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ASSESSMENT OF INTELLECTUAL POTENTIAL OF THE EUROPEAN POPULATION

Tetiana Kornieieva*
Instituto Superior de Gestão, Business and Economics School, CIGEST, Lisbon, Portugal
ORCID iD: 0000-0002-6434-0552

Ana Lúcia Luís
Instituto Superior de Gestão, Business and Economics School, CIGEST, Lisbon, Portugal
ORCID iD: 0000-0003-2975-9654

Natália Teixeira
Instituto Superior de Gestão, Business and Economics School, CIGEST, Lisbon, Portugal
ORCID iD: 0000-0002-8752-6149

Rosa Rodrigues
Instituto Superior de Gestão, Business and Economics School, CIGEST, Lisbon, Portugal
ORCID iD: 0000-0001-6548-418X

*Corresponding author:
E-mail: tetiana.kornieieva@isg.pt

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Introduction. The global practice of economic growth in European countries shows that their determining factor is the formation and development of the intellectual potential of society. Recent changes in the structure of the economy, particularly a growing share of intangible products and information technologies, have necessitated changes in scientific approaches to economic security issues in a country. Objective processes influenced by the growing role of the knowledge economy have changed the world's attitude to priorities in favour of the intellectualisation of labour based on innovation, the introduction of high-tech processes, and the integration of science, education, and entrepreneurship. There is a fundamental reassessment of the human factor, making intelligence and high professionalism of the workforce a priority commodity in the labour market.

Aim and tasks. This study aims to propose the main directions and a set of organisational and economic measures aimed at creating conditions for the efficient use and development of intellectual potential at all levels as the foundation of the economic security of EU countries.

Results. The study uses the methodology for developing the model to calculate ranking coefficients of the impact of elements of intellectual potential formation on economic growth in EU countries (GDP per capita). It has been established that the most significant influence on the formation of intellectual potential on GDP per capita of EU countries is exerted by the intelligence quotient (RCF C_{1y}= 465,387), education level index (RCF C_{12y} = 434,390), human resources with tertiary training and engaged in technology and science (RCF C_{5y} = 389,842), population with tertiary education (RCF C_{6y} = 297,585), share of R&D personnel and researchers in the total active population (RCF C_{3y} = 290,678), and participation rate in education and training (RCF C_{8y} = 285,960).

Conclusions. The study proved that the key to this should be the growing role of the state in motivating the employed population to intellectual self-development and maximising the use of intellectual potential in the labour sector. A comprehensive assessment has shown that the intellectual potential of the employed population is not fully utilised in the economies of European countries, which worsens the prospects for accelerating innovation development and economic growth. Further research should be carried out to increase the competence of the organisation as a result of attracting new technologies and methods of intellectual potential management in accordance with rapid changes in the environment.

Keywords: intellectual potential, intelligence, labour market, economic growth, population.

1. Introduction.

Intellectualisation of the economic environment, innovative enterprises, and the development of information assets has become essential to a highly efficient economy. The share of professions is occupied by "intellectual workers", inventive and motivated, knowledgeable, and capable of independently searching and analysing vast amounts of information (Gajdzik, & Wolniak, 2022; Hu et al., 2023).

The most significant sources for its advanced development are intellectual potential and the demography, territory, raw material, and technological bounds of society. The global practice of economic growth in many countries indicates that the determining factor is the formation and development of people's intellectual potential. Recent changes in the structure of the economy, particularly the growing share of intangible products and information technologies, have necessitated changes in scientific approaches to society's economic security. Intangible factors, such as knowledge, software, information, and the training system, are increasingly important in ensuring economic security.

Objective processes influenced by the growing role of the knowledge economy have altered the world's attitude toward priorities in favour of the intellectualisation of labour based on innovation, the introduction of high-tech processes, and the integration of science, education, and entrepreneurship. A fundamental reassessment of the human factor takes place, making intelligence and high professionalism of the workforce a critical commodity in the labour market (Konno & Schillaci, 2021). Interdisciplinary knowledge generated by scientific and public institutions, training of high-quality human capital, education, creation of additional wealth by the knowledge economy, and formation of an integral vector of society development aimed at improving the quality and safety of all its members has become an integral component of the knowledge society (K-society).

One of the most critical criteria that characterises the intellectual component of social and labour potential of a society is the level of education and professional training of the economically active population.

A high level of education of a significant part of the population, as well as a sufficient level of professional training of the labour force, is an active factor in the economic growth of a country, one of the leading indicators of human development level and economic socialisation. The characteristics of the state of the intellectual component of social and labour potential of society mainly depend on the conditions of its growth, opportunities for its involvement and use in the country's economy, under global trends in the intellectualisation of labour, opportunities for continuous improvement of the level of qualification, and professional development of people employed in all spheres of economic activity.

The increasing role of the intellectual potential of the people employed in the national economy is driven by the rapid progress of science and technology, the development of information and communication technology, qualitative transformations of labour objects and means, and the content of labour activity in the direction of increasing its intellectual intensity and requirements for the level of education, professional competence, and the ability to learn and produce new knowledge and ideas continuously. A modern country can develop its economy, ensure competitiveness, and provide decent conditions for human development only through knowledge, active involvement, and development of the nation's intellect.

In this regard, Heyets (2023) rightly notes that there are many examples when both relatively in natural resources and population countries lag far behind in their development and living standards, while countries with limited resources, where knowledge is one of the determining factors, tend to make significant progress.

At the same time, some urgent problems in strengthening the role of intellectual potential in ensuring the state's economic security require proper understanding and coverage.

The purpose of this study is to propose, based on a generalisation of the experience of the conducted research and identified problems, the main directions and a set of organisational and economic measures aimed at creating conditions for efficient use and development of intellectual potential at all levels as the basis for economic security of the European countries.

The meaning of intellectual potential is used as a complex of intellectual abilities of people, technical and financial, informational and organisational, and economic resources, including aspects which allow resolving the problem of innovative development of a country at present and in the future (Hoang et al., 2020). Considering the processes of the development and formation of an intellectually oriented economy, substantial changes take place in intellectual potential because of a better knowledge of natural laws and society, an increase in the level of complexity of technology and technological processes, an increase in the volume of mental labour, and the need for the qualification of employees.

This complicates the professional and qualification organisation of the people involved in realising intellectual potential. Today, this is explained by experts in secondary and higher education. It is similarly defined by other citizens whose work is characterised by creativity, comprehensive knowledge, and an appropriate level of education.

2. Literature review.

From the standpoint of economic science, the intellect of a nation is seen as "a set of abilities and creative talents of people, their educational and qualification level, based on which the ability to acquire new knowledge and information and use them for the development of science, culture, art, creation and introduction of new technology, application of progressive forms of production and labour organisation, development of the most optimal solutions in all spheres of public life" (Kalbouneh et al., 2023; Widiatmoko et al., 2020).

Keter et al. (2024) focus on the study of intellectual potential, based on understanding it as the ability of society at different economic levels and individuals to create, accumulate and use new knowledge, projects, and ideas (various semantic information) as intellectual property for socio-economic, scientific and technical, spiritual, cultural, moral and legal and other development. Intellectual potential is interpreted as the ability to generate and perceive ideas, plans, and innovations, bringing them to the level of new technologies, designs, and organisational and managerial decisions (Nuzula et al., 2023).

Bilan et al. (2020) argue that intellectual potential should be considered as a set of intellectual resources that embody the scientific achievements of a society and labour resources with inherent intellectual, educational, and qualification characteristics, the rational use of which (in optimal proportion to other economic resources) ensures the achievement of a new quality of knowledge-based economic development.

Suharman et al. (2023) try to specify their vision by defining intellectual potential as a combination of human, material, and intangible potential.

Researchers consider intellectual potential in the literature as a category of the market economy since the results of intellectual labour activity – knowledge, ideas, inventions, and management decisions – are used as goods along with material things, objects, and services in the market, which can be transformed into various innovations offered to the market, evaluated, and made profitable. It is difficult to deny this position, as it makes it clear that the use of intellectual potential ensures the growth of income for employees, enterprises, companies, and the state as a whole and contributes to its competitiveness, and intellectual potential is transformed into intellectual capital (Suharman et al., 2023).

At the same time, many authors have equated concepts of "intellectual potential" and "intellectual capital". Thus, according to Mary da Silva Quintino et al. (2021), intellectual capital is more than pure human intelligence, which includes purposeful intellectual activity and is a resource for a modern enterprise not subject to traditional assessments.

Seitkazieva et al. (2018) consider intellectual capital "as assets whose value according to the balance sheet is zero".

Nemlioglu (2019) believes this concept is much more comprehensive than intellectual property and intangible assets.

Intellectual capital is, first of all, people and the knowledge they have, their skills, and everything else that helps to apply the skills and knowledge efficiently; it is a shared concept for defining intangible values that factually increase the value of an enterprise.

Intellectual potential is much broader in content than intellectual capital (IC).

It is worth recalling that the "potential" is interpreted as "hidden opportunities" hidden opportunities'; its carrier is the one who has sufficient strength to perform any action. Potential capabilities, particularly intellectual capabilities, can be attracted to and used in full, partly, or remain unrealised for certain reasons. Based on these scientific provisions, the following definitions were proposed.

- The intellectual potential of the national economy is the aggregate of all intellectual resources, including people employed in the economy, their knowledge, intellectual abilities, and intangible assets that characterise the aggregate intellectual capabilities that can be used in the course of economic functioning, turning into intellectual capital, ensuring progressive socio-economic transformations, and may remain fully or partially unused.

- The country's intellectual capital is the realised intellectual potential; it is a set of intellectual resources (human intellectual capital, structural capital, and client capital) that the state has available and uses in the course of economic functioning, obtaining the aggregate product of intellectual labour that ensures shifts in economic and innovative development, increase in national income, and improvement of the country's competitiveness and quality of life.

In its pure form, intellectual capital is considered an intellectual product with value. Capitalising human knowledge and commercialising intellectual labour products in the market explains the more common use of "intellectual capital" as a synonym for "intellectual potential" (Brooking et al., 1998; Mariani & Borghi, 2019).

To summarise scientific views, the structure of the intellectual potential of the national economy includes the following:

Firstly, these are human assets (human intellectual potential, which represents the population employed in the economy).

Second, infrastructure assets and intellectual property (organisational and structural capital).

Third, market assets (the capital of interaction with market institutions).

The priority component of the national economy's intellectual potential is human intellectual potential; that is, the people involved in the economy, their knowledge, creative intellectual abilities, and capabilities that can be used to create an intellectual product.

3. Methods.

It is relevant to determine the impact of the indicators of intellectual potential formation on the economic growth of EU countries (GDP per capita).

For this purpose, it is necessary to apply this methodology to build a model to calculate the rating coefficients of the influence of factors of intellectual potential formation on GDP per capita (Kornieieva, 2016).

To apply the methodology, the most influential (hypothetical) factors of intellectual potential formation were selected. The results are listed in Tables A2 and A3.

In the model, each indicator got the notation *Xi* (within the model X_1–X_{13}, since precisely 13 indicators were studied and identified). The results are listed in Table A1.

Each factor listed in Table A1 has a different effect on GDP per capita in the EU. The level of influence can be defined numerically.

To determine the rating indicator of the influence of factors on GDP per capita, the factor rating coefficient X_i $(B_i = tg\varphi_i)$ of a linear model was used. To compare the criteria of the significance of the factors, they must be presented in a coded (dimensionless) form.

For a two-dimensional linear model:

$$y = a + B_i \times X_i \qquad (1)$$

where, X_i is the abscissa (the factor in the natural expression with the corresponding unit of measurement). After moving the beginning of the ordinate to the point $y = a$ it shall consider the values of the factors in the code form x_i^* with the interval of the values for all factors ($x_i^* \ldots x_k^*$) from «0» to «1».

After the transformations of formula (2) in the new coordinate system, we shall get the value b_i^* (rating coefficient of the i-th factor in the comparison format) in a single scale $x_i^*(0 - 1$, equivalent to the natural value X_i).

For the calculations, we shall accept the correspondence $X_{i\,max} \rightarrow x^*_{i\,max}$, where, according to the condition $(x^*_i = 0 \ldots 1) x^*_{i\,max} = 1$.

$$b^*_i = B_i \times X_{i\,max} \qquad (2)$$

The value of the rating coefficient is used to establish the relative impact of the factors on functionality, GDP per capita, (y) and their ranking. For practical verification of the developed methodology and analysis of the research results, as an example, we chose the main components of the intellectual potential formation of the European population.

The values of the rating coefficients of the influence of the significant factors of intellectual potential formation in EU countries on GDP per capita (y), calculated according to the presented values of the factors in the code (dimensionless) form, are given in Table 1.

According to the model used at the macroeconomic level, the rating coefficients (RC) of the influence of the significant factors of intellectual potential formation on economic growth in EU countries (GDP per capita) were calculated.

The most influential factor on the economic growth of the EU countries (GDP per capita) is X_{11} – "Intelligence quotient (IQ)" (RCF $C_{11\,y}$= 465,387). Next up for the rankings is factor X_{12} – "Education level index" (RCF $C_{12\,y}$= 434,390).

The following rankings of the factors follow each other in terms of their values and are in the order of: X_5 – "Human resources with tertiary education (ISCED) and employed in science and technology (from 15 to 74 years), percentage of population in the labour force" (RCF $C_{5\,y}$= 389,842), X_6 – "Population with tertiary education (levels 5-8)" (RCF $C_{6\,y}$= 297,585), X_3 – "Share of R&D personnel and researchers in total active population (percentage of total employment – numerator in full-time equivalent)" (RCF $C_{3\,y}$= 290,678), X_8 – "Participation rate in education and training (All ISCED 2011 levels, from 18 to 74 years)" (RCF $C_{8\,y}$= 285,960), X_7 – "Population with upper secondary, post-secondary non-tertiary and tertiary education (levels 3-8)" (RCF $C_{7\,y}$= 265,515).

Studies show that the share of the active population with tertiary education, the share of R&D personnel and researchers, and the participation rate in education and training influence the economic development of European Union countries (GDP per capita).

The next influential factor is X_1 – "Gross domestic expenditure on R&D (GERD), euro per inhabitant" (RCF $C_{1\,y}$= 256,732) creating the preconditions for accelerating the growth and competitiveness of EU economies.

X_{13} – "Human Development Index (HDI)" (RCF $C_{13\,y}$= 222,864) these ranking results show that the level of long and healthy life and access to knowledge affect GDP growth per capita. X_2 – "Business enterprise expenditure on R&D, euro per inhabitant" (RCF $C_{2\,y}$= 204,790), X_4 – "Patent applications to the EPO by country of inventors" (RCF $C_{4\,y}$= 202,896), X_{10} – "Quality of Life Index" (RCF $C_{10\,y}$= 190,980), X_9 – "Total high-tech trade, exports" (RCF $C_{9\,y}$= 181,340). The introduction of high-tech processes and the production of new knowledge-intensive products are currently key factors in sustainable economic growth (Pham et al., 2024; Yang et al., 2024).

The study uses the methodology for building a model for calculating the rating coefficients of the influence of factors of intellectual potential formation on economic growth in EU countries (GDP per capita). According to the rating coefficients of the influence of factors of intellectual potential formation on the GDP per capita in the EU countries, it has been established that the influence is exerted by: X_{11} – Intelligence quotient (IQ); X_{12} – Education level index; X_5 – Human resources with tertiary education (ISCED) and employed in science and technology; X_6 – Population with tertiary education; X_3 – Share of R&D personnel and researchers in total active population; X_8 – Participation rate in education and training; X_7 – Population with upper secondary, post-secondary non-tertiary and tertiary education; X_1 – Gross domestic expenditure on R&D (GERD), euro per inhabitant; X_{13} – Human Development Index (HDI); X_2 – Business enterprise expenditure on R&D, euro per inhabitant; X_4 – Patent applications to the EPO by country of inventors; X_{10} – Quality of Life Index; X_9 – Total high-tech trade, exports.

Table 1. The value of the coefficients of the rating of the influence of factors of intellectual potential formation in the EU countries on GDP per capita (y).

Factor	Name of the Factor	Equation $y_{ji} = B_i \times X_i + a_i$	The Maximum Value of the Abscissa X_{imax}	Rating Coefficients (RC) of Factors $K_i = b_i^* = B_i \times X_{imax}$
X_{11}	Intelligence quotient (IQ)	6,9601x – 192,83	66,865	465,387
X_{12}	Education level index	7,6535x – 142,17	56,757	434,390
X_5	Human resources with tertiary education (ISCED) and employed in science and technology (from 15 to 74 years), percentage of population in the labour force	4,9425x – 64,629	78,875	389,842
X_6	Population with tertiary education (levels 5-8)	2,0898x + 29,358	142,399	297,585
X_3	Share of R&D personnel and researchers in total active population (percentage of total employment – numerator in full-time equivalent)	2,6889x + 55,14	108,103	290,678
X_8	Participation rate in education and training (All ISCED 2011 levels, from 18 to 74 years)	1,3205x + 4,5792	216,554	285,960
X_7	Population with upper secondary, post-secondary non-tertiary and tertiary education (levels 3-8)	5,3103x + 8,7405	50,000	265,515
X_1	Gross domestic expenditure on R&D (GERD), euro per inhabitant	6,9387x + 6,5001	37,000	256,732
X_{13}	Human Development Index (HDI)	5,1452x – 37,849	43,315	222,864
X_2	Business enterprise expenditure on R&D, euro per inhabitant	4,4231x + 75,861	46,300	204,790
X_4	Patent applications to the EPO by country of inventors	2,2596x + 62,398	89,793	202,896
X_{10}	Quality of Life Index	1,9098x + 159,89	100,000	190,980
X_9	Total high-tech trade, exports	5,4486x – 6,6893	33,282	181,340

Source: based on the Eurostat (2024), Organisation for Economic Co-Operation and Development (2024), World Bank (2024).

4. Results and Discussion.

Purchasing Power Parity (PPP) considers the relative cost of living and precisely depicts actual variances in income. The study of GDP per capita at the level of the European Union – 27 counties–shows that the dynamics of changes in the indicator are steadily increasing from EUR 28200 in 2016 to EUR 37600 in 2023 (EUR 9400) (Eurostat, 2024).

Among European countries, the highest level was in Sweden at EUR 43900 (2023) and Germany at EUR 43300 (2023) (Eurostat, 2024).

Among other countries, GDP per capita was the highest in the United States at EUR 47400 (2022), South Korea at EUR 48390 (2022), and the United Kingdom at EUR 35200 (2022) (Eurostat, 2024).

Therefore, it is necessary to consider further the factors influencing the intellectual potential of the European population and other countries.

One of the most important indicators is gross domestic spending on R&D (euro per inhabitant). Among European countries, Sweden spends the most on research and development: EUR 1831.830 per inhabitant (2022), Germany EUR 1458.911 per inhabitant (2022), and Finland EUR 1430.381 per inhabitant (2022).

Among other countries, gross domestic expenditure on R&D was the highest in the United States (EUR 2051.402/ inhabitant, 2021), South Korea (EUR 1457.704/ inhabitant, 2021), and Japan (EUR 1110.815/ inhabitant, 2021). Turkey's EUR 134.766/inhabitant (2022) has the lowest gross domestic expenditure on R&D indicators. Commercial R&D expenditure is the most significant element of experimental development. This is intended to develop a plan for a new or substantively improved product. Grounded in earlier studies and practice, it comprises the concept, design, and testing of product options (Fig. 1-6).

Business enterprise expenditure on R&D was the highest in Sweden at EUR 1349.457/inhabitant (2022), Germany at EUR 982.847/inhabitant (2022), and Finland at EUR 972.723/inhabitant (2022). Among other countries, this indicator had the highest value in the United States, EUR 1591.939/inhabitant (2021) and South Korea, EUR 1153.310/ inhabitant (2021).

Research and development personnel are employed in R&D operations. It consists of technical and maintenance personnel and scientific employees. They are professionals involved in the formation or design of new knowledge.

The Share of R&D personnel and researchers in the total active population indicator has the highest values in Sweden at 2.43% (2022), Finland at 2.26% (2022), Germany at 1.91% (2022), and France at 1.85% (2022).

Filings from European applicants (European Union, 27 countries) have grown steadily from 2016 to 2022 (+8.8%), reaching a share of 43.0%. Totally in 2022-2023, the topmost states of significant increases were Sweden (+26.7%), Portugal (+97.8%), Poland (+56.2%), and the P.R. China (+8.8%), and R. Korea (+21.0%).

During the period 2016-2022, the human resources with tertiary education (ISCED) and working in science and technology indicators showed an upward trend in the European Union: 27 countries (+3.8 pp), Sweden (+5.0 pp), France (+5.2 pp), Portugal (+5.1%), and Poland (+3.7 pp).

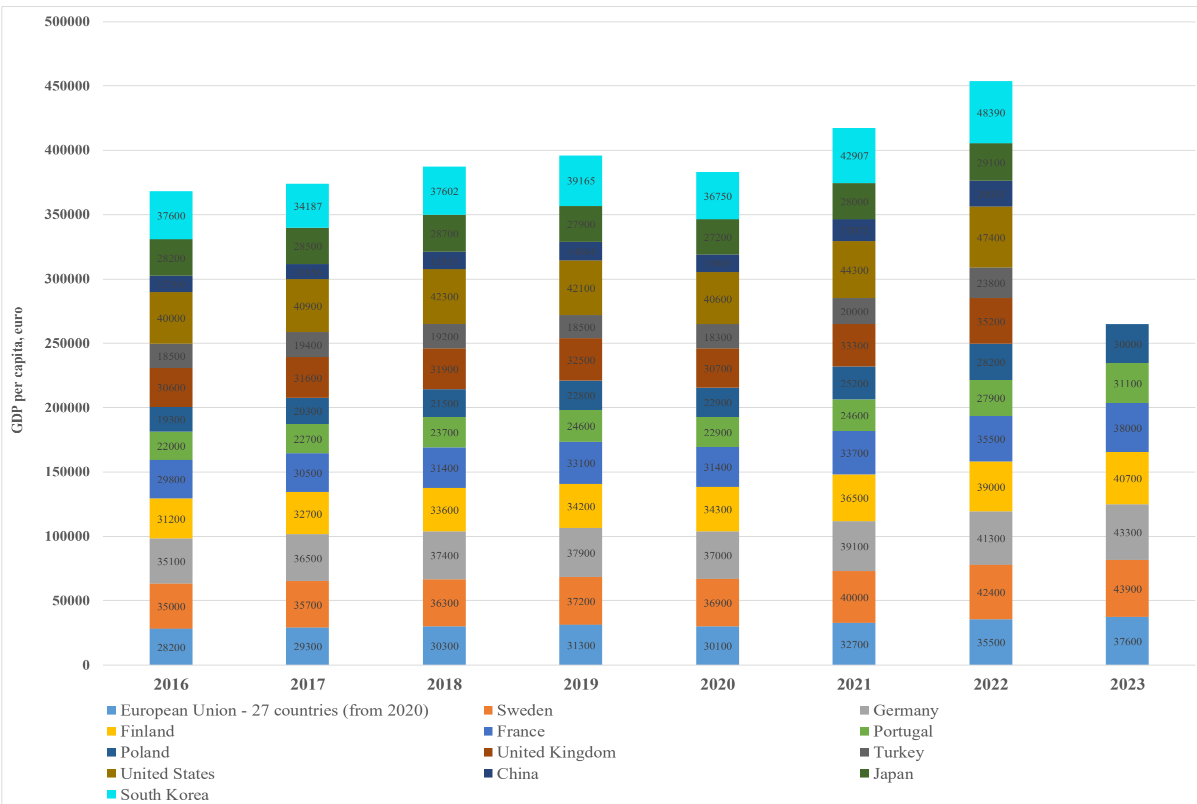

Fig. 1. Indicator of purchasing power adjusted GDP per capita in the countries, EUR, 2016–2023.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

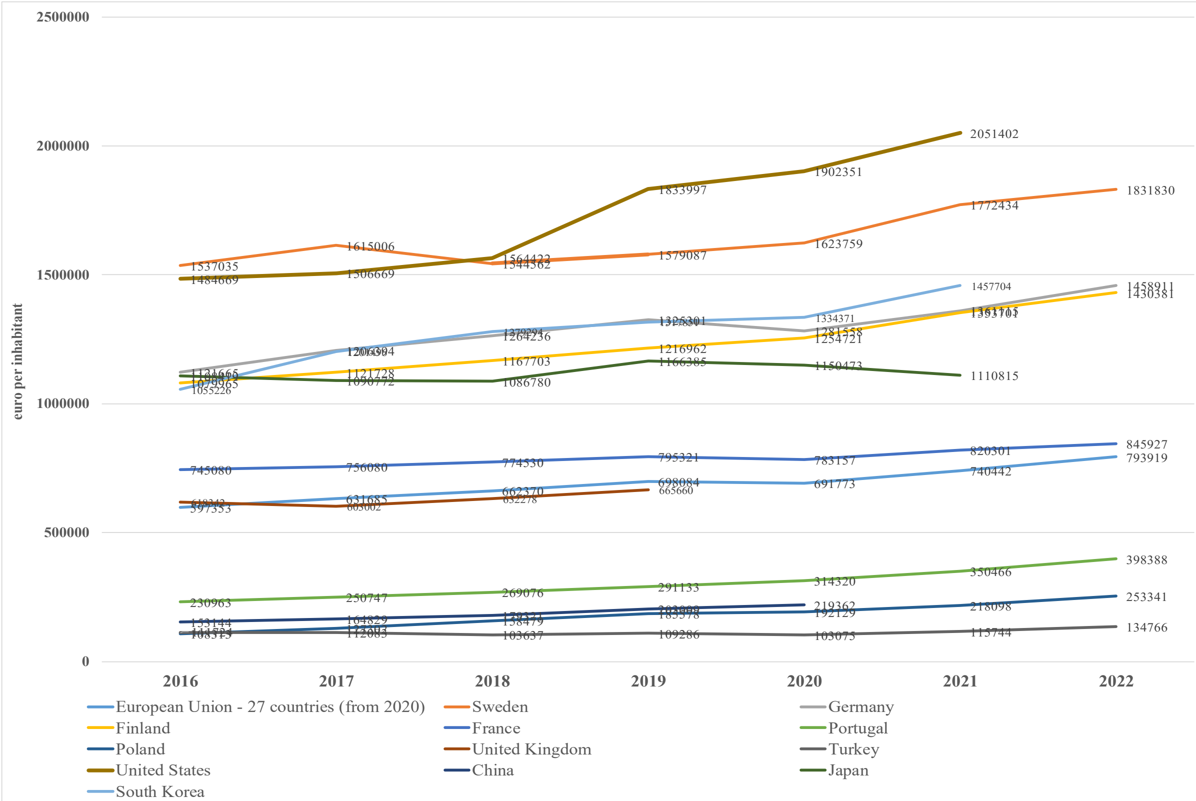

Fig. 2. Gross domestic expenditure on R&D (GERD), euro per inhabitant, 2016–2022.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

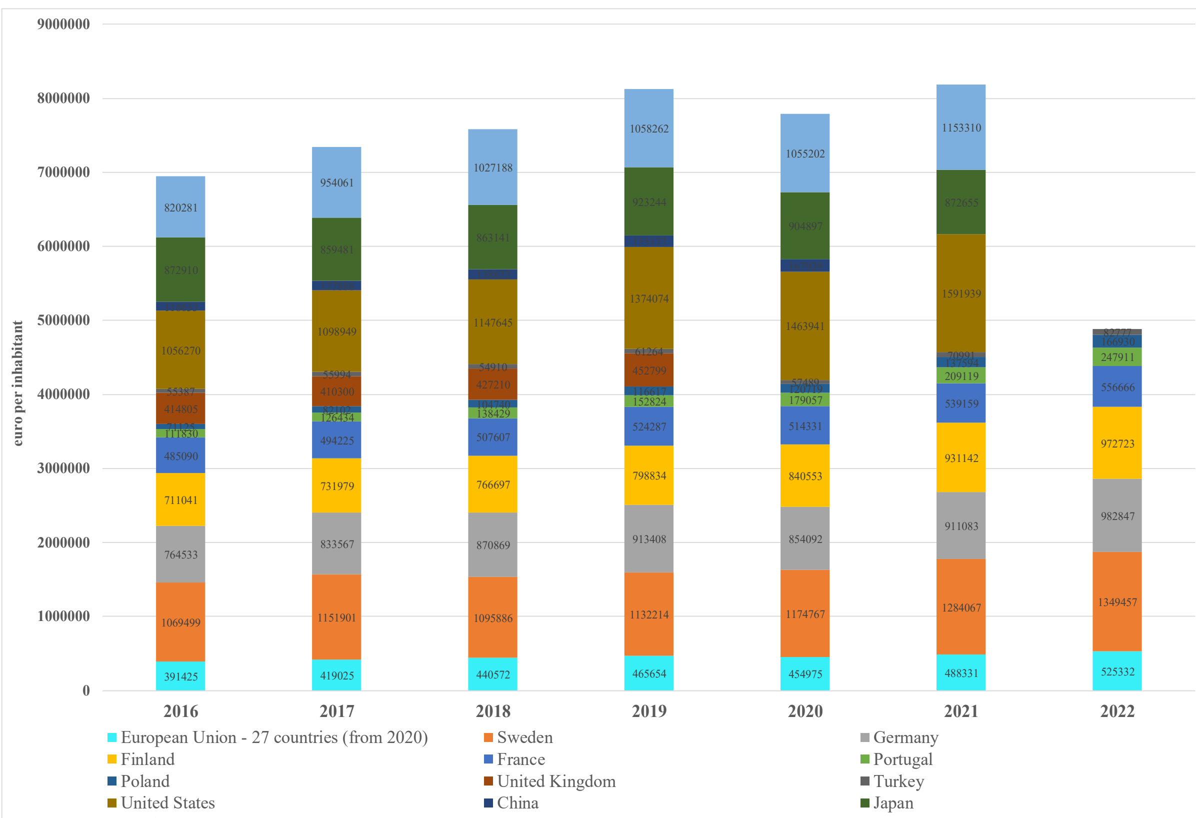

Fig. 3. Business enterprise expenditure on R&D, euro per inhabitant, 2016–2022.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

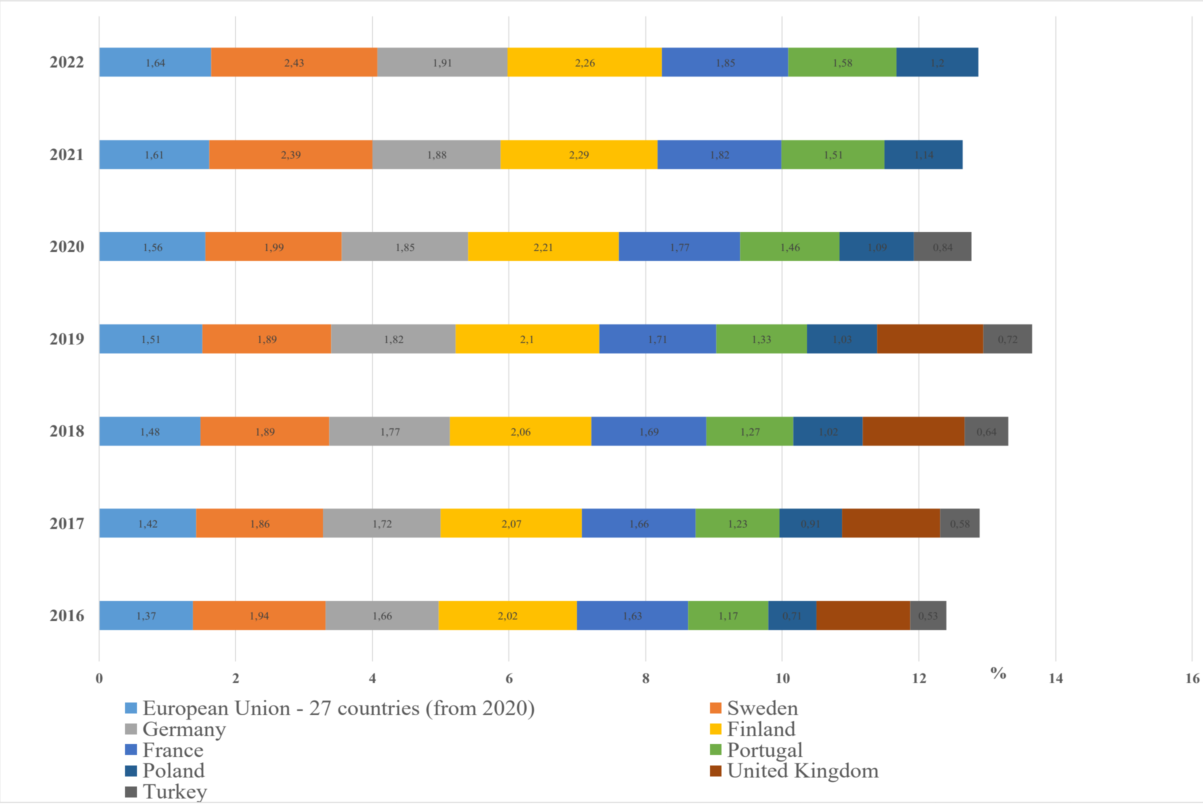

Fig. 4. Share of R&D personnel and researchers in total active population (percentage of total employment – numerator in full-time equivalent), 2016–2022.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

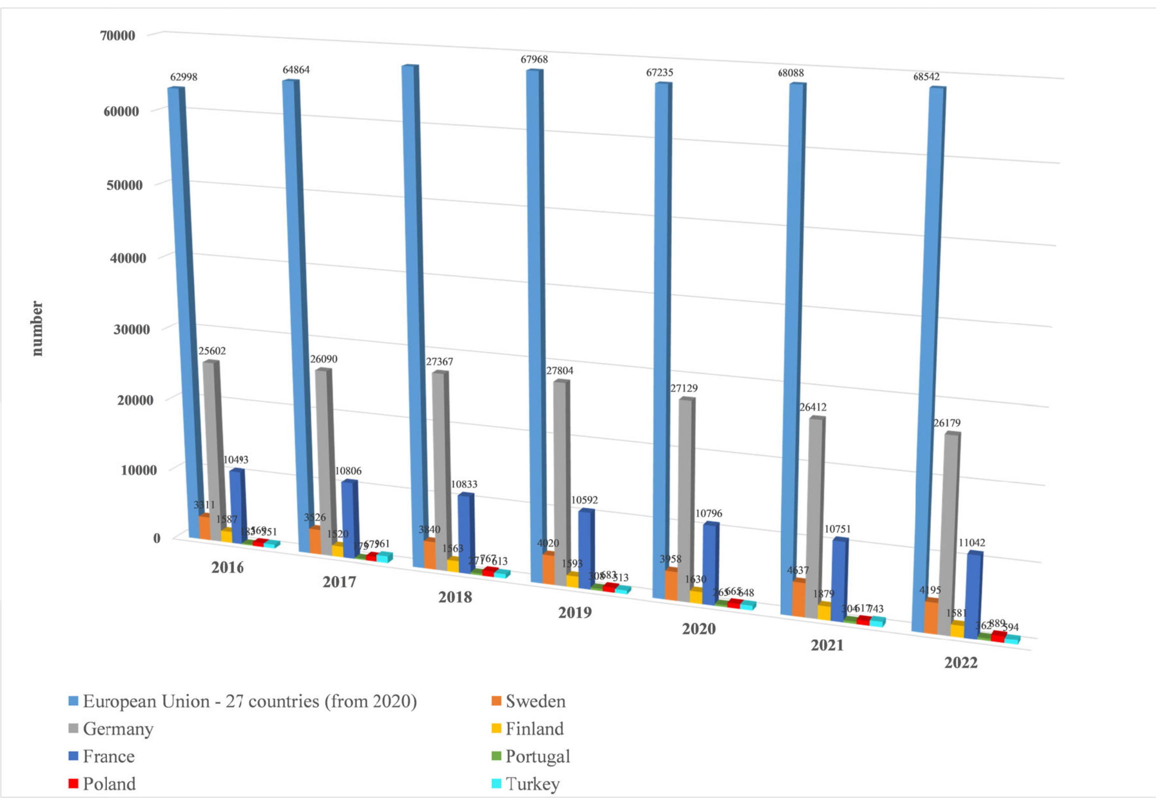

Fig. 5. Patent applications to the EPO by country of inventors, number, 2016–2022.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

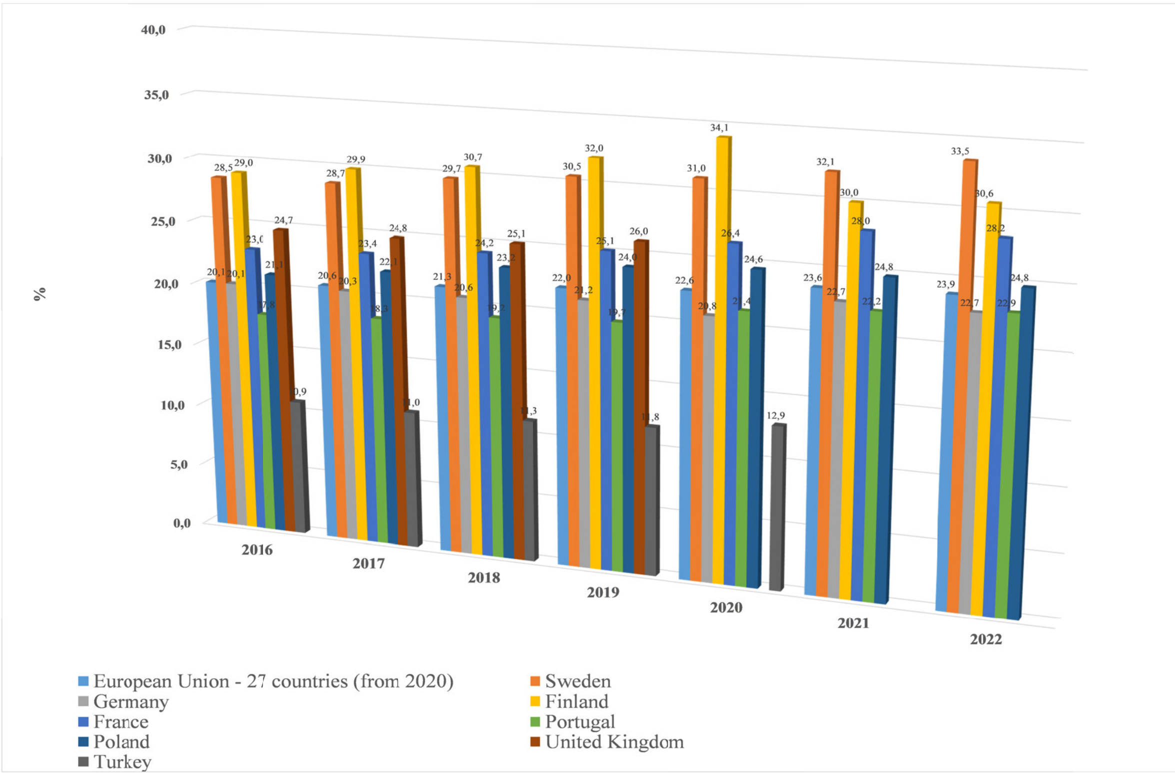

Fig. 6. Human resources with tertiary education (ISCED) and employed in science and technology (from 15 to 74 years), percentage of population in the labour force, 2016–2022.

Source: based on Eurostat (2024); Organisation for Economic Co-Operation and Development (2024).

Over the period 2016-2022, the percentage of participants in training and education (18 to 74 years) increased in the European Union in 27 countries (+1.2 percentage points), Sweden (+5.2 percentage points), Portugal (+3.8%), and Poland (+2.1 percentage points). However, there was also a negative trend in France (-4.3 percentage points) and Finland (- 1.3 percentage points).

The Quality of Life Index (QoL) measures the quality of life in cities and towns worldwide with the help of certain features: purchasing power, safety, health care, cost of living, property price-to-income ratio, commuting time, pollution, and climate index.

The Quality of Life Index for the period 2016-2023 decreased in Germany (-20.7), South Korea (-37.3), France (-19.8), Turkey (-17.9), Portugal (-17.4), the United Kingdom (-13.8), Poland (-13.7), and the United States (-11.2). However, in Finland, China, and Japan, the QoL index increased by (+6.5), (+5.07), and (+0.24), respectively. South Korea (102.4), Finland (101.2), Germany (100.7), the United Kingdom (99.1), the United States (97.4), Sweden (97.0), France (96.7), Poland (96.4) and Portugal (93.0).

In 2023, the HDI had the following values by country: Sweden (0.952), Germany (0.950), Finland (0.942), the United Kingdom (0.940), South Korea (0.929), the United States (0.927), Japan (0.920), France (0.910), Poland (0.881), Turkey (0.855), and China (0.788).

Effective management of the national economy is possible by considering several factors of using the intellectual potential of the employed population:

– competitiveness and priorities of socio-economic policy;

– the state of development of the labour market, demand for intellectual labour;

– state incentives for innovative enterprises and creative individuals;

– level of financing of scientific and technical works and research activities;

– state of material and technical and innovative development of enterprises;

– level of modernisation of workplaces, availability and effectiveness of systems of motivation of employees, the prestige of work;

– level of protection of intellectual property and intellectualisation of labour;

– level of remuneration and social protection of employees.

5. Conclusions.

The study uses the methods for developing a model to calculate the ranking coefficients of the impact of factors of intellectual potential formation on economic growth in EU countries (GDP per capita). It has been established that the most significant influence on the formation of intellectual potential on GDP per capita of EU countries is exerted: intelligence quotient (RCF $C_{1\,y}$= 465,387); education level index (RCF $C_{12\,y}$= 434,390); human resources with tertiary education and working in technology and science (RCF $C_{5\,y}$= 389,842); population with tertiary education (RCF $C_{6\,y}$= 297,585); share of R&D personnel and researchers in total active population (RCF $C_{3\,y}$= 290,678); participation rate in education and training (RCF $C_{8\,y}$= 285,960); population with upper secondary, post-secondary non-tertiary and tertiary education (RCF $C_{7\,y}$= 265,515); gross domestic expenditure on R&D (RCF $C_{1\,y}$= 256,732); Human Development Index (RCF $C_{13\,y}$= 222,864); business enterprise expenditure on R&D (RCF $C_{2\,y}$= 204,790); patent applications to the EPO by country of inventors (RCF $C_{4\,y}$= 202,896); Quality of Life Index (RCF $C_{10\,y}$= 190,980); total high-tech trade, exports (RCF $C_{9\,y}$= 181,340).

The essence of the intellectual potential of the European population is defined as a set of knowledge, intellectual abilities and capabilities of the population engaged in labour activity in the country's economy, which, combined with the intellectual capabilities of organisational and structural capital and capital of interaction with market institutions, is able to ensure the intensification of innovation, economic growth and high-quality human development in the general context of knowledge-oriented social progress.

In the study, the model for calculating the ranking coefficients of the impact of factors showed that the intellectual potential of the European population needs to be appropriately used and irrationally in the economy, which worsens the prospects for accelerating innovation development and economic growth.

Further consolidation of such trends will mean the threat of a gradual unclaimed part of human intellectual potential, which will accompany intellectual and economic losses for the European countries' population and economies. Improving the state regulation of the use and development of the intellectual potential of the European population should be based on the following principles:

- creating conditions for the adaptation of the economically active population to the competitive environment and the requirements of the knowledge economy; creating a need for every citizen to improve their educational level constantly;
- ensuring high standards of quality of training available to employees during their employment; improving the quality of education by creating quality management systems for educational services by European and international standards and engaging education professionals in international cooperation;
- providing opportunities for second education on affordable loans, organising comprehensive retraining and advanced training for employees at least every 3 years (in the context of rapid knowledge obsolescence) in accordance with market demands and the objectives of ensuring an “innovative breakthrough”;
- comprehensive state support for producers who create, implement and use new technologies, and new product designs, attract the intelligence of young professionals and promote their professional qualifications;
- ensuring high motivation of the population for effective employment, maximum use and development of intellectual abilities, creativity and innovation;
- introducing flexible and favourable interest rates in the financial market for lending to entrepreneurs, which would expand the financial capacity of enterprises and increase the opportunities for investing in the creation of new productive jobs, training and retraining of personnel;
- implementation of measures aimed at preserving the intellectual potential of research, educational, state institutions, enterprises and organisations through increased investment and reform of remuneration and income of highly skilled employees.

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Appendix A. Preliminary Tests.

Table A1. Indicator of purchasing power adjusted GDP per capita in the countries, euro, 2016–2023.

	Countries	Years								Deviation, 2023/2016 2022/2016	
		2016	2017	2018	2019	2020	2021	2022	2023	Absolute, +/−	Relative, %
1	2	3	4	5	6	7	8	9	10	11	12
1	European Union – 27 countries (from 2020)	28200	29300	30300	31300	30100	32700	35500	37600	9400	33.3
2	Sweden	35000	35700	36300	37200	36900	40000	42400	43900	8900	25.4
3	Germany	35100	36500	37400	37900	37000	39100	41300	43300	8200	23.4
4	Finland	31200	32700	33600	34200	34300	36500	39000	40700	9500	30.4
5	France	29800	30500	31400	33100	31400	33700	35500	38000	8200	27.5
6	Portugal	22000	22700	23700	24600	22900	24600	27900	31100	9100	41.4
7	Poland	19300	20300	21500	22800	22900	25200	28200	30000	10700	55.4
8	United Kingdom	30600	31600	31900	32500	30700	33300	35200	-	4600	15.0
9	Turkey	18500	19400	19200	18500	18300	20000	23800	-	5300	28.6
10	United States	40000	40900	42300	42100	40600	44300	47400	-	7400	18.5
11	China	12769	11856	13511	14844	13983	17072	20035	-	7266	56.9
12	Japan	28200	28500	28700	27900	27200	28000	29100	-	900	3.2
13	South Korea	37600	34187	37602	39165	36750	42907	48390	-	10790	28.7

Source: based on the Eurostat (2024), Organisation for Economic Co-Operation and Development (2024).

Table A2. Factors affecting intellectual potential of population of the European countries, 2016–2022.

	Countries	Years								Deviation, 2022/2016	
		2016	2017	2018	2019	2020	2021	2022	2023	Absolute, +/–	Relative %
1	2	3	4	5	6	7	8	9	10	11	12
Gross domestic expenditure on R&D (GERD), euro per inhabitant											
1	European Union – 27 countries (from 2020)	597.353	631.685	662.37	698.084	691.773	740.442	793.919	-	196.566	32.9
2	Sweden	1537.035	1615.006	1544.562	1 579.087	1623.759	1772.434	1831.830	-	294.795	19.2
3	Germany	1121.665	1206.394	1264.236	1 325.301	1281.558	1361.115	1458.911	-	337.246	30.1
4	Finland	1079.965	1121.728	1167.703	1 216.962	1254.721	1353.701	1430.381	-	350.416	32.4
5	France	745.080	756.080	774.530	795.321	783.157	820.301	845.927	-	100.847	13.5
6	Portugal	230.963	250.747	269.076	291.133	314.32	350.466	398.388	-	167.425	72.5
7	Poland	108.313	127.302	158.479	185.578	192.129	218.098	253.341	-	145.028	133.9
8	United Kingdom	618.342	603.002	632.278	665.660	-	-	-	-	47.318	7.7
9	Turkey	111.724	112.083	103.637	109.286	103.075	115.744	134.766	-	23.042	20.6
10	United States	1484.669	1506.669	1564.422	1833.997	1902.351	2051.402	-	-	566.733	38.2
11	China	153.144	164.829	179.321	203.009	219.362	-	-	-	66.218	43.2
12	Japan	1108.419	1090.772	1086.78	1166.385	1150.473	1110.815	-	-	2396	0.2
13	South Korea	1055.226	1201.496	1279.294	1317.851	1334.371	1457.704	-	-	402.478	38.1
Business enterprise expenditure on R&D, euro per inhabitant											
1	European Union – 27 countries (from 2020)	391.425	419.025	440.572	465.654	454.975	488.331	525.332	-	133.907	34.2
2	Sweden	1069.499	1151.901	1095.886	1132.214	1174.767	1284.067	1349.457	-	279.958	26.2
3	Germany	764.533	833.567	870.869	913.408	854.092	911.083	982.847	-	218.314	28.6
4	Finland	711.041	731.979	766.697	798.834	840.553	931.142	972.723	-	261.682	36.8
5	France	485.090	494.225	507.607	524.287	514.331	539.159	556.666	-	71.576	14.8
6	Portugal	111.830	126.434	138.429	152.824	179.057	209.119	247.911	-	136.081	121.7
7	Poland	71.125	82.102	104.740	116.617	120.719	137.594	166.930	-	95.805	134.7
8	United Kingdom	414.805	410.300	427.210	452.799	-	-	-	-	37.994	9.2
9	Turkey	55.387	55.994	54.910	61.264	57.489	70.991	82.777	-	27.390	49.5
10	United States	1056.270	1098.949	1147.645	1374.074	1463.941	1591.939	-	-	535.669	50.7
11	China	118.633	127.888	138.822	155.137	167.929	-	-	-	49.296	41.5
12	Japan	872.910	859.481	863.141	923.244	904.897	872.655	-	-	- 0,255.000	-0,03
13	South Korea	820.281	954.061	1027.188	1058.262	1055.202	1153.310	-	-	333.029	40.6
Share of R&D personnel and researchers in total active population (percentage of total employment – numerator in full-time equivalent)											
1	European Union – 27 countries (from 2020)	1.37	1.42	1.48	1.51	1.56	1.61	1.64	-	0.27	-
2	Sweden	1.94	1.86	1.89	1.89	1.99	2.39	2.43	-	0.49	-
3	Germany	1.66	1.72	1.77	1.82	1.85	1.88	1.91	-	0.25	-
4	Finland	2.02	2.07	2.06	2.10	2.21	2.29	2.26	-	0.24	-
5	France	1.63	1.66	1.69	1.71	1.77	1.82	1.85	-	0.22	-
6	Portugal	1.17	1.23	1.27	1.33	1.46	1.51	1.58	-	0.41	-
7	Poland	0.71	0.91	1.02	1.03	1.09	1.14	1.20	-	0.49	-
8	United Kingdom	1.37	1.44	1.49	1.55	-	-	-	-	0.18	-
9	Turkey	0.53	0.58	0.64	0.72	0.84	-	-	-	0.31	-
Patent applications to the EPO by country of inventors, number											
1	European Union – 27 countries (from 2020)	62998	64864	67667	67968	67235	68088	68542	-	5544	8.8
2	Sweden	3311	3526	3840	4020	3958	4637	4195	-	884	26.7
3	Germany	25602	26090	27367	27804	27129	26412	26179	-	577	2.3
4	Finland	1587	1520	1563	1593	1630	1879	1581	-	-6	-0.4
5	France	10493	10806	10833	10592	10796	10751	11042	-	549	5.2
6	Portugal	183	173	271	308	265	304	362	-	179	97.8
7	Poland	569	675	767	683	665	617	889	-	320	56.2
8	Turkey	551	961	613	513	648	743	594	-	43	7.8
Human resources with tertiary education (ISCED) and/or employed in science and technology (from 25 to 64 years), percentage of population in the labour force											
1	European Union – 27 countries (from 2020)	44.4	45.1	46.0	46.9	48.0	48.7	49.2	-	4.8	-
2	Sweden	57.9	58.6	59.9	60.7	61.4	62.5	64.1	-	6.2	-
3	Germany	48.4	48.7	49.3	50.3	50.8	52.0	52.0	-	3.6	-
4	Finland	56.9	57.7	58.4	59.9	61.6	57.7	57.8	-	0.9	-
5	France	50.6	50.9	52.2	53.5	55.2	55.0	55.8	-	5.2	-
6	Portugal	36.2	36.4	37.5	38.3	40.2	41.5	41.8	-	5.6	-
7	Poland	42.8	44.0	45.2	46.0	46.6	47.0	47.4	-	4.6	-
8	United Kingdom	56.8	57.0	57.6	59.1	-	-	-	-	2.3	-
9	Turkey	27.5	28.1	28.8	30.3	32.6	-	-	-	5.1	-

Human resources with tertiary education (ISCED) and employed in science and technology (from 15 to 74 years), percentage of population in the labour force										
1	European Union – 27 countries (from 2020)	20.1	20.6	21.3	22.0	22.6	23.6	23.9	-	3.8	-
2	Sweden	28.5	28.7	29.7	30.5	31.0	32.1	33.5	-	5.0	-
3	Germany	20.1	20.3	20.6	21.2	20.8	22.7	22.7	-	2.6	-
4	Finland	29.0	29.9	30.7	32.0	34.1	30.0	30.6	-	1.6	-
5	France	23.0	23.4	24.2	25.1	26.4	28.0	28.2	-	5.2	-
6	Portugal	17.8	18.3	19.2	19.7	21.4	22.2	22.9	-	5.1	-
7	Poland	21.1	22.1	23.2	24.0	24.6	24.8	24.8	-	3.7	-
8	United Kingdom	24.7	24.8	25.1	26.0	-	-	-	-	1.3	-
9	Turkey	10.9	11.0	11.3	11.8	12.9	-	-	-	2.0	-
Population with tertiary education (levels 5-8), %										
1	European Union – 27 countries (from 2020)	25.7	26.4	27.1	27.9	28.9	29.7	30.2	-	4.5	-
2	Sweden	35.3	36.0	37.1	37.8	38.3	39.7	41.1	-	5.8	-
3	Germany	24.4	24.8	25.2	26.0	27.2	28.0	28.2	-	3.8	-
4	Finland	35.9	36.4	37.3	38.5	39.8	35.5	35.9	-	0.0	-
5	France	30.9	31.4	32.8	33.8	35.3	36.3	36.9	-	6.0	-
6	Portugal	21.5	21.7	22.5	23.8	25.4	28.3	28.6	-	7.1	-
7	Poland	25.2	26.3	27.2	28.2	28.9	29.1	29.6	-	4.4	-
8	United Kingdom	38.3	38.7	39.3	40.6	-	-	-	-	2.3	-
9	Turkey	16.0	16.6	17.3	18.4	19.7	-	-	-	3.7	-
Population with upper secondary, post-secondary non-tertiary and tertiary education (levels 3-8), %										
1	European Union – 27 countries (from 2020)	72.6	73.1	73.7	74.3	74.9	74.9	75.1	-	2.5	-
2	Sweden	78.9	78.9	79.1	79.2	79.3	79.9	80.5	-	1.6	-
3	Germany	80.2	80.2	80.4	80.5	80.0	78.0	77.0	-	-3.2	-
4	Finland	81.4	81.6	82.3	83.1	84.1	81.8	81.9	-	0.5	-
5	France	74.5	74.8	75.6	76.6	77.7	77.9	78.7	-	4.2	-
6	Portugal	47.1	48.3	50.2	52.4	55.5	59.7	60.4	-	13.3	-
7	Poland	85.4	86.1	86.5	86.7	87.1	87.0	87.1	-	1.7	-
8	United Kingdom	79.5	80.0	80.3	80.9	-	-	-	-	1.4	-
9	Turkey	35.6	36.6	37.7	39.5	41.3	-	-	-	5.7	-
Participation rate in education and training (All ISCED 2011 levels, from 18 to 74 years), %										
1	European Union – 27 countries (from 2020)	14.4	14.5	14.6	14.8	13.3	14.7	15.6	-	1.2	-
2	Sweden	31.0	31.6	32.6	35.6	30.2	34.7	36.2	-	5.2	-
3	Germany	13.1	13.1	12.9	12.9	12.5	12.2	12.5	-	-0.6	-
4	Finland	27.3	28.0	28.7	29.0	27.0	29.8	26.0	-	-1.3	-
5	France	21.7	21.6	21.3	22.1	16.8	15.5	17.4	-	-4.3	-
6	Portugal	13.7	13.7	14.1	14.3	14.1	16.8	17.5	-	3.8	-
7	Poland	9.1	9.0	10.2	9.2	8.2	9.4	11.2	-	2.1	-
8	United Kingdom	16.9	16.8	16.9	17.0	-	-	-	-	0.1	-
9	Turkey	10.7	10.5	10.6	9.9	9.8	-	-	-	-0.9	-
Total high-tech trade, exports (percentage of total)										
1	European Union – 27 countries (from 2020)	14.09	14.12	14.17	14.81	15.29	14.83	14.33	-	0.24	-
2	Sweden	13.38	11.88	11.28	11.91	12.85	11.43	11.96	-	-1.42	-
3	Germany	15.21	15.10	15.24	15.73	15.36	15.08	14.52	-	-0.69	-
4	Finland	6.84	6.59	6.08	6.30	6.78	6.79	6.27	-	-0.57	-
5	France	21.68	20.57	20.46	21.45	18.50	17.26	17.17	-	-4.51	-
6	Portugal	4.44	4.54	3.98	5.38	5.50	4.74	5.18	-	0.74	-
7	Poland	8.50	8.42	8.34	8.68	8.97	8.77	9.14	-	0.64	-
Quality of Life Index										
1	Sweden	185.8	172.7	176.8	178.7	175.9	171.4	175.3	-	-10	-
2	Germany	199.7	189.7	190.0	187.0	179.8	176.8	180.3	179.0	-20.7	-
3	Finland	184.0	182.9	195.3	194.0	190.2	182.8	185.0	190.5	6.5	-
4	France	173.6	160.3	166.2	157.8	153.9	150.7	156.7	153.8	-19.8	-
5	Portugal	181.2	178.4	166.7	163.5	162.9	161.9	162.5	163.8	-17.4	-
6	Poland	153.6	150.2	146.6	148.0	141.8	132.6	140.0	139.9	-13.7	-
7	United Kingdom	180.2	172.9	171.9	170.8	162.7	159.0	161.7	166.4	-13.8	-
8	Turkey	137.3	129.6	127.6	125,5	127.1	126.0	124.1	119.4	-17.9	-
9	United States	183.9	179.7	181.1	179.2	172.1	167.1	170.72	172.7	-11.2	-
10	China	99.03	90.9	99.4	97.92	102.8	103.2	105.07	104.1	5.07	-
11	Japan	176.06	147.5	176.0	180.5	168.0	162.3	169.5	176.3	0.24	-
12	South Korea	170.3	162.5	155.4	149,5	139.0	130.0	125.0	133.0	-37.3	-

Intelligence quotient (IQ)											
1	Sweden	-	-	-	-	-	-	-	97.0	-	-
2	Germany	-	-	-	-	-	-	-	100.7	-	-
3	Finland	-	-	-	-	-	-	-	101.2	-	-
4	France	-	-	-	-	-	-	-	96.7	-	-
5	Portugal	-	-	-	-	-	-	-	93.0	-	-
6	Poland	-	-	-	-	-	-	-	96.4	-	-
7	United Kingdom	-	-	-	-	-	-	-	99.1	-	-
8	Turkey	-	-	-	-	-	-	-	87.0	-	-
9	United States	-	-	-	-	-	-	-	97.4	-	-
10	China	-	-	-	-	-	-	-	104.1	-	-
11	Japan	-	-	-	-	-	-	-	106.5	-	-
12	South Korea	-	-	-	-	-	-	-	102.4	-	-
Education level index											
1	Sweden	0.91	0.92	0.92	0.92	0.92	0.96	-	-	0.05	-
2	Germany	0.94	0.94	0.94	0.94	0.94	0.94	-	-	0.00	-
3	Finland	0.92	0.93	0.93	0.93	0.93	0.96	-	-	0.04	-
4	France	0.81	0.82	0.82	0.83	0.83	0.83	-	-	0.02	-
5	Portugal	0.76	0.77	0.77	0.78	0.79	0.79	-	-	0.03	-
6	Poland	0.88	0.88	0.88	0.88	0.88	0.88	-	-	0.00	-
7	United Kingdom	0.92	0.93	0.92	0.93	0.93	0.93	-	-	0.01	-
8	Turkey	0.76	0.77	0.78	0.79	0.79	0.80	-	-	0.04	-
9	United States	0.90	0.90	0.90	0.91	0.91	0.91	-	-	0.01	-
10	China	0.62	0.63	0.64	0.65	0.65	0.65	-	-	0.03	-
11	Japan	0.87	0.87	0.87	0.87	0.87	0.87	-	-	0.00	-
12	South Korea	0.87	0.87	0.87	0.88	0.88	0.88	-	-	0.01	-
Human Development Index (HDI)											
1	Sweden	0.939	0.941	0.942	0.947	0.944	0.949	0.952	-	0.013	-
2	Germany	0.941	0.944	0.945	0.951	0.948	0.948	0.950	-	0.009	-
3	Finland	0.930	0.934	0.936	0.939	0.939	0.941	0.942	-	0.012	-
4	France	0.895	0.898	0.901	0905	0.900	0.906	0.910	-	0.015	-
5	Portugal	0.853	0.859	0.860	0.864	0.861	0.865	0.874	-	0.021	-
6	Poland	0.872	0.875	0.877	0.880	0.874	0.876	0.881	-	0.009	-
7	United Kingdom	0.927	0.930	0.929	0.933	0.920	0.931	0.940	-	0.013	-
8	Turkey	0.823	0.833	0.839	0.842	0.835	0.841	0.855	-	0.032	-
9	United States	0.922	0.924	0.927	0.933	0.923	0.921	0.927	-	0.005	-
10	China	0.740	0.747	0.755	0.775	0.781	0.785	0.788	-	0.048	-
11	Japan	0.921	0.922	0.923	0.918	0.917	0.920	0.920	-	-0.001	-
12	South Korea	0.912	0.916	0.919	0.922	0.922	0.926	0.929	-	0.017	-

Source: based on the Eurostat (2024), Organisation for Economic Co-Operation and Development (2024).