DOI: http://doi.org/10.31617/1.2025(164)09
UDC 336.02:331.108=111

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FINANCIAL POLICY FOR HUMAN CAPITAL DEVELOPMENT

Human capital development is one of the priorities for the public financial policy's application. Its tools can vary significantly, depending on the model of the national economy. In the countries with the advanced economies, to ensure human capital development, the main government's attention is paid to the issues of improvements in the studying technics, coordination between the educational process and the main labor market demands, implementation of the optimal mechanism for the fundamental and applied science's financial support, and innovations introduction in production as well. The aim

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ФІНАНСОВА ПОЛІТИКА РОЗВИТКУ ЛЮДСЬКОГО КАПІТАЛУ

Розвиток людського капіталу є одним з пріоритетів реалізації фінансової політики держави. Її інструментарій може суттєво різнитись залежно від моделі національної економіки. Країни з розвиненою економікою приділяють увагу питанням вдосконалення освітніх технологій, адаптації навчального процесу до основних запитів ринку праці, пошуку оптимального механізму фінансового забезпечення фундаментальної й прикладної науки, своєчасного впровадження інноваційних розробок у виробничий процес, що має забезпечити розвиток людського капіталу. Метою статті є визначення ролі людського

of this research is to determine the role of human capital as a determinant of economic growth in European countries and to justify the priority financial policy measures for its development. The hypothesis is that there is an interconnection between public and private investments in human potential development, education, R&D, the national economy's institutional architectonics improvement, and economic growth as well. To confirm the above hypothesis, the methods of comparative analysis, the study of time series, regression analysis, deduction and induction, systematization and scientific abstraction were applied. The sample includes the economies of the EU–27 member-states, the United Kingdom, Iceland, Norway, Switzerland, and Ukraine over the period from 2000 to 2023. The financial policy's role in ensuring human capital development is revealed. The human development index's impact on economic growth is evaluated. The relationship between the aforementioned indicators appeared to be statistically significant and positive. The peculiarities of education financing in the sampled countries are investigated. The role of public and private investments in R&D is revealed. High-technology exports and the dynamics of the researchers' in R&D number in the sampled countries are considered. The strategic priorities for reforming the education and science financing system using fundraising and endowment tools are identified. The increased funding for fundamental and applied research is justified. The conditions under which – regarding martial law – the development of high-tech military can become a guarantee for human capital growth are revealed. The financial policy's dominants for human potential development are identified.

Keywords: public financial policy, human capital, budgetary policy, productive budget expenditures, education and R&D expenditures, endowment, fundraising.

капіталу як детермінанти економічного зростання у країнах Європи та обґрунтування пріоритетних заходів фінансової політики для його розвитку. Висунуто гіпотезу щодо наявності взаємозв'язку між публічними та приватними інвестиціями в розвиток людського потенціалу, освіту, науку й технології та розбудовою інституційної архітектоніки національної економіки й її зростанням. Для підтвердження гіпотези застосовано методи: компаративного аналізу, вивчення динамічних рядів, прийоми регресійного аналізу, дедукції та індукції, систематизації та наукове абстрагування. Вибірка включає економіки ЄС–27, Великої Британії, Ісландії, Норвегії, Швейцарії та України у 2000–2023 рр. Розкрито роль фінансової політики у забезпеченні розвитку людського капіталу. Здійснено оцінку впливу індексу людського розвитку на економічне зростання. Визначено, що взаємозв'язок між зазначеними індикаторами є статистично значимим та позитивним. Проаналізовано особливості фінансування освіти у країнах вибірки. Розкрито роль публічних та приватних інвестицій в НДДКР. Розглянуто наукоємний експорт і динаміку чисельності науково-технологічного персоналу країн вибірки. Обґрунтовано стратегічні пріоритети реформування системи фінансування освіти та науки з використанням інструментарію фандрайзингу і ендаументу. Визначено потребу збільшення фінансування фундаментальних і прикладних досліджень. Розкрито умови, за яких під час воєнного стану розвиток high-tech military може стати запорукою зростання людського капіталу. Охарактеризовано домінанти фінансової політики розвитку людського потенціалу.

Ключові слова: державна фінансова політика, людський капітал, бюджетна політика, продуктивні видатки бюджету, фінансування освіти і науки, ендавмент, фандрайзинг.

JEL Classification: E69, H39, O15, O20.

Introduction

Ensuring sustainable economic growth is the main task of public policy, which involves coordinated operation of financial, economic and institutional tools to achieve it. The results of economic growth are manifested in improving the level of public welfare, reducing social inequality, and developing human potential as well. The latter is one of crucial determinants of economic development on an innovative basis. Advanced economies pay significant attention to the educational technologies' development, adapting education to the needs of the labor market, finding the

optimal mechanism for financial support for fundamental and applied science, and introducing scientific developments into the production process. Technological modernization of the economy is mpossible without a high level of human development and qualified personnel. That requires significant budget allocations to the sphere of social production, the formation of a favorable environment for attracting investments from business in education, science, healthcare, social infrastructure, etc. In the conditions of increasing competition in the capital and labor markets, the issue of forming the national economies' competitive advantages becomes essential as well. That requires formation and implementation of a balanced and well-founded public financial policy. It is also important to strengthen the efficiency of institutions and the overall governance, which increases public confidence in structural changes in the applied policy. Scientific substantiation of financial policy measures for the human potential development, aimed at expanding the share of high-tech and knowledge-intensive production, is relevant and appropriate.

The issue of the human capital's impact on economic growth and the financing mechanisms' development for the programs to stimulate human potential is investigated by a plethora of researchers and experts. Hanushek and Woessmann (2020) highlighted the interdependencies between education, knowledge capital and economic growth. The quality of education and, as a result, the knowledge accumulated by the society have a decisive impact on economic development. The quality of educational services and the level of their compliance with the labor market demands are vital. Simionescu et al. (2021) investigated the role of innovation, foreign direct investment and human capital development in ensuring the competitiveness of the EU member-states economies. The researchers proved that the enterprises', institutions' and organizations' personnel innovative skills playd the dominant role in the new technologies' development, and therefore public and private investments in education and science were the basis for increasing the respective national economy's. Tirelli and Spinesi (2021) examined the impact of investments in R&D on economic development, considering the information asymmetry and globalization trends. The authors emphasized that innovatively active investors could access a wider range of financing sources, including non-debt, and were more resilient to market fluctuations.

Boeing et al. (2022) examined the impact of budget subsidies for R&D in China on the dynamics of investment in the production's technical modernization and economic growth as well. The authors state that the increase in public spending on science may be associated with a certain reduction in private investment in R&D, but is generally associated with an increase in the scientific and technical personnel's number and sustainable economic growth. It was found that control over the public resources' usage should be strengthened, and that required development of a new financial space's

architectonics. Kučera and Fiľa (2022) quantitatively assess two stochastic dependencies: the impact of R&D spending on innovations and the impact of the latter on economic growth. The authors prove the statistical significance of both interdependencies. The technological factors' overall impact, in particular artificial intelligence, on the processes of economic growth in the context of the existential threats that accompany them is in the focus of Jones (2023). Kussaiynov et al. (2023) analyzed the impact of human capital on the development of the Kazakhstanian economy, focusing specifically on the investments in education and public healthcare. Scientists note the absence of a statistically robust interconnection between the phenomena under study. Maug (2025) examined the relationship between corporate finance and human capital development, identifying the causes and consequences of business sector investment in the latter's development. The author separately highlighted the totality of risks and restrictions on the growth of human capital.

Nazukova (2021) studied the tools of post-crisis budget financing of education in the context of ensuring sustainable economic growth and human potential development. Mazaraki et al. (2021) pointed out the feasibility of introducing the experience of implementing a digital policy (similar to that implemented by China) for Ukraine in the context of civilizational challenges and the needs of ensuring sustainable growth.

Ilyina (2021; 2022) investigated budget investments in human capital during the large-scale crises (pandemics and wars), emphasizing the priority of developing a strategy for managing such investments. Kachula (2023) considered the specifics of financing education as a prerequisite for growth under martial law. Chugunov and Liubchak (2024) address the issues of budgeting under martial law, revealing the basic principles of public financial policy. Mazaraki & Umantsiv (2025) propose a new methodological approach to justifying the directions for the domestic economic policy's modification in the context of the actual imbalances. However, the development of financial tools for stimulating human potential requires further research, which determines the relevance of this article.

The aim of the research is to determine the role of human capital as a determinant of economic growth in European countries and to justify the priority financial policy measures for its development.

The initial hypothesis of the research is the assumption of a connection between public and private investments in the development of human potential, education, R&D, the improvements in the institutional architecture of the national economy and its growth. In the course of a study the endogenous factors of economic growth countries with advanced and emerging market economies was considered. The aforementioned sample included the EU-27 countries as well as the United Kingdom, Iceland, Norway, Switzerland and Ukraine. Given that economic growth is a complex phenomenon that occurs with a certain time lag, the interval

of 2000–2023 was chosen for the analysis. The information base of the study was the statistical data and forecasts of the UN, the World Bank, the IMF and the World Intellectual Property Organization.

A combination of general and specific scientific methods was applied. Comparative analysis techniques were used to collate the sampled national economies' parameters. Methods of dynamic series mathematics analysis, in particular grouping, ranking and calculation of average values, were used to process the statistical information. The regression analysis method was used to determine the influence of human capital development indicators on economic growth. Induction and deduction were used to determine the endogenous factors of human capital growth. Methods of systematization and scientific abstraction were used to formulate the priorities of fiscal policy to ensure human capital growth.

The paper consists of three sections. The first section reveals the interdependence between the economic growth rates and the changes in the human development index. A regression analysis of the above indicators was conducted. A general trend in the sampled countries was identified and their grouping was carried out. The second section reveals the role of financing education and science as an endogenous factor of the national economy's growth. The expenditures on education and R&D are analyzed in terms of funding sources. The export structure and the number of population in knowledge-intensive production are investigated as well. The priorities of the financial policy for human capital development are determined in the third section. Strengthening the innovation activity's forecasting accuracy and monitoring of performance based budgeting are identified as strategic priorities. The role of alternative sources of human capital development funding programs is revealed.

1. The role of human capital in ensuring economic growth

Economic growth indicators are important in the context of assessing economic development and social welfare. On the one hand, it is essential to determine the impact of economic development on the incomes increase and the inequality reduction, taking the social needs into account. On the other hand, the determination of the relationship between the level of human capital development and the dynamics of economic growth is crucial. In the Cobb-Douglas production function, physical and human capital are imperfect substitutes, and sustainable economic growth is possible only under the conditions of their harmonious combination. Human capital is a set of psychophysiological and intellectual properties of the population involved in social production. The structure and dynamics of investments in education and public health care affect the national economies' competitiveness. Qualified personnel are faster at perceiving technological and organizational innovations, ensuring permanent technological renewal of production. The scientists, researchers,

and entrepreneurs, who sense the future trends in social development and the population demands, provide breakthrough ideas and technological development.

The existence of production factors is not a prerequisite for economic growth. Only their effective combination can ensure positive macro-dynamics, and for that the specific system should be created. The core of the above should be the set of knowledge, competencies, and attitudes – the intellectual component of human capital (Chugunov et al., 2021). There is a number of approaches to asses the latter. The Human Development Index (hereinafter – HDI), the calculation methodology of which was proposed in the first Human Development Report of the United Nations Development Program (UNDP) in 1990, is the most common. Since 2010, the indicator has been calculated using modern methodology. The issue of public financial regulation of human development is Chugunov and Kozarezenko (2017).

HDI combines three groups of society's characteristics regarding public healthcare, education and economic well-being. The above are determined by the average life expectancy at birth, the literacy rate of the population and the average expected duration of schooling, as well as gross domestic product per capita at purchasing power parity (expressed in US dollars), respectively. HDI varies from 0.000 to 1.000, and the countries are included in groups with very high (over 0.800), high (from 0.700 to 0.799), medium (from 0.550 to 0.699), and low (up to 0.549 inclusive) human development.

All the sampled countries at the beginning of the observations, in 2000, belonged to the groups with high or very HDI. Thus, the high HDI was recorded mainly in the economies of Central Europe and the Baltics, in particular in Ukraine (0.716, the minimum for the sample), Romania (0.730), Bulgaria (0.733), Latvia (0.764), Croatia (0.769), Slovakia (0.774), Lithuania (0.778), Hungary (0.781) and Estonia (0.793). The same group included the countries of Southern Europe: Malta (0.790) and Portugal (0.797). The leader of the sample in 2000 wasNorway with an HDI of 0.924.

At the end of the observation period, only Ukraine belonged to the group of countries with a high HDI (at the level of 0.779). The most problematic aspects remain life expectancy, which is significantly affected by military operations, environmental factors, quality and accessibility of medical care, etc. The potential HDI growth points for Ukraine are the improvement of public healthcare infrastructure and additional investments in the aforementioned sector, financial support for the medical personnel, etc. Among the sampled countries, Ukraine has the lowest level of population income, which in conditions of full-scale invasion, is largely supported by the funds from external stakeholders and does not have a high reserve for economic growth. In 2001, Malta (0.801) and Estonia (0.802) were in the group of countries with very high HDI. In 2002, they were joined by

Hungary (0.800), in 2003 by Lithuania (0.812); in 2004, by Slovakia (0.806), Croatia (0.807), and Latvia (0.809); in 2008, by Romania (0.815), and lastly, in 2011, by Bulgaria (0.803).

The annual HDI growth rates for the sampled countries were calculated, as well as the average investigated index's growth rate for 2000–2023. The above were compared with the dynamics of economic growth, expressed the real GDP per capita growth rate (*Figure 1*).

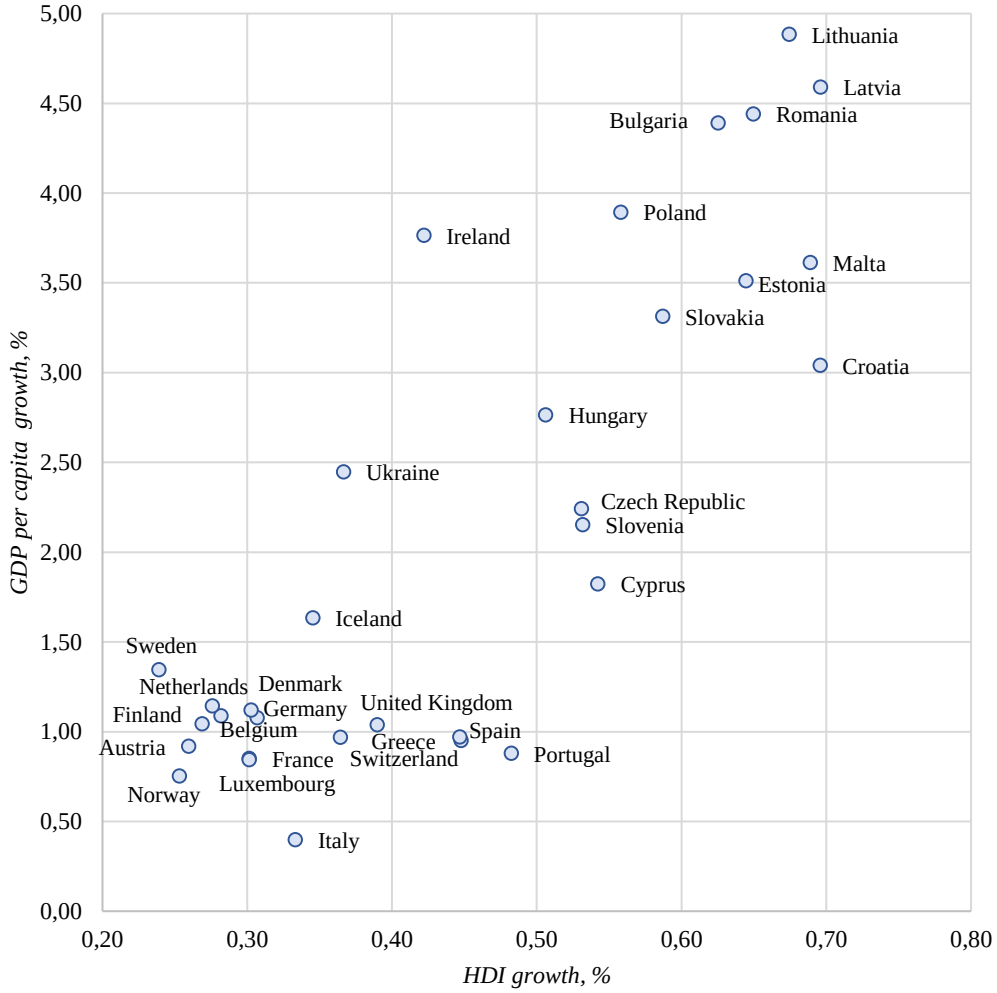

Figure 1. Dynamics the HDI and economic growth in European countries in 2000–2023

Source: calculated and compiled by the authors based on data from the UN and the World Bank (UN. Human Development Reports, 2025; World Bank Open Data, 2025a).

For the majority of the sampled countries, the HDI dynamics were upward. The above was due to the several reasons: improvement into the quality of social security and health care, leading to an increase in the expected and actual life expectancy, improvement into the educational practices and extanded accessibility of education. Integration trends in the analyzed period of 2000–2023 were reflected in three the EU enlargements:

the fifth (2004, when Estonia, Cyprus, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia, Hungary, and the Czech Republic joined), the sixth (Bulgaria and Romania in 2007) and the seventh (the accession of Croatia in 2013). The above was preceded by the changes in the economic, social and demographic policies of the candidate-countries, when the results achieved by the so-called "old" member states, became targets for the transformations in the relevant areas.

The sampled countries can be divided into two subgroups. The first subgroup involves mainly the "old EU" (in particular, the United Kingdom, which was a member of the European Community until 2020), as well as Iceland, Norway and Switzerland. That subgroup is characterized by an average increase in the HDI up to nearly 0.50% (the highest average value observed – 0.48% – was in Portugal) and an average growth rate of real GDP per capita up to nearly 2.00% (the maximum average indicator is 1.63% – found in Iceland). Such indicators can be partially explained by the high "starting positions" of the national economies of the subgroup, but their steady growth indicates the rationality of the respective authorities' development applied strategies. The second subgroup includes the economies of the "new" EU member-states. The minimum average HDI increase for the above subgroup – 0.51% – was observed in Hungary. The maximum indicator at 0.70% was observed in Latvia and Croatia.

The exceptions to this sample are the cases of Ireland and Ukraine. The Irish economy demonstrated rather high average growth of real GDP per capita for the "old markets" – 3.76% – with the low HDI growth rates (0.42%). The Ukrainian national economy is characterized by a moderate average growth of real GDP per capita for the subgroup of emerging markets – 2.45%. Regarding the above parameter, Ukraine was an outsider in the region, being ahead only of Slovenia (2.15%) and the Czech Republic (2.24%). At the same time, Bulgaria (0.63%), Estonia (0.64%), Romania (0.65%), Lithuania (0.67%), Malta (0.69%), Croatia (0.70%), and Latvia (0.70%) were in the subgroup of economies that were growing most intensively both in terms of HDI and in terms of GDP per capita growth. The scale and sectoral specialization of the economy should be considered in an in-depth analysis of the differences in the main macro indicators of the sample.

Using econometric methods, it was found that with an increase in HDI by 0.10 percentage points, real GDP per capita increased by 0.75 percentage points. The coefficient of determination is quite high and equals to 0.693. The "accelerated" growth of emerging markets compared to the "core" of the EU and other developed countries is explained both by different starting positions and by the need for institutional reforms, the search for effective models of the economic agents' interaction, and the gradual "equalization" of the main social and economic indicators as a result of integration in the studied region. Thus, the growth of human potential can be considered both as the root cause and as a consequence of economic growth.

2. Education and science funding as an endogenous component of economic growth

The intellectual component of human capital depends on the development of scientific and educational environment investments in those areas. Educational investments can be decomposed into several components. Firstly, the function of financing education is associated with the activities of public institutions, although their role varies significantly. After all, each educational level has its own characteristics and financing mechanisms. Secondly, the economic agents' awareness in the presence of a robust positive relationship between the qualitative level of educational training and the results of economic activity encourages the expansion of private investment in the educational sphere. And finally, the business sector and various non-profit organizations that act as the grantmakers play an increasingly important role in the formation of the educational ecosystem.

Jorgenson and Fraumeni (1992) proved that the appropriate level of educational investments was decisive for the formation of total individual labor income throughout life. By labor income, they understood not only the results of an individual's activity in the labor market, but also the multiple benefits that education provides, increasing the potential of an individual in non-market activities. The sampled countries are comparable in literacy, but differ significantly in the levels of educational enrolment (basic, secondary, and tertiary) of the corresponding social and demographic strata. Zumeta et al. (2012) conclude that rational financing of education should be recognized as a priority for governments and private investors in the context of globalization.

Domestic authors emphasize that public spending on education should consider the current age structure of the population and the specifics of the various recipients' educational requests (Khachatrian et al., 2023). This is especially relevant in the context of the lifelong education paradigm.

It is advisable to assess the ratio of public spending on education and annual real GDP growth rates in the sample countries for the period of 2000–2023. The analysis shows significant differences in the average GDP per capita growth rates of advanced and emerging market economies over the period under study. The average economic growth rate of the countries in the sample is 2.12% of annual GDP per capita growth, and all the "new" EU member-states developed much more intensively than the "core" ones. Lithuania (4.88% of GDP per capita) and Latvia (4.59% of GDP per capita) were characterized by particularly high growth rates. The average public expenditures on education in those countries turned out to be lower than the average for the sample (5.20% of GDP), amounting to 4.71% of GDP for Lithuania and 5.12% of GDP for Latvia. Obviously, there is a certain non-normalized lag between the moment in life when an individual acquires the

necessary educational competencies and the time when the same individual will be able to practically apply them. That is why the relationship between public educational expenditure and economic growth rates is nonlinear. The highest rates of public expenditure on education are in the countries of Northern Europe, ranging from 6.42% of GDP in Finland to 7.64% of GDP in Denmark. At the same time, the average growth rates of the national economies of this subsample ranged from 0.75% in Norway to 1.63% in Iceland.

Sustainable economic growth implies an inextricable link between education and science. Therefore, it is logical to study the dynamics of public and private spending on science in the sampled countries, as well as other parameters of their scientific and technical environment.

We focused on the three key parameters for analysis:

- R&D expenditures in terms of 4 sources (the business sector, the government, educational institutions, and non-profit organizations);
- the share of high-tech exports in the structure of foreign trade (as a basic characteristic of the national economy's scientific potential);
- the number of population involvement in R&D.

Table 1 presents the average values of selected indicators of scientific activity in the sampled countries for the period of 2000–2023.

The lowest average R&D expenditures for the specified period are observed in Romania (0.45% of GDP). Lower than the average for the sample – 1.58% of GDP – during the analysis period, "scientific" expenditures were recorded in Cyprus and Malta, Latvia, Bulgaria, Ukraine, Slovakia, Greece, Lithuania, Poland, Croatia, Hungary, Spain, Portugal, Italy, Ireland, Luxembourg, Estonia and the Czech Republic. The leaders of the sample were Finland (3.18% of GDP) and Sweden (3.36% of GDP). It should be noted that not only the share of R&D expenditures, but also the structure and institutional capacity of the respective economies determine their sustainability and development potential.

Given current development trends, it is expedient to evaluate each national economy by the share of its high-tech exports in the overall structure. On average, 15.85% of products (goods, works, services) exported by the sample countries during the period 2007–2023 were high-tech.

The indicator ranged from 5.88% (Portugal) to 38.80% (Malta). However, it is worth considering the structural specifics of the economy and institutional traditions of Malta, as well as the extremely high volatility and predominantly downward dynamics of that country's indicator, which decreased from 53.02% in 2000 to 43.27% in 2023. This indicator was high in Hungary, Cyprus, Norway, Switzerland, the United Kingdom, the Netherlands, France, Iceland, and Ireland.

Table 1

Indicators of scientific activity in European countries in 2000–2023

Country	Annual GDP growth per capita, %	R&D expenditure, % of GDP	Share of high-tech exports, % of exported goods*	Number of persons engaged in R&D, persons per 1 million population***
Austria	0.92	2.73	13.59	4 584
Belgium	1.09	2.38	12.90	4 261
Bulgaria	4.39	0.63	9.12	1 762
United Kingdom	1.04	2.01	23.22	4 141
Greece	0.95	0.87	12.03	2 631
Denmark	1.08	2.77	15.38	6 593
Estonia	3.51	1.37	18.32	3 151
Ireland	3.76	1.26	29.59	4 001
Iceland	1.63	2.45	29.01	6 634
Spain	0.97	1.22	7.44	2 696
Italy	0.40	1.25	7.96	1 904
Cyprus	1.82	0.49	20.71	1 112
Latvia	4.59	0.58	14.81	1 805
Lithuania	4.88	0.87	11.88	2 839
Luxembourg	0.84	1.36	7.51	4 716
Malta	3.61	0.55	38.80	1 562
Netherlands	1.14	1.96	24.66	4 195
Germany	1.12	2.79	16.61	4 298
Norway	0.75	1.74	21.39	5 652
Poland	3.89	0.89	8.76	2 174
Portugal	0.88	1.24	5.88	3 606
Romania	4.44	0.45	9.92	925
Slovakia	3.31	0.72	9.11	2 572
Slovenia	2.15	1.89	6.87	3 789
Hungary	2.77	1.20	20.14	2 581
Ukraine	2.45	0.70	6.05**	1 228
Finland	1.04	3.18	11.93	7 449
France	0.85	2.17	25.02	4 011
Croatia	3.04	0.92	10.43	1 751
Czech Republic	2.24	1.56	18.60	3 052
Switzerland	0.97	2.86	22.72	4 553
Sweden	1.34	3.36	16.97	6 336

* In 2007–2023
** In 2011–2023
*** Using an adjusted methodology for countries with a population of less than 1 million: Iceland, Luxembourg, and Malta.

Source: calculated and compiled by the authors based on (World Bank Open Data, 2025a; 2025b; 2025c; 2025d).

It should be noted that 6 European economies entered the top 10 most innovative in the world (Switzerland – 1st place; Sweden – 2nd; Great Britain – 6th, Finland – 7th; Netherlands – 8th; Denmark – 9th place) (Global Innovation Index, 2025). For Ukraine, the indicator was calculated over the period of 2011–2023 and was characterized by moderate growth from 4.51% at the beginning of the period to 6.69% at the end. The dominance of raw materials and low-tech products in the export structure indicates the extensive nature of national production, significantly reducing the competitive potential of the

economy. Ukraine ranks 66th out of 139 countries studied by the criterion of innovativeness.

In the socio-demographic context, it is important to distinguish the social stratum of people directly involved in R&D – scientific and technical personnel. Nordhaus (2015) formulated the singularity hypothesis, according to which the rapid growth of automated computing and the development of artificial intelligence will soon cross a certain limit (singularity), after which economic growth will accelerate, and heterogeneous improvements will crucially transform the national economy. However, that will unlikely lead to a rapid reduction in the number of scientific and technical personnel, but will only free them from information collection and processing operations. Instead, the generation of ideas, the formulation and verification of hypotheses, and other highly intellectual activities of scientific and technical personnel become critically important.

To ensure comparability of indicators for sampled countries that differ significantly in population size, we estimated the number of people involved in R&D per 1 million population of the respective country. The average indicator for the sample over the period was 3.518 people per 1 million population. It was the highest in Finland, and the lowest in Romania (7.449 and 925 people per 1 million population, respectively). The level of population involvement in R&D was also high in other Nordic countries: 5.562 people per 1 million population in Norway, 6.336 people per 1 million population in Sweden, 6.593 people per 1 million population in Denmark, 6.634 people per 1 million population in Iceland (adjusted for the actual population size of the country). The involvement of the population in R&D not only contributes to the increase in the technological advancement of production, but is also a sign of a successful individual career trajectory. Conversely, the reduction in the corresponding social and labor stratum may indicate an imperfect governmental policy in the labor sphere, a decrease in the prestige of scientific professions, etc., which should be regarded while preparing the development strategies for the relevant national economies.

Until 2016, the level of involvement in R&D in Ukraine exceeded 1.000 people per 1 million population, and since 2017, it reduced almost twice. However, those dynamics can be explained by the mass migration of highly qualified citizens due to russian military aggression, large-scale destruction of scientific and technical infrastructure, and temporary occupation of territories. In addition, military actions have necessitated a revision of the budget expenditures' structure in favor of strengthening defense capabilities. State funding of science is insufficient. The average ratio of public expenditures on scientific and technical activities for the period of 2020–2024 was 0.22% of GDP, the expected indicator for 2025 is 0.17% of GDP (at the 2024 level).

In view of the above, it is necessary to comprehensively apply the institutional tools for regulating scientific and technological development,

involving both public and private financial resources. It seems rational to create such scientific and technological ecosystem, where the government, educational and scientific institutions as well as business entities can become full partners, directing their efforts and resources to achieve a common goal, such as ensuring sustainable economic development on an innovative basis.

3. Priorities of financial policy for human capital development

Creating the most favorable conditions for the sustainable and intensive development of human capital (as a basic endogenous factor for ensuring social and economic growth) is an urgent and important task of implementing financial policy. Strengthening and improving the mechanism for coordinating the elements of the innovation system is actualized under the conditions of joint public-private financing of development and production of high-tech goods, works and services.

Public demands for obtaining competitive quality of education should be in the focus of public financial and economic policymakers. The outflow of applicants abroad and a significant deterioration in the demographic structure of Ukrainian society are a direct consequence of the insufficient demand for this group of services since the 1990s. Intensive military operations act as a kind of catalyst for depopulation processes, accelerating the emigration, in particular the young age stratum. According to the UN, as of October 2025, 5.75 million Ukrainians had been forcibly displaced as a result of the full-scale invasion (UN. Ukraine Refugee Situation, 2025). At the same time, according to the European Commission, as of August 2025, 4.3 million Ukrainians had received temporary protection status in the EU member states (European Commission, 2025).

That highlights the need to improve the functioning principles of the higher education system in terms of its deeper integration with science. Both the funding system itself and the method of implementing R&D results into the educational process require transformation. It is essential to strengthen the applied aspects of educational programs, improve the mechanism for independent assessment of the education quality as well as the financial capacity of educational and scientific institutions. A positive factor in domestic innovation activity is the guaranteed basic funding of scientific activity for universities that have research or national status. The purposefulness of the state's intentions to ensure qualitative changes in the industry is evidenced by budget funding (based on competitive tasks and in accordance with the strategic priorities of science and technology) of fundamental and applied research (Kaneva et al., 2022). At the same time, during the competitive selection of such projects, it is important to take the specifics of the field of scientific activity into account, which directly affects the volume of financial support needs.

The close relationship between market demands and the content of higher education programs should meet the requirements of the modern economy. The competitiveness of education can be strengthened by directly involving employers in internship programs, preparing scientific and

methodological support for educational courses, giving open lectures, holding round tables, forums, seminars and conferences. Positive synergy of cooperation between education and business is possible on the basis of a targeted order for the training of highly qualified specialists.

According to Acemoğlu and Robinson (2025), quality of education contributes to the economic culture formation, the elimination of conflicts between economic agents and has a positive impact on human capital. Acemoğlu (2023) emphasizes that the entire positive potential of innovations can be "distorted" if the latter are not adequately interpreted through the market mechanism. Therefore, to intensify economic growth, it is necessary to stimulate investments in human capital development.

Underfunding of fundamental research leads to the inevitable loss of scientific and technical personnel; whose new training is quite problematic and costly. It is even unlikely that further increase in funding of this area will help to return the professionals (who have changed their profession or emigrated). Therefore, such research requires systematic and consistent support. Fundamental research should develop according to the principles of stimulating scientific competition, improving the financing tools of scientific institutions and organizations, in particular the National and sectoral academies of sciences, and coordination between elements of scientific infrastructure, the network of higher education institutions and business entities of the real sector of the economy.

The tools of structural-functional analysis and performance based budgeting are the most appropriate for assessing the effectiveness of investments in the scientific sphere. Economic, social and technological criteria (in particular, ensuring the international competitiveness of domestic knowledge-intensive industries, harmonizing research topics with the priorities of institutional modernization and the strategy of social and economic development) should be taken into account when making decisions on the allocation of public resources for scientific research. Science is a system-forming endogenous element of the innovative model of economic development.

Further improvement in the architectonics of human capital's financial regulation requires increasing the accuracy of forecasting innovation activity and strengthening control over the economic development programs' implementation efficiency. It is necessary to ensure the consistency of the budget programs' preparation with the strategic priorities of innovative development. Special attention deserves planning of the main spending units' activities and development of simple and understandable methodology for monitoring and controlling their effectiveness. Moreover, it is necessary to improve the institutional framework of the mechanism for medium-term forecasting of social and economic development.

For a long time, targeted private financing using funds from individuals and legal entities was an alternative to public financing of

education and science. In particular, the practices of direct ordering of educational services or performing a set of research works were widespread. Currently, the other mechanisms have proven themselves in this area. Those mechanisms are fundraising, crowdfunding, crowdsourcing, and endowment funds. Although in those cases mainly private financial and other resources are used, the intentions of their owners are different from targeted individual financing. Donors of such resources are guided not only by the desire to obtain private benefit, but also by an orientation towards the public good. Mazaraki and Volosovych (2023) note that the dynamics and scale of development of these practices have already led to the transformation in investment relations due to the active use of FinTech solutions, which opens up the new opportunities for the sustainable development of the educational and scientific spheres.

An endowment is an integral component in the financing system of both private and public educational institutions in countries with advanced economies. It is an institutionally separate perpetual fund, which is created on the basis of charitable contributions (both in the form of fundraising and using crowdfunding platforms) from donors and is used to finance the human capital development. An endowment allows to provide educational scholarships, research grants, without burdening the state and local budgets. Typically, the educational institution receiving the endowment invests donor funds and uses the corresponding investment income for its own needs. The first known example of an endowment is the allocation of personal funds by Countess Margaret Beaufort in 1502 to a special fund for a personal professorship in Cambridge and Oxford (Collinson et al., 2003).

Endowments have become particularly widespread in the United States, where the American Council on Education identifies two main tasks: ensuring financial sustainability of educational institutions in conditions of economic uncertainty and achieving greater flexibility in the complex of financing issues. In 2015, the capitalization of endowments of 89 educational institutions in the United States exceeded 381.00 billion USD and had a tendency to grow (Ryan Jr., 2016). As of 2024, for 648 universities and colleges capitalization of endowments exceeded USD 873.70 billion (NACUBO, 2025, February 12). The median endowment is USD 243.00 million; about 30% of all higher education institutions have endowments of up to USD 100 million inclusive. In 2015, the top 10 in terms of endowment capitalization included two public universities: the University of Michigan and the University of Texas System (Ryan Jr., 2016). In 2024, they were joined by the Texas A&M University System and the University of California (NACUBO, 2025, February 12). Many higher education institutions with a relatively small number of applicants have significant endowment funds that fully cover the cost of organizing the educational process. The endowment is so important to US education that Harvard University, with the largest capitalization at USD 51.98 million, even bears the name of the donor who made the first contribution to its endowment fund.

In Ukraine, a successful case of fundraising campaigns in the field of human capital development is the KSE Foundation. Donations from domestic and international philanthropists, the Ukrainian business community are directed to educational grants for target categories – military personnel, their children, people who lost their homes as a result of the war, etc. International fundraising allows an educational institution to attract the largest number of financial resources; in 2024 alone, more than 37 million USD were accumulated, of which 86% were funds from American donors (Forbes Ukraine, 2025). Fundraising companies require high trust in the use of funds, a proper background of the institution and the development of a fundraising ecosystem, which assumes the presence of an appropriate level of economic culture.

Barro (1996) notes that economic growth is promoted not only by institutional, but also by financial factors. The quality of public administration, prioritization of vectors and the structure of public expenditures, etc. are of particular importance. Sala-i-Martin and Barro (1995) developed a model of technology diffusion, emphasizing the division of public spending into productive and unproductive groups. In addition to spending on human resource development (education, applied and fundamental science, health care), budget spending on the development of technological weapons is also recognized as productive. Under a full-scale invasion, the development of the high-tech military sector can become a driver for economic growth. Hence, it is necessary to increase investment in this sector and promote the attraction of private, including foreign, financial resources. As a strategic investor, the state serves as a certain reference point for business entities. The institutional environment for the development of the economy's defense-industrial sector should be improved.

Financial policy should be aimed at building an effective structure of the economy, stimulating innovation and investment activity of business entities. Its tools can have different mixes of administrative and tax incentives, effectively contributing to the competitive environment's development and functioning. The creation of full-cycle production in cooperation with foreign investors is a modern requirement. It is advisable to simplify permitting procedures, which can contribute to the growth of the knowledge-intensive economy. At the same time, it is the state that must guarantee the protection of property rights of foreign investors, as well as provide certain fiscal benefits, adhering to the principles of targeting, timeliness and overall efficiency. The tools of tax incentives for the R&D sector, which has a positive effect on expanding the share of the knowledge-intensive economy, should be applied.

Conclusions

Human capital is a basic element of economic growth models. The impact of a specific assessment indicator of human potential – the Human Development Index (HDI) – on the growth rates of the national economy is positive. For most of the sampled countries, the dynamics of the HDI was upward, which is associated with both an increase in the quality of medical care and the improvement of educational practices, increased accessibility of

education for all segments of the population, as well as the expansion in social production. Using a regression model, a positive relationship between the human development indicator and real GDP per capita was found. The dominance of the growth rates of emerging markets compared to advanced economies in the region is explained by different starting positions, the need for comprehensive institutional reforms, and the gradual "equalization" of social and economic indicators as a result of integration.

The relationship between the indicator of public spending on education and economic growth is nonlinear due to the presence of a certain non-normalized lag between the acquisition of the necessary educational competencies by an individual and the time when that individual will be able to apply them. Education is closely related to science, and both areas are inextricably linked to the economy's technological development level. Proper financing of the R&D sector has led to the fact that 6 European countries have entered the top 10 most innovative economies in the world. It is important to consistently and systematically apply effective institutional tools for regulating scientific and technological development with the involvement of both public and private financial resources. Moreover, it is necessary to create a scientific and technological ecosystem in which the state, educational and scientific institutions, as well as business entities can become full partners in directing their efforts and resources to achieve a common goal, such as ensuring sustainable economic development on an innovative basis.

This research confirmed the hypothesis of the existence of a stochastic relationship between public and private investments in human potential development, education, science and technology, the improvements in the institutional architectonics of the national economy and its growth.

The specific high-tech military research sector deserves special attention, the potential of which has been fully revealed in Ukraine since the full-scale russian invasion, and in the future has a chance to become a driver of growth. Public financial policymakers should focus especially on increasing the usage efficiency of state and local budgets; increasing public investments in the economy's technological sector. The tools of structural and functional analysis and performance based budgeting are the most appropriate when assessing investments' in the scientific sphere efficiency. Economic, social and technological criteria should be considered when making decisions on the public resources allocation for scientific research. Funding for scientific and technological activities at the level of 0.17% of GDP in 2024 and 2025 is critically low. The state should promote the attraction of private investment in the fields of education, science and high-tech economy. Alternative funding sources for grants for education and scientific research are fundraising, crowdfunding, crowdsourcing, and endowment funds. It is important to strengthen trust in the use of these funds, to increase the financial capacity of educational institutions, and to develop an ecosystem of extra-budgetary financing.

In further research, it is worth revealing the tools for increasing the efficiency of using budget funds, in particular for human capital development programs. The impact of fiscal incentives on European countries high-tech sectors' development should be investigated as well.

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Conflict of interest. The authors certify that they don't have any financial or non-financial interest in the subject matter or materials discussed in this manuscript; the authors have no association with state bodies, any organizations or commercial entities having a financial interest in or financial conflict with the subject matter or research presented in the manuscript. Given that the authors are affiliated with the institution that publishes this journal, which may cause potential conflict or suspicion of bias and therefore the final decision to publish this article (including the reviewers and editors) is made by the members of the Editorial Board who are not the employees of this institution.

The authors received no direct funding for this research.

Chugunov, I., Pasichnyi, M., & Nepytaliuk, A. (2025). Financial policy for human capital development. *Scientia fructuosa, 6*(164), 134–153. http://doi.org/10.31617/1.2025(164)09

Received by the editorial office 22.09.2025.
Accepted for printing 29.10.2025.
Published online 16.12.2025.