. The greatest amount of this relation can show the purpose of development and economic policy. It is easy to demonstrate, that in the point of extremum, that is, the maximum of efficiency coefficient $K_Э \to \max$, the value of the coefficient represents the relation of growth rate of current product to the growth rate of national wealth: $K_E = g_Y/g_W = [dY_t/dt] / [dW/dt]$, at $dK_E/dt > 0$, $t < t0$ at $dK_E/dt < 0$, $t > t0$, where t0 - maximum point K_E

At the same time necessary expenses can be high enough, that will require to change not only the pricing rules in the world, but also the strategy of development. The problem remains because the level of national wealth is unevenly distributed among the countries. Besides, there are historical conditions of development. All these have predetermined various trajectories of social and economic progress of these countries.

Certainly, in reality, the problems of ecological damage and its influence on the economy and social relations are considerably deeper and more difficult. However, the foreshortening of ecological efficiency presented by me will be useful at provision of ecological efficiency in practice. Not to pollute should become profitable. All social rules must be focused on this and the motives of agents’ behaviour should be encouraged as well. Such approach will demand change of both the “market” logic of managing, and “market” psychology of business. It will be necessary to change profit-oriented behaviour. However, there should not be illusions. The problem is that a compulsion is required to include the damage of nature into costs. Otherwise accounting rules of calculation will not allow concentrating the capital in the funds restoring nature losses. Numerous macroeconomic models are usually built on the assumption that “ecological costs” as if slow down economic growth and their growth rate is subtracted from the general rate of economic growth. The similar paradigm seems not simply incorrect, but wrong because treatment facilities, special purification systems for various environments and other equipment are necessary to be considered as the basic condition of modern development and growth, changing economic psychology, motivation and models. Further we will show how the functions of economic agents - health and qualification (microeconomic functions) - can be included in the analysis of macroeconomic changes as two original ecological components.

2. Health functions and qualifications of economic agents

It is possible to present the function of health reserve and skills level function, depending on the income level per one agent (see Figure 4).

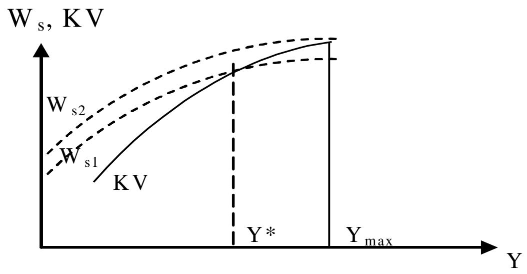

Figure 4. Function of health and skills reserves from income
Note: the author´s own processing [3].

Let's admit that health reserve is more than skills reserve for one and the same income level. Both functions grow in decelerating rate, but from some value of national/per capita income the skills reserve Y* grows more, than the health reserve, and then this growth stops at all at Y_{max}. From the moment Y* qualification becomes more significant. Its further growth which may be connected with technological breakthrough, can provide the move of curve W_{s1} to position W_{s2}, thereby, the health reserve for the given income level will increase. The linkage of health reserve function and skills to income level allows formulating the problem of rupture between the two functions and the optimum distribution of investments between preservation, restoration or increase of health reserve, or professional skill improvement and augmentation of capital stock. In a word, human capital augmentation by means of training and professional skills improvement is accompanied by its deterioration, the real physical deterioration expressed in health reserve deterioration and decrease of working capacity and productivity.

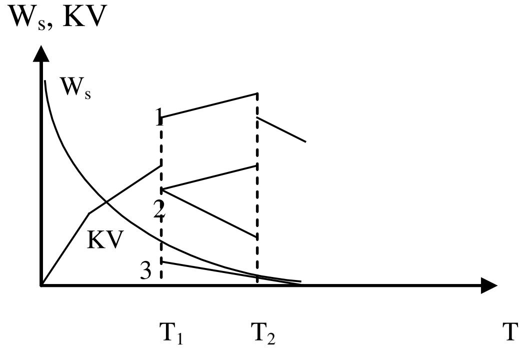

Figure 5. Change of skills function
Note: the author´s own processing [3].

It is possible to present the change of skills function on the periods of agent's development. Then at the moment T_1, this function is moved to position 1 (Figure 5) under training and professional skills improvement, and the situation of disqualification is possible, for example, owing to illness (curve 3, function section W_s), which can be described by curve 2 going downwards (degradation), or upwards (partial restoration of qualification). Age reduction of qualification will be observed since the age moment T_2.

Thus, the dysfunction of economic agent (DF_A) is, in essence, a set of health (D_{Ws}) and qualification (D_{KV}) dysfunction. Qualification dysfunction is a disqualification which is expressed in the loss of necessary knowledge, or inability to apply the knowledge which the agent disposes. The same analogy can be transferred to large and small social systems. The dysfunction itself on each component can be presented through the functions of health reserve and skills. Certain sectors of these functions will correspond to dysfunction. Then we will write down:

$$DF_A = D_{Ws} + D_{KV}$$

Then, macroeconomic policy should proceed from the necessity of this function minimization, or it would be necessary to formulate the task differently, to present the well-being function (SFW) as the sum of health reserve function (W_s) and skills level function (KV). Then the problem of global maximum search for the whole system will be formulate., However, nobody prevents to preserve the formula for microeconomic level:

$$DF_A \rightarrow \min \text{ , } SFW(t) = W_S(t) + KV(t) \rightarrow \max$$

Function of dysfunction symbolizes the minimum of losses at achieving a certain maximum, as there may be several movement trajectories as well as maxima (the one for each trajectory). It is possible, that it would be necessary to build each function empirically, considering the agents' age structure in the economic system, because this structure will influence the form of corresponding functions greatly. As it was shown on theoretical diagrams, the functions can be a broken line, because they have their own elasticity for the given period of time.

Different qualifications and the number of experts of each qualification are of importance in the economy relative their contribution to the rate of economic growth and to the national income increment. That is why the problem of detection and forecast of economy qualification matrix according to the contribution of each professional group in the development makes sense. In this formulation the given problem, being solved, will allow to operate both education system, labour markets, and development as a whole.

Agent's well-beings are composed of the health reserve and accumulated qualification. Actually, it can be presented as the sum of two functions: B_i (t) =W_{si} (t) +KV_i (t). The available resources, the projected institutions, accumulated physical capital (dwelling, infrastructure, industrial areas/capacities, etc.) serve these basic functions and provide, or do not provide, their increment.

The so-called qualification approach can be applied to the estimation of education system. In this case the mathematical model describes the dynamics of skills level:

$$\frac{\partial k}{\partial t} = f(k) + Z(t), k(t=0) = k_0$$

where: k (t) - expert's qualification or the educational capital (competences) accumulated owing to training;

k_0 - qualification before training, at a certain initial period of time;

Z (t) - function of education system expenses.

The solution of this differential equation depends on function selection f (k), and on the assumptions defining mastering of the material in the course of training, the use of this qualification in the economy, etc. It is conceived, that these solutions can be perceived only as tentative, because, first, they do not take into account institutional quality and effects connected with it. Secondly, they depend on the selection of the specified function. And thirdly, they assume, for example, "lifeless" assumptions, such as: constant intensity of expenses function, function linearity f (k), intensive use of the expert leading to his disqualification, instead of skills increase and accumulation of experience, etc. It is important to take into account, how accumulated experience defines the qualification dynamics after the training has long been finished. The same refers to labour market condition and economy as a whole which can claim or cannot claim the experts of this or that level. In other words, the competences would not be able to find the practical application and approbation.

With accumulation of operational experience qualification of trained experts should grow, but not decrease or remain invariable, which, at modern competition, actually means qualification decrease. It is an optimum variant. In other words, if education system is effective, it should provide further development of experts in their specialties with qualification increment.

Reduction of health reserve or decrease of "nation's health" as a macroeconomic indicator affects the possibility of knowledge production and the skill level, which goes down. As a result, productivity and technological level of production is reduced. The life quality also decreases.

Under the presented material, we will show the functions of health reserve and skills in conformity with the graphic dependences given above in analytical way. Then, it is possible to write down:

$$W_s = a_1 - a_2 e^{-\beta 1 y}, \quad KV = b_1 - b_2 e^{-\beta 2 y}$$

Having differentiated the function on the level of the per capita income, we will get:

$$\frac{\partial W_s}{\partial y} = c_1 e^{-\beta 1 y}, \quad \frac{\partial (KV)}{\partial y} = c_2 e^{-\beta 2 y}$$

It is possible to present the dependence of function of health reserve and skills level in two ways as follows:

$$W_s = a - b e^{-\alpha KV}, \quad \frac{\partial KV}{\partial t} = AKV_0 e^{\mu W_{sw}}$$

Then: $\frac{\partial W_s}{\partial t} = c_3 e^{-\alpha KV}; \frac{\partial W_s}{\partial t} = \frac{\partial W_s}{\partial t}\frac{\partial y}{\partial y} = \frac{\partial W_s}{\partial y}\frac{\partial y}{\partial t} = c_1 e^{-\beta 1 y}\frac{\partial y}{\partial t}$, whence follows, that

$$\frac{\partial y}{\partial t} = c_4 e^{\beta 1 y - \alpha KV}$$

Having expressed the qualification function, we will get:

$$KV = \frac{\beta_1}{\alpha} y - \frac{1}{\alpha} \ln[\frac{1}{c_4} \frac{\partial y}{\partial t}]$$

Having substituted this expression in the function of health reserve, we will get:

$$W_s = a - \frac{b}{c_4} \frac{\partial y}{\partial t} e^{-(1+\beta 1 y)}$$

Thus, the solution, as well as the form of qualification and health reserve functions will depend on dynamics y - gross product (per capita). Another way is to set the function of qualification and the expenses intensity of education system, that is, to use the equation: $\frac{\partial KV}{\partial t} = f(KV) + Z(t), KV(t=0) = RV_0$. Having accepted f (KV) = φ KV (φ <0 - indicator characterizing knowledge perception, that is, efficiency of knowledge mastering (speed) and Z (t) = Z_0, we will get: $\frac{\partial KV}{\partial t} = \phi KV + Z_0$.

The general solution of this equation is the expression:

$$KV(t) = -\frac{Z_0}{\phi} + (KV_0 + \frac{Z_0}{\phi}) e^{\phi t}$$

Having accepted KV_0=0,5, Z_0=1, φ =-0,5 we will get: KV (t) = 2 - 1,5 $e^{-0.5 t}$. The diagram will reflect the qualification increase depending on the time (see Figure 6).

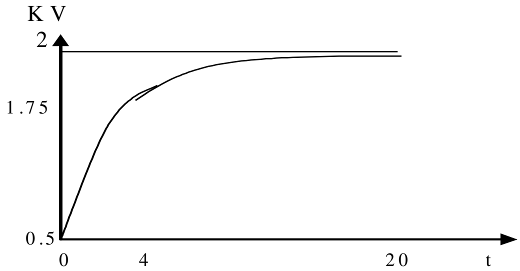

Figure 6. Change of skills function

Note: the author´s own processing [3].

If we accept KV = a - b $e^{-\alpha W_s}$ and $W_s = b_1 + b_2 e^{-\beta t}$. Having accepted a=1, b=0,2, α =0,3, β =0,5, b1=1,5, b2=0,5, we will get W_s=1,5+0,5 $e^{-0,5 t}$ and then the diagrams for the function of health reserve and skills will be in the way it is presented in Figure 7.

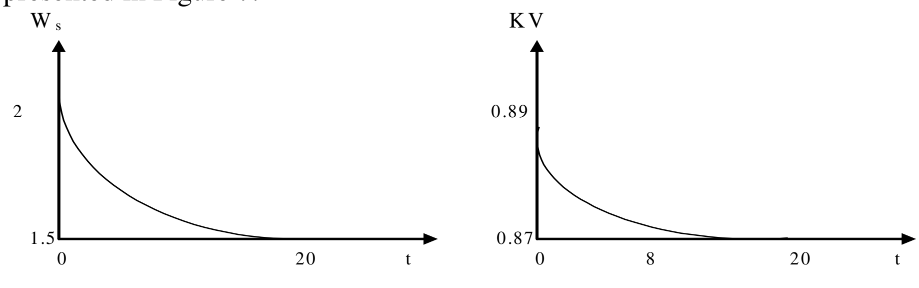

Figure 7. Change of health reserve and skills function

Note: the author´s own processing [3].

As seen from Figure 7, the decrease of health reserve can lower though slightly the possibilities of professional skills improvement at the used values. Qualification function decreases the same way as the health reserve function does. Such change differs from the model presented above where certain constant expenses intensity for education Z_0 was set.

Thus, it is necessary to consider the action of different factors and interconnection of various systems at macroeconomic models formation. Otherwise, the result will be actually set by mathematical function, or be limited by the conditions of considered subsystem functioning. In this case the education system is meant. However, with reference to systems where the population's health is extremely low, or the population even starves, no import of education can cardinally change the situation until the function of health reserve allows doing it. Naturally, it is necessary to take into consideration the function of professional development. In other words, it is necessary to invest in economy so, that finished products and consumption are connected with two sectors, providing health and education, the output of which would have realization within the limits of a specific national system. Only in this way it will be possible to break off a vicious circle of poverty or backwardness of any strength. To lift the decreasing curve of health reserve upwards and to extend it to the right so that its intersection with axis of abscises occurs as late as possible is an absolutely reasonable aim. Agents wish to live as long as possible and at the same time to preserve labour activity or, more generally, vital activity. It is this purpose that is righteous from the point of view of "social state" and carrying out of corresponding economic policy. And together with the necessity of education and qualification improvement it can be achieved. Thus, the increase of qualification level will act as one of the tools of its achieving and health improvement will simultaneously provide motivation to training.

Having introduced the investments share directed on health and education d1 and d2 accordingly, and the share of savings from wages and income s1 and s2 accordingly, having accepted, that investments into economic system can be reduced to two components, to investments in education (knowledge, technology) and in public health services, it is possible to get the following simple macroeconomic model of system. And it is possible to consider investments into capital funds as a new technological possibility and as a knowledge version. For this purpose we will write down:

I (t) = α (t) S (t) - generally investments are not equal to savings;

Y = S+C, Y = w+p - we will present the income as the sum of savings (S) and consumption (C) because the received income goes for consumption or it is saved up. Or it can be presented as the wages sum (w) and profits (p);

I = d1 w + d2 p = d1 w + d2 (Y-w) = w (d1-d2) + d2 Y.

α (t) S (t) = w (d1-d2) + d2 Y,

α (s1 w+s2 p) = w (d1-d2) + d2 Y,

Having substituted p = Y - w and having expressed Y, we will get:

$$Y(t) = w(t)\frac{(d1-d2)-\alpha(t)(s1-s2)}{\alpha(t)s2-d2}$$

Proceeding from the expressions received above, we have: $y = c_4 \int_{t1}^{t2} e^{\beta 1 y - \alpha KV} dt$. Having expressed y (t) through wages and parametres of investment process and savings, it is possible to solve the resulted equation relative to qualification function, having got the dependence on wages and institutional parameters of "investment-savings" process in macroeconomics.

Efficiency assumes the presence of criterion which is used for estimation, taking into account system's development purposes, a set of alternatives (trajectories) of development and decision-making within the limits of the system, restrictions and a range of stability and system's viability.

The skills level is defined by agent's competence in these or those professional questions and at the solution of these or those problems. Therefore, qualification is defined through the competence. Professional development and reproduction of competences are a product (problem) of education system. Professional development, in its turn, leads to competitiveness growth of the agent on the labour market. Hence, proceeding from experience and empirical data, it is possible to introduce flexible norms for skills level, according to the labour market requirements to qualification and competences and to use the suggested device for the estimation of education quality change. The need in personnel of the necessary qualification is formed by the economic system, and education system should react to this requirement with the account of the state component as the government can order education system experts of other qualification, than it is required on the labour market.

If there is a situation of markets "failure'", including the labour market in the economy, then having reacted to this situation accordingly, education system can prepare personnel "failure" in the future, with a certain lag equal to the number of years for expert training. Hence, education system represents a special sector of economy which should not react to the market fluctuations, and should be guided by the prospect in the solution of personnel reproduction problems for the economy, that is, it should focus on the economy's future and its requirement for a certain skill level.

The other danger is that this future estimation can appear to be overrated and the so well-prepared personnel will not be simply accepted by the economy. For example, the level of competence and knowledge will not correspond to the available equity, laboratory basis. And then the best workers, scientists, engineers will search for work places in corresponding conditions.

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