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HUMAN CAPITAL AND THE PHENOMENON OF INCREASING RETURNS IN ECONOMIC GROWTH MODELS

FIRUZA MAYILYAN*
Yerevan State University

Abstract: The paper investigates the historical preconditions underlying the emergence of the concept of the principle of diminishing returns to factors of production. An analysis of the manifestation of this principle in the scope of all factors of production is carried out. In light of the analysis of the characteristics of human capital, an approach has been proposed in which the principle of diminishing marginal returns is not applicable to investments in human capital at the macroeconomic level in the long run. Human capital generates increasing returns on investment while alleviating the impact of diminishing returns on other factors of production. In general, while accepting the principle of diminishing returns to factors of production, it should be noted that the mechanical extension of this principle to all types of economic activity is not scientifically justified. There are certain types of activities and economic sectors to which, in our opinion, this law does not apply. Moreover, these types of activities hinder the manifestation of the principle of diminishing returns to other factors of production. In particular, it is known that increased investment leads to diminishing returns on investment. However, this pattern applies to investment in physical capital. In our opinion, this pattern does not apply to investment in human capital. Moreover, investment in human capital is presumably expected to provide increasing returns. However, it should be emphasized that this approach lacks a clear system of evidence and is based on empirical observations. Furthermore, the principle of increasing returns to investment in human capital has a long-term lag in its impact on economic variables and manifests itself in the long term and primarily at the macro level.

Key words: *factors of production, principle of increasing returns, human capital, investments in human capital, physical capital, knowledge, economic cycle, economic growth.*

Introduction

Economic theory encompasses a set of principles that appear foundational and the continued advancement of the economic science is grounded in these fundamental axioms. Among these foundational principles is the principle of diminishing marginal returns to the factors of production. In accordance with the principle of diminishing marginal returns, as the quantity of a variable factor increases, while holding the quantity of all other factors constant, a threshold will be reached, beyond which the marginal

* **Firuza Mayilyan** – Doctor of Economics, Professor at the Chair of Economics and International Economic Relations, Faculty of Economics and Management, YSU
E-mail: fmayilyan77@mail.ru ORCID ID: https://orcid.org/0000-0003-0655-6176

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product of the variable factor will start to diminish. It is noteworthy that this law lacks a well-defined systematic approach to evidence and is grounded on empirical observations.

The methodological foundations of this principal stem from the concept known as the law of diminishing soil fertility, which was initially formulated in the 18th century by the French economist J. Turgot and at a later stage – by the English economist E. West (*Rumyantsev, 1972*). E. West and D. Ricardo attempted to elucidate the tendency for profit rate to decline related to this "law" and leveraged it to support the theory of differential rent. T. R. Malthus applied this principle to validate his theory of population (*Malthus T.R.*, 1868). At the turn of the 19th and 20th centuries, among the leading proponents of this law were L. Brentano and M. Zering - in Germany, S. N. Bulgakov, M. I. Tugan-Baranovsky, P. B. Struve, P. P. Maslov - in Russia. Within the first half of the 20th century A. Marshall, B. Clark and others expounded upon the law of diminishing marginal productivity as a fundamental law that is relevant not only in agriculture, but also in industry and holds comprehensive significance (*Manuelli R.E., Seshadri A.* 2014). Subsequently, the principle of diminishing marginal returns expanded to cover all types of economic activity: savings, investment in physical capital, investment in human capital, etc. Currently, the law of diminishing returns is one of the essential laws underpinning the economic science. From a general perspective, accepting this principle, we should highlight that the automatic extension of this principle to all types of economic activity is devoid of scientific justification. Different types of activities and areas of the economy can be identified where we contend that this law is not relevant. Moreover, these specific activities hinder the manifestation of the principle of diminishing returns of other factors of production. (*Mayilyan F. N.*, 2021). Specifically, it is established that the expansion of investments leads to diminishing returns on investments. However, this pattern is applicable to investments in physical capital. From our standpoint, this pattern is not applicable to investments in human capital. Moreover, investments in human capital are expected to generate increasing returns. It is noteworthy that human capital, in our view, refers to a combination of inherent and developed abilities, knowledge, skills, and motivations resulting from investments that are effectively employed in the labor process, thus supporting the growth of its productivity. The course of history and development in human society contradicts the theory of T.R. Malthus, and, in our opinion, it can be attributed to the fact that the increasing return of human capital hinders the manifestation of diminishing returns of other factors of production. However, it is crucial to highlight that the increasing return on investment in human capital is observable only within the scope of the entire economy, but not at the level of distinct individuals, specifically in the long-run perspective. The phenomenon of increasing returns in models of economic growth can be attributed to the increasing returns of human capital (*Mayilyan F. N.*, 2021).

The main objective of this article is to substantiate the author's approach, which explains the increasing returns to investing in human capital over the long term and at the macro level, based on a critical analysis of generally accepted theoretical approaches in economic theory. According to these theoretical foundations, the law of diminishing returns applies to all types of investment, including investments in human capital. The author attempts to propose a new approach that contradicts this generally accepted approach.

Literature Review

Since the mid-20th century, particularly during the 1950s and 1960s, scholars have increasingly focused on the role of human capital in driving the economic growth of different countries, a trend that has been reflected in the advancement of endogenous growth models. The emergence of a new class of economic growth models incorporating endogenous technological progress has led to a heightened interest in the issues of economic dynamics. Three key implications of these models, which could have considerable practical significance, had a pivotal role in this. Specifically: 1. economies of scale stemming from the growth in resources involved in the process of new knowledge acquisition; 2. the ability to impact the rate of long-term economic growth by fostering the increase rate of human capital accumulation; 3. the impact of human capital growth rates on the structure and scope of international trade and globalization processes. In the 1960s and 1970s, extensive debate emerged concerning the inclusion of education in the model's economic growth. Consequently, two methods for integrating education into the models of economic growth have emerged, which differ substantially from each other. One approach is to conceptualize human capital as one of the factors in the production function that is not directly associated with the technical progress (G. Uzawa, 1965; R. Lucas, 1988; Menkiw, P. Romer, D. Weil, 1992). In this case, the growth rate of the economy is determined by the growth rate of human capital. An alternative approach is to consider that the growth rate of the technological progress is determined by the aggregate level of the human capital.

The founding figures of these theories are P. Romer, R. Lucas, S. Rebello, who, through their models, provided a theoretical foundation for the approach according to which economic growth is explained by investments in human capital, the acquisition of experience and on-the-job training. They also underlined that positive externalities arising from the training prevent a decrease in the marginal productivity of human capital.

P. Romer classifies the economy into three primary sectors. In the first sector, the research sector, as a result of the concentration of human capital ($H_{A)}$ usage within it and the current repository of knowledge (A), new knowledge is acquired, which is subsequently materialized in the form of new technologies. The expansion of new knowledge is expressed by the formula:

$$A'=ϭH_AA \qquad (1)$$

where

ϭ is a parameter of scientific productivity.

P. Romer points out that graduates of engineering universities a century ago possessed the same level of human capital as current graduates, as they studied for approximately the same duration lacking practical work experience. However, the labor productivity of a modern engineer is considerably higher, as they have access to a more extensive repository of knowledge. Knowledge is regarded in this context as a non-competitive production factor that is simultaneously and equally accessible to everyone with the capacity and intention to use it.

Firms in the secondary sector of the economy acquire scientific knowledge obtained within the research domain for the production of the factors of production. Every enterprise within this sector is a monopolist: it holds a patent for the manufacturing of its products and, therefore, can derive a monopoly profit from its realization. The patent

is considered as lasting indefinitely. The tertiary sector of the economy, based on the available factors of production, labor costs (L) and human capital (Hy), ensures the production of final consumer goods. The relevant production function is:

$$Y(Hy, L, x) = Hy^{\alpha}L^{\beta}\sum_{i=1}^{\infty} Xi^{1-\alpha-\beta} \quad (2)$$

where

i - is the index assigned to each distinct type of the factors of production;

x_i - is the listing of the factors of production used by a company for the production of final goods;

α and β - are certain technological parameters.

The acquired level of expertise in P. Romer's model aligns with a specific level of technological advancement, which varies with the accumulation of new knowledge and the emergence of new technologies. According to the model, the technological aspect of knowledge is a non-competitive good, unlike the competitive aspect of knowledge, i.e., human capital. However, if, within the research sector, each specialist has access to the comprehensive knowledge base, subsequently, in the secondary and tertiary sectors the use of a specific idea (development) is regulated by the current patent legislation framework. Once an enterprise in the secondary sector acquires and masters an innovative and cutting-edge technological idea, it protects its monopoly right and control to use it under a patent and arranges the production of pertinent factors of production for tertiary sector enterprises specializing in the production of final goods.

K. Arow (. *Arrow K. J.* 1962) and G. Uzawa (*Uzawa H.* 1965) underlined the importance of considering the positive externalities of education and on-the-job training in the models of economic growth. H. Uzawa, in his studies, proposed to include the education sector in the model of economic growth, in which the employment determines the factor of labor productivity. Accordingly, labor efficiency was growing in line with the increasing employment in the education sector. R. Lucas, in his studies, (*Lucas R. E.* 1988) while investigating the relationship between investments in human capital and economic growth, justified the differences between the rates of economic growth of countries based on the amount of investments in human capital. By studying the relationship between the stock of human capital in individual firms, the economy-wide average of human capital resources, and the level of output, he concluded that, as a consequence of individual decisions, comparatively lower investment is made in human capital than required to foster sustainable growth. R. Lucas clarified the underlying reason for this phenomenon by the fact that individuals, when making decisions pertaining to investments in human capital, do not consider the impact of individual investments in human capital that will increase the level of productivity of other individuals. Specifically, the rate of social return on investment in human capital exceeds the individual return rate on human capital. R. Lucas presumed that an increase in the average level of human capital across the entire economy results in an increase in the level of labor productivity of all employees. The study of Lucas outlines a dual-sector model of economic growth where human capital is introduced into the Cobb-Douglas production function as a factor similar to productive capital:

$$Y = AK^{\alpha}(uhL)^{1-\alpha} h_{\alpha}{}^{y} \quad (3)$$

where

$0 < \alpha < 1$;

A, K and L are the levels of technological advancement, physical capital and labor force, respectively;

U - is the proportion of aggregate labor time allocated to work;

h - is the rate of human capital accumulation;

h_a^y - is the average positive external effect of human capital.

In the second part of the model, Lucas incorporates the share of human capital that is not applied in the manufacturing sector. Endogenous growth is only feasible if the development of additional human capital provides constant returns:

$$h_i^{\cdot} = h_i B(1 - u_i) - \delta h_i \qquad (4)$$

where

δ - is the decline in human capital value;

B- is a parameter that defines the rate at which investments in the manufacturing sector are converted into human capital growth;

$(1 - u_i)$ - is the segment of the population pursuing self-guided education.

In the neoclassical model developed by Lucas, the assumption of constant marginal returns to scale in production is retained while assuming the irrelevance of non-reproducible factors. As equation (4) indicates, an increase in the stock of human capital occurs regardless of its level. Based on this assumption, Lucas develops a growth model as follows:

$$g_h = \frac{hi^{\cdot}}{hi} = B(1 - u_i) - \delta \qquad (5)$$

In comparison with the Solow model, the driver of the economic growth in this model is not technological advancement, but individual investments in human capital.

However, R. Lucas's model generally aligns with constant growth, on the premise of a time-dependent production function, and is often applied to represent the effects of technological advancement, according to which production parameters, investment, and consumption can increase at a rate of *g*. Therefore, in this model, the accumulation of human capital is a universal factor of production, while the growth rate of human capital establishes the rate of the economic growth. Concurrently, as we have underlined above, R. Lucas highlights the heterogeneity of the positive effects of human capital within the national economy, therefore; as outlined in the model above, the benefits from the accumulation of human capital are not confined solely to the direct impact on the economic growth.

R. Nelson and E. Phelps have investigated the role of human capital as a factor of economic growth, which contributes to the generation of technological changes and their further implementation (*Sharaev Y.V.*, 2006). They assumed that a global repository of knowledge base exists and is accessible to all countries. However, the capabilities of countries to introduce new technologies depend on their capacity to absorb, which is directly determined by the educational level of the employees, i.e., the level of human capital accumulated through their efforts. I. Benhabib and M. Spiegel further developed the model of R. Nelson and E. Phelps, underlining that the gap between the theoretically feasible and the actual level of knowledge in developing countries can be diminished by introducing technological innovations. On the basis of the analysis of the extended production function, they arrived at the conclusion that the stock of human capital has a considerably stronger effect on the growth of the per capita GNP rate than the rate of its formation and accumulation. G. Barro, H. Sella and G. Martin, on the basis of an analysis of extensive statistical resources from 87 countries (1965–1975) and 97 countries (1975–

1985), identified a significant correlation between the economic growth and the educational level of the population (*Sharaev Y.V.*, 2006). Moreover, according to the study, the growth in public expenditure on education has a significant impact on the economic growth. Therefore, an increase in the specific share of government spending on education within the GNP structure by 1.5% induces a faster rate of economic growth by 0.3%. A practical model of economic growth considering the contribution of human capital was developed by G. Menkiw, D. Romer and D. Weil (1992), which is primarily a modification of the Cobb-Douglas production function and the fundamental Solow model grounded in human capital (*Sharaev Y.V.*, 2006).

The production function in this expanded Solow model is structured as

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta} \quad (6)$$

where

H(t) - is the stock of human capital at time t;

α and β - are the shares of the impact of physical and human capital on output growth;

A(t) - is the level of technology varying over time at a rate of *g*, that is

$A(t) = A0e^{g}$.

The model was tested in 1960–1985 across three groups of countries (developed countries, countries with an average level of development and oil-exporting countries). The data obtained indicated the significant role of human capital in the economic growth of all countries involved in the study. In the developing countries, 80% of variations in per capita income were stemming from differences in the levels of human capital. The Mankiw-Romer-Weil (MRW) model has gained considerable prevalence and constituted the basis for research and further development of economic growth models considering the human capital, which, consequently, adopt alternative methods for the evaluation of the human capital.

The returns to education have been estimated in a large number of studies since the late 1950s. A number of studies have generalized existing estimates at the global level. For example, according to calculations by (Psacharopoulos and Patrinos, 2018), each additional year of education leads to an 8.8% increase in income. These global returns estimates are stable over time, although education may have different effects on income depending on the country, region, demographic group, and duration of schooling. Jones (Jones, 2019) noted that existing reviews of the literature estimating returns to education using instrumental variables indicate not only comparable returns—around 10%—but also a causal effect of education on income.

Returns to experience contribute to economic growth, and work involves learning new knowledge and skills, as well as refining existing ones. From this perspective, work can also be considered a form of education—usually much longer than formal schooling (Jedwab et al., 2021). Due to limited data availability, the literature often uses potential rather than actual labor market experience. In its basic formulation, potential experience is calculated as the difference between a worker's age, the length of their education, and preschool age (six years). The lower the likelihood of underemployment or temporary withdrawal from the labor market, the closer the estimates of potential and actual experience will be.

Demirguc-Kunt and Torre (Demirguc-Kunt, Torre, 2020) proposed a method for accounting for the prevalence of three key adult health risk factors characteristic of European and Central Asian countries: obesity, smoking, and alcoholism, as important

constraints on economic growth. These factors are associated with various diseases (primarily cardiovascular diseases) and mortality risks. Estimates of the calibration coefficients were based on median effect sizes obtained in various microeconomic studies. Because the actual impact of these factors on morbidity and mortality is also influenced by the quality of the healthcare system, the calculations also included indicators of child stunting and adult mortality, which more closely reflect the actual health status (rather than the risks) of the population. However, there was no correlation between per capita income levels and the resulting estimates of health-related human capital.

It should be noted that modern models of economic growth that take human capital into account, despite the diversity of approaches, assessment methods, and mechanisms for the influence of human capital on economic growth, are united in one thing: they are all based on the principle of diminishing returns to human capital. We believe that human capital from the macroeconomic standpoint and in the long run (in the context of prolonged economic cycles) demonstrates a trend of increasing returns. Furthermore, it is attributed to the increasing returns on investment in human capital that obstructs the manifestation of diminishing returns on other factors of production (*Mayilyan F. N., 2021*).

Methodology

Currently, the interest of economic science in human capital has increased significantly, but the mechanism and underlying fundamental causes of the beneficial effects of human capital on the long-term rate of economic growth remain the subject of ongoing discussions and research. For instance, in the works of the following scientists (Jones, 2014; Manuelli, Seshadri, 2014; Lucas, 2015; Jones, 2019), it is underlined that human capital has a pivotal role in the economic development across various countries. Even among proponents who assert that human capital is the main cause of economic growth, there is disagreement concerning numerous significant issues, namely: how human capital at the individual level shapes the relevant aggregate macroeconomic indicator; if human capital affects the aggregate output of the economy or its growth rate; how exactly are human capital, knowledge and technological advancement related in the economy? To adequately address these questions, it is crucial to distinguish between the return of human capital at the micro and macro level, as well as between private and social norms regarding the return on education. Current approaches to assessing private rates of return on education generally do not acknowledge its impact on the direct and indirect benefits to the population, its monetary and non-monetary returns, or the contribution of educational policies towards enhancing the social cohesion. Therefore, estimates regarding the private rates of return on education can be considered as the lower limit of social benefits that arise from investments in human capital (*Mankiw G., Romer D., Weil D., 1992*). Since macroeconomic estimates incorporate the majority of the induced externalities, and microeconomic estimates include a partial share of the benefits that could emerge from direct individual investments in one's own human capital, the distinction between the two estimates can be interpreted as an indicator of the magnitude of externalities arising from human capital. According to A. de la Fuente and A. Ciccone, the majority of the credible sources of such externalities result from the correlation between human capital and the rate of technological innovation, as well as

the indirect effect of education on labor productivity and employment through its influence on the quality of social institutions, which may be regarded as a constituent of social capital (*Mankiw G., Romer D., Weil D., 1992*). Certain theoretical models also suggest that the accumulation of human capital can increase its externalities, since some benefits arising from a more educated labor force will dissipate from it and generate benefits that cannot be claimed by those who have made relevant investments in human capital in the form of higher wages and other incomes as a result of the growing gap between the relevant private and social rates of return (*Manuelli R.E., Seshadri A., 2014*).

In this paper, based on historical and logical methods of scientific research, on the basis of the findings of a critical comparative analysis of contemporary theories of growth including the component of human capital, an attempt is undertaken to theoretically validate the distinctive characteristic of human capital, which enables us to elucidate the phenomenon of increasing returns while conducting empirical testing of economic growth models, explains the reasons for the cyclical development of the economy in terms of the aggregate effect of investments in human capital, and provides insights into the question of how exactly human capital, knowledge and technical advancement are interrelated in the economy.

It is assumed that the following mechanisms operate through which investments in human capital affect the productivity of other factors of production; moreover, they prevent the implementation of the law of diminishing returns: 1) investments in human capital enhance the effectiveness of research activities and ensure scientific and technological advancement; 2) education contributes to the formation of human capital, which directly affects the accumulation of knowledge and, consequently, the expansion of productive capacity of all factors of production. Meanwhile, knowledge is perceived as a universally accessible public good; specifically, it can circulate freely from organizations and people that develop it to those organizations and people that utilize it, thus generating beneficial externalities in social production. Due to the existence of positive externalities of new knowledge and human capital, increasing returns to human capital should be observed on the macro level. Therefore, it may be inferred that an increase in per capita human capital within any country also leads to an increase in investment in physical and human capital, contributes to higher rates of per capita income growth, and, ultimately, is realized in higher labor productivity and compensation per employee.

Results

The findings from a wide range of empirical studies on the economic growth of countries contradict the principle of diminishing returns, as well as constant returns to scale. Empirical evidence consistently implies increasing returns to scale in the models of economic growth. Therefore, M. Todaro underlines that across the entire economy, the evidence and outcomes of empirical testing of endogenous growth models refute the principle of diminishing marginal returns to capital and indicate that at the macroeconomic level the principle of increasing returns, determined by positive externalities, functions (*Todaro M.P., 1997*). P. Romer further did not exclude the possibility that the aggregate production function may be identified by increasing returns to scale (*Romer P. M., 1986*). But P. Romer clarifies this by stating it as the increasing return on physical capital.

D. Acemoglu (*Acemoglu D., 1996*) strives to formulate a theoretical justification for increasing social returns generated by the accumulation of human capital. He postulates a mechanism of monetary externality that is determined by the interaction of investment and resource-intensive search in the labor market. This mechanism is demonstrated in practice as follows: despite the absence of technological externalities and the fact that all employees compete for the same jobs, the effects of inclusion of investments in human capital increase due to external factors generated in the course of human capital accumulation (*Mayilyan F. N., 2021*).

We consider that increasing returns to scale are governed by the principle of increasing returns, not based on physical capital, but rather on human capital. However, increasing returns on human capital can be realized only at the macroeconomic level across the entire economy, and not at the individual level, and only in the long run perspective. Naturally, at the level of individuals there may also be deviations from this pattern. (*Mayilyan F. N., 2015*). For instance, if an individual is characterized by extraordinary talent, then relatively small investments in human capital can produce considerable returns compared to larger investments in the human capital of less talented individuals. However, at the macro level, these differences are equalized, since the accumulation of human capital is ongoing - retiring human capital is replaced by the incoming employees. Furthermore, human capital has the potential not only to accumulate, but also to be transferred through the application of formalized knowledge, experience and skills in the production process. Increasing returns on human capital are guaranteed through the accumulation, implementation and transfer of new knowledge. But to explicitly illustrate this pattern, the continuous accumulation of knowledge at a "decisive point" is crucial, which fosters the rapid economic growth. We believe that this precisely clarifies the fact of increasing returns in empirical tests of the models of economic growth.

However, it should be emphasized that the process of human capital accumulation itself does not automatically ensure increasing returns on investment in human capital and does not contribute to self-perpetuating economic growth. To ensure sustainable economic growth, it is first and foremost necessary to create the necessary institutional conditions for the full realization and effective use of human capital. This is especially relevant for developing countries, where the level of accumulated human capital may be high, but its contribution to economic growth may be insignificant. Furthermore, this leads to an outflow of human capital and a distortion of the entire structure of human capital reproduction. Therefore, it is crucial to develop a program at the state level aimed at improving the conditions for reproduction, and, in particular, the conditions for the effective realization of human capital. This will ensure that investments in human capital are capable of ensuring high rates of economic growth due to their unique characteristics.

The reasons for the increasing return on human capital are as follows:

1. In contrast to the physical capital, which through its application gradually deteriorates and exits the production process due to physical and moral wear and tear, the human capital, throughout a defined period of utilization (the individual's working lifetime), is enhanced, improving in quality and accumulating: the knowledge and skills of employees are developing and improving, experience is accumulating over time, the degree of specificity and cross-specialization is advancing. With the passage of time, human capital wears out both physically and morally: the rapid development of science

and technology leads to a fast pace of knowledge depreciation, which imposes increased demands on employees and requires additional investments in human capital for the duration of an active working lifetime. And, consequently, this requires investments in human capital across the entire active working life of an individual. Here, it is vital to underline that investments aimed at improving or developing new knowledge and skills in individuals with prior training are more effective and require fewer financial and time resources. Skilled individuals find it easier to acquire new knowledge and improve previously acquired knowledge and skills. Specifically, the rate of return on investment in this case is higher in contrast to untrained individuals (*Mayilyan F. N., 2021*).

2. Physical capital is depleted entirely after the completion of its effective lifecycle. Unlike physical capital, human capital, after the expiration of its productive use, is not fully depleted, as the key element of human capital, knowledge, is accumulated in some form or another, can be transferred to next generations, is persistently used as well as contributes to the generation of new knowledge, skills and experience. It is crucial to underline that considerable importance is attached to the system of science and education in the process of transferring explicit knowledge, whereas social capital is significant in the transfer of tacit knowledge (*Mayilyan F. N., 2021*). Social capital serves as the crucial mechanism that ensures the effective transfer of tacit knowledge in a distinct system. Social capital refers to a set of norms, standards, and institutional relationships between members of society and government authorities, as well as interpersonal relations among members of society, established on trust and contributing to the increase of labor productivity. From the perspective of tacit knowledge transfer, the proportional allocation of social capital within society is equally significant (this issue is explored more comprehensively by the author in the paper "The Role of Social Capital in the Process of Formation and Realization of Human Capital") (*Mayilyan F.N., 2012*).

3. Human capital in the process of development and usage, frequently, depending on the scope of utilization of human capital and the peculiarities of the profession, contributes to the growth of the human capital of other individuals (exchange of experience, professional development, etc.). To be more specific, in the process of employing human capital, a synergistic effect is realized, which consequently provides considerable positive externalities from investments in human capital. Nevertheless, it should be highlighted that positive externalities emerging in the process of accumulation and utilization of human capital cannot be precisely measured, since the scope of externalities spans across all types of human activities and has a multiplicative effect. In this context, the inclusion of the value of positive externalities in the models of economic growth is bound by certain limitations (*Mayilyan F. N., 2021*).

4. Investments in human capital generate positive externalities demonstrated by the decline in disease rates, rise in average life expectancy, improvement of life quality, education quality, decline in unemployment rates, decrease in crime rates, enhancement of the environment within the country etc.

5. Contrary to conventional resources, the fundamental aspect of human capital, the knowledge base and resource, is inexhaustible and indicates a pattern of exponential growth: the higher the value it assumes, the faster it increases. The demonstrations of this pattern are intensifying and becoming more evident in recent decades, due to the rapid pace of digitalization of the economy. If land and physical capital, considered as factors of production, demonstrate the tendency of diminishing returns, then human

capital prevents the demonstration of the tendency of diminishing returns of these factors, thereby assuring economic growth and development. N.D. Kondratyev, in his distinguished work "Problems of Economic Dynamics," underlined that growth and development are irreversible processes, since they are grounded on the process of ongoing accumulation of knowledge, which is not considerably affected by economic conditions. On the contrary, the intensity of knowledge accumulation defines the economic landscape, solving the issue of the phases of economic development and helping ensure that the economy is not situated at the same level or stage of development on more than one occasion (*Kondratiev N.D., 1989*).

6. If the investment in physical capital is determined only by economic incentives and generates a private return on investment, then the process of investing in human capital is strongly affected by national, historical, psychological and socio-cultural factors. Consequently, investments in human capital, in addition to private returns, also provide social returns. And frequently, social returns outweigh the level of private returns from investments in human capital, thereby reinforcing the trend of increasing returns on human capital (*Mayilyan F. N., 2021*).

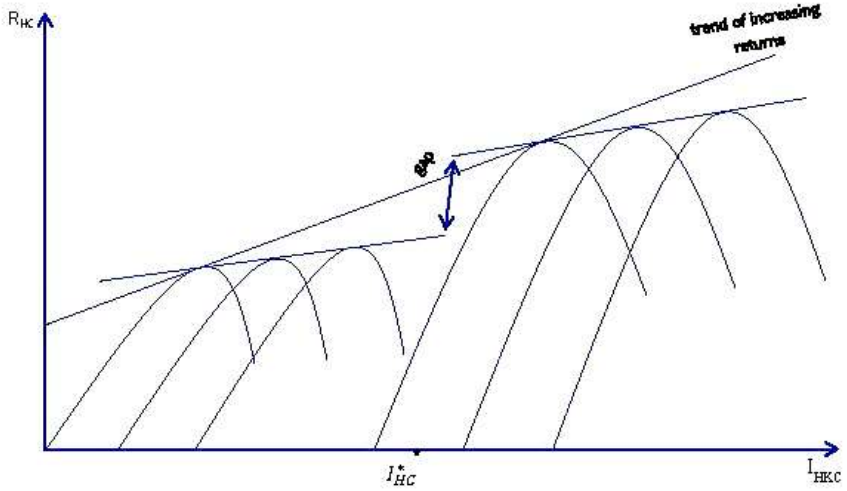
7. Investments in human capital usually generate a higher return rate when compared to physical capital both on the level of individuals and society as a whole. Although it should be highlighted that this pattern has some features that are indicated in the economies of developing countries, where the private return on human capital is often considerably lower than the level of social return. This is not attributed to the efficiency of the institutional setting for the realization of human capital as in developed countries, but to the high level of exploitation of human capital (*Mayilyan F.N.*, 2019).

Conclusion

If we analyze the return on investment in human capital at the macro level and in the long run (in the scope of large economic cycles) we can argue that investments in human capital are not constrained to the principle of diminishing returns. The process of renewal of human capital is ongoing; specifically, in the scope of economic cycles, human capital is constantly renewed. If in terms of quantitative analysis, the renewal of human capital within the scope of individual countries and regions can be simple, extended or narrowed, then in terms of qualitative analysis, due to the exponential pace in the accumulation of knowledge, the extended renewal is ensured in qualitative terms. If we aggregate the total investment in human capital of individuals, and the amount of private and social returns from investments in human capital, we can assume that at the macro level and in the long run a trend of increasing returns is expected. Namely, a function reflecting the relationship between investments in human capital and income will be obtained. It is important to highlight this principle in the scope of long-wave economic cycles. Consequently, the increasing trend of the economic cycle is due to the increasing returns on human capital. At a pivotal stage of knowledge accumulation (followed by a scientific and technological breakthrough) the return on investment in human capital increases dramatically. An illustration of the theoretical hypothesis of the principle of increasing returns on investment in human capital at the macro level can be introduced as follows (graph 1).

Graph1

Dynamics of return on investment in human capital



Source: *The schedule was compiled by the author.*

Where

$\boldsymbol{I_{HC}}$ *– investment in human capital*

$\boldsymbol{R_{HC}}$ *– return on investment in human capital*

$\boldsymbol{I^*_{HC}}$ *- the level of investment that aligns with the pivotal level of knowledge accumulation.*

As we see in graph 1, total investments in total human capital generate increasing returns over a specified period; subsequent to reaching a particular point, a trend of diminishing returns becomes evident (this trend appears until the point I^*_{HC}). But this trend emerges within the short-term period of the economic cycle and at the micro level. As investments in human capital continuously rise, the cumulative knowledge accumulation is ensured, and the "critical" level of knowledge accumulation is attained (the level that ensures a scientific breakthrough) a dramatic increase in the level of return from investments in human capital is demonstrated (indicated by an arrow on the graph). Specifically, in the long run and at the macro level, when investments in human capital are examined from the perspective of society as a whole and not of individuals, there is a tendency toward increasing returns on investments in total human capital. Investments in human capital are key factors that ensure the continuous development of science and economics. Essentially, investments in human capital should be regarded as the most profitable type of investment that provides high returns.

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