TRANSITION TO A NEW PARADIGM OF HUMAN CAPITAL DEVELOPMENT IN THE DYNAMIC ENVIRONMENT OF THE KNOWLEDGE ECONOMY

Purpose. Establishing the qualitative characteristics of human capital and their compliance with modern trends of technical and technological development, formation of theoretical and methodological foundations of a new paradigm of human capital in a dynamic environment of the knowledge economy.

Methodology. The study is based on a set of general scientific and specific methods of scientific knowledge, namely: dialectical approach — to determine the main characteristics and factors of modern technical and technological development; methods of analysis and synthesis — when studying the essential characteristics of human capital and methodological approaches to its quantitative measurement; grouping and classification — when forming a sample of countries to study the impact of public welfare on human capital indicators; mathematical statistics — to establish the relationship between per capita GVA and HDI.

Findings. On the basis of the analysis of theoretical and methodological approaches proposed by leading international organizations to understand the essence of human capital, the lack of unity in the interpretation of this category with virtually unified methods of its quantitative measurement is stated. The main features of the current stage of technical and technological development, which is identified as a knowledge economy, are highlighted, and the inconsistency of key components in the existing indicators of human capital assessment with the realities of knowledge-intensive economic growth is shown. A regression model is built, based on which the dependence of human development indicators and, accordingly, human capital on the achieved level of social welfare in a given country is shown. The reasons of this dependence are identified and the principles of a new paradigm of human capital in the dynamic environment of the knowledge economy are proposed.

Originality. The limitations of the dominant theoretical and methodological approaches to the quantitative assessment of human capital in the knowledge economy have been established. The transition to a new paradigm of its formation in modern conditions is grounded. It is proved that the qualitative parameters of human capital depend on the level of social welfare achieved in a particular country, which means that the processes of investing in human capital and increasing economic growth rates in individual countries are not always linear. The latter has been identified as one of the factors of intensification of global imbalances in technical and technological development.

Practical value. Understanding the dependence of socio-economic development on the technical and technological component and its compliance with the basic characteristics of human capital allows governments to develop more effective economic policies aimed at forming an effective knowledge-based economy.

Keywords: technical and technological development, knowledge economy, human capital, innovation, global inequality

Introduction. The current stage of human civilization progress is notable for cardinal changes in all spheres of the society functioning. Transition to a new period of engineering and technological progress, i.e. formation of the knowledge economy, is the most important one. By contrast with the previous epochs, the latter brings scientific knowledge and information to the forefront transforming them into the real-life production resources and key development drivers. Under the conditions, traditional productive factors become irrelevant; a human, being a direct creator of new knowledge and the main information carrier, becomes the crucial factor of social wealth creation. Hence, human capital is so essential for the knowledge economy: only the economic system, possessing sufficient quantity and quality of human resources able to generate new ideas, produce innovations, and implement fresh technologies; it can support both high and stable rates of science-intensive type of economic growth. Awareness of the dependence has made governments of many countries emphasize the increase in the amount of human capital and create favourable conditions to reproduce it. In turn, the abovementioned heightened competition for human resources. Under the pressure of competitive forces, shareholders aspire to maximize equity value of their company in the shortest time possible keeping on only highly qualified experts. The abovementioned becomes the weighty factor of a demand-supply gap in the labour market, increases the requirements for intellectual qualities of young specialists and employees, and intensifies migration processes. Consequently, business globalization and stiff competition for engineering and technological leadership sharpen discrepancies in the levels of life quality and accessibility to innovative resources between the developed economies and developing ones, thus being the factor of rise in inequality.

Literature review. The global development disparity of engineering and technological progress has become a research object of many outstanding scientists. Relying upon R. Solow’s ideas on the inevitable convergence of the countries, having access to the same technologies (Solow, 1956), they tried to introduce new factors into economic growth models, and demonstrate their effect on the public welfare growth. In the 1960s—1990s, the most popular approaches were those where the priority factor of economic growth. Starting from pioneering works by R. Lucas (1988) and P. Romer (1992), who actually transformed technological progress from an exogenic factor into an endogenic one and first connected it with human capital qual-
ity, and ending with studies by G. Mankiw, D. Romer, and D. Weil (1990), who proved definitely that investment in human capital could push through the disparity in economic growth rates among different world countries (G. Mankiw, D. Romer, & D. Weil 1992). During the time period, scholars mainly focused on the educational component of human capital. The matter is that R. Lucas, applying extensive empiric data, proved that growth rates of human capital itself is directly proportional to the educational time investment. Relying upon the idea, G. Mankiw, D. Romer, & D. Weil developed their model while measuring human capital as the share of population, who attended secondary school (i.e. aged 12–17 years) multiplied by a share of employable school-age population (i.e. aged 15–19 years). In the context of such an approach, the scholars miss basic education as well as higher one. However, the abovementioned could not prevent them from supporting once again the dependence of economic growth rates upon human capital.

Further, Aghion & Howitt (1992) paid attention to the importance of innovative factor for economic growth and formalized the known Schumpeterian idea on creative destruction for their model. That needed certain changes in the traditional concept of influence of an educational component of human capital. It has become clear enough that only highly skilled workforce can generate innovations. Ch. Jones has proved convincingly that the connection between public welfare and human capital, described by the available models of economic growth, took place only before the first half of the 20th century. After scientific and technological revolution of the 1950s, new technologies started identifying production profitability; hence, investment in Research & Development has become an item of priority. Thus, the increase in the number of scientists, researchers, and scholars started to be considered as the key factor of enhancing of the critical amount of human capital.

While developing the tendency, scholars improved constantly the available approaches. Mainly, it was a feedback to numerous empirical validations of the formulated models of economic growth in the light of human capital. In such a way, popular models by R. Barro & X. Sala-i-Martin; W. Baumol; B. DeLong; P. Krugman; P. Klenow & A. Rodriguez-Clare and other scholars have appeared which tried to explain in one way or another the GDP-human capital interconnection, being hardly obvious in practice, and show conditions and characteristics of the latter able to generate long-term economic growth. The problems remain topical since the new data, obtained in the field of technological advance, support the idea of non-linear growth of human capital investment as well as increase in the economic growth rates of certain countries. While analysing the current connections between human capital coefficients, R. Barro has recognized that only about a half of the coefficient estimates is positive and statistically significant [1]. Having analysed a huge number of scientific papers, concerning human capital problem, J. Botev, B. Égert, Z. Smidova, and D. Turner brought to light the paradox, the widely accepted scientific paradigm of human capital, combining knowledge, skills, and psychological features of a human as a source to increase his/her benefits as well as public welfare as a measure of the capability, embodied in a human factor, more advanced means of production, able to improve the production efficiency drastically, are developed and put into operation. Hence, a human plays a double role in the field of social production being a source of its progress as well as a beneficiary of its results. Thus, it is quite natural that economic science has always connected labour productivity growth with personnel skill level; and from the second half of the 20th century – with quantitative and qualitative characteristics of human capital.

T. Schulz (1960), who implemented the category to be applied scientifically, has mentioned that his concept relies upon something existing actually and possessing economic characteristic to render future services having a defined cost. Therefore, human capital started to be interpreted as a form of capital, combining knowledge, skills, and psychological features of a human as a source to increase his/her benefits as well as public welfare as a measure of the capability, embodied in a human factor, to produce a profit. In 1962, G. Becker, who is considered to be a creator of the scientific paradigm of human capital, focused on a formation process of the latter as a store of knowledge, skills, and motivations resulting from the investment in education, health care, accumulation of professional background, search for information, work-related mobility and so on. Such new theoretical approaches to analyse workforce initiated since the 1960s bolstered significantly a role of complicated labour in production focused increasingly on the achievements of scientific and technological revolution of the 1950s. Production processes required specific personnel skills which would help put into operation more complicated equipment and implement new techniques. That is why intellect, living knowledge, skills, abilities, and professionalism within a narrow sphere of economic activity were among the mandatory parameters to form the workforce. G. Becker was one of the pioneers who started evaluating qualitatively the components of human capital singling out the three basic forms: general knowledge (general human capital); specific knowledge (specific human capital); and other knowledge (additional human capital). The scholar believed that the first form of the capital resulted from parenting as well as from high school education and university education. The second form is developed in the process of direct labour activities at a certain workplace. Finally, the third one depends upon a human ability to handle information helping enhance a knowledge level and find more forward-looking field of economic activity (Becker, 1995).

Over time, scholars applied the first efforts to evaluate quantitatively human capital while developing economic growth models (for more details see [6]). The necessity for data, representing quantitative characteristics of human capital, encouraged numerous international organisations to measure it constantly. Currently, the approaches, implemented by the World Bank, International Bank for Reconstruction and Development, Organisation for Economic Co-operation and Development, the World Economic Forum, and the United Nations are the most popular ones (Table).

As Table explains, conceptual approaches of different organisations interpret ‘human capital’ category somewhat variously. Version one of studies by the Organisation for Economic Co-operation and Development, put an emphasis on knowledge and skills while further the category was expanded.
Interpretation of human capital by international organisations

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Content of the category</th>
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<tbody>
<tr>
<td>Organisation for Economic Co-operation and Development (OECD, 1998)</td>
<td>Knowledge, skills, competencies and attributes embodied in individuals, and can be considered as relevant for economic activities</td>
</tr>
<tr>
<td>Organisation for Economic Co-operation and Development (OECD, 2001)</td>
<td>Knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being</td>
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<tr>
<td>Organisation for Economic Co-operation and Development (OECD, 2011)</td>
<td>Skills and competencies, mainly acquired through education and experience, which also can represent inborn abilities, certain motivational and behavioural aspects as well as such attributes as physical, emotional, and mental health</td>
</tr>
<tr>
<td>United Nations (UN, 2016)</td>
<td>Knowledge, skills, competencies and attributes what was based on parenting, education, on-the-job training, informal learning, health care, migration</td>
</tr>
<tr>
<td>World Economic Forum, 2017</td>
<td>Human capital represents a level of formal education of younger and senior citizens as a result of past educational investment; formal education of next generation workforce; further training and retraining of the current workforce; application and accumulation of skills among the adult population; and width and depth of use of the specialized skills in the work</td>
</tr>
<tr>
<td>World Bank (International Bank for Reconstruction and Development and the World Bank, 2018)</td>
<td>Human capital consists of the knowledge, skills, and health that people accumulate over their lives, enabling them to realize their potential as productive members of society. It has large payoffs for individuals, societies, and countries</td>
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While understanding the complexity of the multidimensional approach to obtain the unified human capital index, the United Nations Economic Commission for Europe has developed a guide to measure it. The guide relies upon the available procedures and singles out three dominating calculation methods, namely: cost-based; based on determination of income, earned by an individual throughout life; based on certain indicators. Procedure one grounds on Shultz (1961), Kendrick (1976), and & Eisner (1985) studies. It involves calculation of human capital as the discounted value of past investment flows by the economic entity personally, by his/her family, by employers, and by the state. In terms of procedure two, comprised of contributions by Weisbrod (1961), Graham & Webb (1979), Jorgenson & Fraumeni (1989, 1992a, 1992b), and Inclusive Wealth Report (2012, 2014), human capital is measured as the total of the discounted cost of all future income flows expected to be earned by the population throughout life. If procedure one is focused on the investment expenditures (i.e. contribution to capital provision), procedure two concentrates on its returns, i.e. monetary evaluation of financial benefits, which a human capital owner may obtain over the course of life. The two procedures are considered as analogous to cost side and revenue-raising side of the System of National Accounts (Abraham, 2010). Finally, procedure three, represented by the OECD (2001, 2011) and Barro-Lee (2010, 2013), evaluates human capital on the basis of such three educational indicators as adult literacy rate, education coverage, and its average duration [7].

Materials of the World Economic Forum note that it is impossible to determine human capital only by means of formal education and qualification of employees since there are numerous factors increasing or decreasing it. Hence, dynamic measurement of the category, represented in the methods calculating the Global Index of Human Capital (World Economic Forum, 2017) is quite important. The latter consists of three components: efficiency (i.e. level of formal education of the younger and the older generations as a result of past educational investment); progress (i.e. formal education of next generation workforce, and further training and retraining of the current workforce), allocation (i.e. use of the skills and their accumulation among adult population); and know-how (width and depth of use of the specialized skills in the work) [8].

In contrast to the above Global Index of Human Capital, the Human Capital Index (HCI) of the World Bank rests on the measurement of human capital that will be available to a child who is born now and reaches the age of 18 in terms of certain health and educational characteristics of a certain country. The index represents expected efficiency of the child as a future worker relative to the standard being similar
for each country in view of fullness of educational and health indices (World Bank, 2018). The HCI comprises the following components: survival, the expected schooling years, and health. Component one mirrors the fact that children, born now, should survive until the process of human capital accumulation starts with the help of formal education. The survival is measured by means of under-five mortality rate. Component two contains information on the number of education years the child may reckon for until 18. Moreover, the information combines with quality index, i.e. how many children get schooling. The index is based upon relative success of countries engaged in the international testing as for the mastering mathematics and natural sciences. Thus, taking into consideration quality of education, the component visualizes such reality that in some countries children are taught far fewer than in others despite the fact that they attend school during similar time period. Finally, a health component applies two indices for the total health level of a country: growth inhibition rate in under-five children and adult survival rate determined as a share of fifteen-year-olds who will survive up to 60. Index one represents the health observed during prenatal, child, and early development of children; index two explains a range of health consequences the child, born now, can survive as an adult [9].

Analysis of the considered approaches (irrespective of their difference in view of the measurement components) shows that all of them give the highest priority to the educational component. The fact is meant by the recent report of the World Bank pointing out that certain discrepancies between the quantitative and qualitative education indices form the majority of differences in the human development index among 174 countries under study. Thus, comparison of the average country from high- and low-income groups has demonstrated that 33 % of differences in their growth depend upon human capital where 25 % are explained by educational parameters [10]. Consequently, according to studies by the world organisations, from the viewpoint of human capital, success of the current development stage is determined mainly by means of quantitative and qualitative educational indices.

Nevertheless, more profound studies show that the connection is not always a linear one. Metaanalysis of 60 research works on dependence between education and macroeconomic results of the country development, published from 1989 to 2011, demonstrated that almost 20 % of the estimates of human capital ratios were negative. The recent studies by the OECD also emphasize complexity in the determination of the stable positive human capital influence on the per capita income or on the efficiency level (Botev, et al., 2019; Guillemette, et al., 2017; Fournier and Johanson 2016) [2, 3, 5]. The scholars try to explain the paradox connecting it in the majority of cases with imperfection of the approaches to quantitative measurement of human capital.

Having such ambiguous results in the field of analysis of human capital as such, we have concentrated our attention on the human development index (HDI) measuring the key components of human capital (i.e. life expectancy at birth, expected years, and middle years of schooling) but connecting them with public welfare [11]. According to 2019 rating as for the data on the development of the world economies, Norway takes the lead in terms of GNI per capita being $66,694 thous. and Denmark ranks No.15 in the world where similar index is $58,662 thousand. The data were applied to develop a regression model of $Y = 0.9115 + 0.0006X$ type. In terms of the model, in 2019, top ten of the countries, shown in Fig. 1, demonstrate that 100 % increase in GNI per capita results in 0.06 on average.

However, the data concerning developing countries (we consider countries ranking Nos. 70–79 in the world, whose human capital indices as for the education and health are not the lowest ones) demonstrate nonavailability of HDI-economic growth connection. Correlation coefficient between the variables for countries, shown in Fig. 2, turned out to be negative ($r = -0.377$).

Ukraine ranks No.74 in the abovementioned rating neighbouring the ‘third world’ countries. As it follows from Fig. 2, $a$, in terms of similar HDI value, being 0.079, Ukraine demonstrates the lowest GNI index per capita, i.e. $13,216$ thousand. Hence, the model demonstrated rather high index of positive correlation between HDI as a resulting variable ($Y$) and GNI (in terms of PPP) per capita as a factor variable ($X$). The abovementioned supports the idea that high indices of human development and, hence, human capital have the developed economies. According to the model, correlation coefficient turned out to be 0.768 only for ten top countries of the rating. Hence, increase in the GNI index (namely, its GDP components within the country as well as net profit got abroad) is the
source of resource provision of the human capital development. In addition, it is the factor intensifying uneven socioeconomic development of the world.

First of all, the tendency can be explained as follows. The current economy has changed drastically its basic development drivers; it is moving rapidly to a knowledge-based model where innovations become motive power and knowledge, education, and science are the sources. Respectively, a creative worker, able to generate new ideas, design new facilities, and implement new technologies, is the key component of such an economy. The conditions involve not only increase in the share of intellectual labour while creating value added; factors of the creativity growth become powerful. It is common knowledge that creativity can be fully implemented if only environment is friendly, i.e., favourable conditions have been created to unlock maximally the talents and creative potentials. Consequently, today we are witnessing the global tendency of transition of representatives of creative human capital to the countries having high welfare indices; basing on it, we can provide the advanced profitability of the key resource. It is known that the yield rate of new knowledge depends upon the available for certain economy mental vocabulary as well as incentives to invest in the storage. It is understood that higher return on human capital in a certain country inspires ambitions to unlock proper potential right there where it is possible to earn higher profits.

Along with it, concentration of scientists and engineers where adequate infrastructure and creative environment are available, becomes the extra factor intensifying the effect of innovation deployment. Policies of the advanced countries, encouraging mobility of researchers and gifted students, favour creation of clusters of science, technologies, and human capital as the means to augment proper research potential and support innovative environment. Currently, the USA embraces 49.1% of all foreign doctoral students trained in the field of natural and engineering sciences. The UK embraces 9.2%; and France embraces 7.4% [12]. The USA, the UK, France, and Germany lead among the countries inviting foreign Doctors of Sciences and researchers to participate in scientific and educational projects. While creating more favourable conditions for research practice, publications, and activities in laboratories, equipped with unique facilities, the countries improve in such a way qualitative characteristics of human capital of a certain community within their terrains and promote higher innovation [Ibidem]. Hence, each year we observe a growing tendency of migration in search for higher labour remuneration. In turn, the abovementioned gives rise to disparities in the centres of education costs and centres of income generation. Among other things, it concerns indices of share of specialties of innovative economy. Among other things, it concerns indices of innovation, the world competitiveness, technological availability and others. We consider it important to consider the structure of human capital accumulation in a country while calculating a share of negative, passive, and positive human capital to evaluate its creativity and efficiency. Totally, the additions will make it possible to evaluate better innovative tendencies of human capital development as well as its potential and real effect on the current economic growth.

Conclusions. The new stage of technical and technological development, determined as creation of the knowledge economy, is characterized by cardinal changes in the basic factors of economic progress of a society. Currently, scientific knowledge and information become the driving production resources, which need formation of human capital of special quality. Nowadays, industries need creative workers able to generate new ideas, produce innovation, and implement new technologies. Demand for such human capital makes countries compete for talents, which deepens global unevenness of technical and technological development.

First, economists paid attention to human capital as a factor producing economic welfare of countries in the 1960s – 1990s, when the first models of economic growth were developed and technical progress was taken into consideration. In
The course of economic development (especially, when achievements of scientific and technical revolution of the 1950s started to be introduced into production), the models began to demonstrate their limitedness as for the explanation of new phenomena and processes of science-intensive economic growth. Generation two of models, developed by R. Barro & X. Sala-i-Martin, W. Baumol, B. DeLong, P. Krugman, P. Klenow & A. Rodriguez-Clare, was intended to search for new factors of economic development, and explain nonlinear nature of GDP-human capital connection in certain countries.

Empiric assessment of new models of economic growth is based upon the use of qualitative evaluations of public welfare and human capital. Currently, the latter is measured relying upon the theoretical and methodological approaches developed by the key international organisations. First, analysis of the approaches demonstrates ambiguous interpretation of human capital idea by different institutions; second, similarity of methods for its quantitative measurement is shown where particular attention is paid to the educational component.

The knowledge economy, being science-intensive, computerized, and innovative, brings to the fore fundamentally new requirements for workforce, which cannot be evaluated fully with the help of indicators used by the major international organisation as a basis for the development of human capital indices. Hence, it is required to move towards the current new paradigm of its formation; theoretical and methodological approaches for its evaluation should involve qualitative component of human capital, efficiency of investment in its formation and development, and real as well as potential ability to obtain and apply new technologies.

The developed regression model helped demonstrate dependence of human development indices and, hence, human capital upon the achieved level of public welfare in a certain country. The abovementioned is explained by the effect of increasing productivity of intellect use within the environment of larger knowledge concentration. The latter is intensified in the process of talent migration as well as implementation of policies of the key world countries as for the attraction of gifted youth and scientists. The abovementioned is among the factors deepening global disparities of technical and technological progress since the better-quality capital is concentrated in the advanced economies.
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