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# AN ALTERNATIVE MODELING OF THE INNOVATIVE POTENTIAL OF COMPANIES

## ABSTRACT

Modern economic conditions require the testing and introduction of new methods to find ways to achieve a prolonged effect in terms of ownership and investment attractiveness. The purpose of the article is to develop theoretical and methodological tasks regarding ways to maximize the investment attractiveness of companies, using external search information about the state of innovation potential of companies with different levels of economic development and the selection of logically justified descriptors of influence.

We have defined the principles of the author's concept - Unified concept of building innovation potential - (UKDIP), the essence of which is to find unified ways to increase the innovative potential of business entities, at the expense of descriptors of the state of the innovation sector (gross domestic expenditure on R&D, the number of researchers, the number of government researchers, number of triadic patent families). We confirmed the relationship between the meta-factors of innovation using the foundations of the implicit theory. Using the clustering method, we have formed 4 latent clusters with varying degrees of investment attractiveness. The approach defined by us can serve as one of the options for effective methods of researching the influence of factors that contribute to the growth of the innovative potential of individual companies and, consequently, the national economy as a whole.

**Keywords:** innovations; concept; implicit theory; investment attractiveness, potential

**JEL Classification:** B23, E32, E58, G01

## INTRODUCTION

A company with a high innovative potential, found itself in a developed information space, possessing patents, research and development, inventions, new ideas, and new technologies will always occupy a higher competitive position among partners. Progressive studies show that the competitive attractiveness of an enterprise increases due to the growth of available resources, and also, the introduction of new techniques and technologies [6, 28]. The current global market makes the highest demands for increasing labour productivity, resources, methods of forming and increasing the potential of enterprises and sectors of the economy and reducing production costs.

Any manufacturing company is organized to meet the various demands of society and the beneficial interests of the owners and employees of the enterprise. This provides a system for the long-term operation of the company for the production of high-quality and cost-effective products. The implementation of this task is impossible without creating a mechanism for the full, successful and rational use of all resources of the enterprise's potential.

At the current problematic frontier of economic development on the scale of the world economy, there is an objective need to intensify investment activity, since this is an important component of the entire economic policy of the state, which guarantees constant macroeconomic growth, building up innovative potential, and as a result, strengthening the social result and balancing the macrostructure.

The innovative potential of an enterprise is the ability of an economic entity to implement a set of investment abilities in order to create additional capital flows through the mobilization of available resources, to increase the price of an investment object.

The device of the company's innovative potential, which has many aspects, describes the specifics of building the procedure for its assessment based on the stipulated principles. The key instructions for evaluating the effectiveness of a business in attracting and applying investment resources are the use of a single integrated approach and its analytical evaluation. The dynamics of the performance indicators of companies are associated with a number of factors, starting with insufficient subsidization of innovative activity and ineffective investment policy of most companies. Adequacy of the sizes and sources of financing seems to be the key source for activating innovative activity. The implementation of investments is a step-by-step process, one of the necessary stages of which is the selection of innovative resources to finance investments. In the dynamics and structure of investment financing, the importance of enterprises' own funds as part of investment resources prevails in comparison with the involvement of other sources. Innovations are the driving force behind scientific progress and scientific and technological formation in the economy, guaranteeing the technological renewal of all sectors of the economy to the production of investment products - modern and progressive. The article discusses the most important issues related to the discovery of useful correlations between factors and variables that characterize the innovative feature of the company and indicates possible prospects for building innovative potential. The purpose of this article is to evaluate the state of the innovative potential in the state of innovation potential in countries with different levels of economic development based on logically sound innovation-related impact descriptors, with particular emphasis on the goal of maximizing the investment attractiveness of companies. However, the practical significance is that the results of this study will contribute to the assessment of the general readiness of economic entities to accept innovations through the innovative potential and justify the requirements for the main potential-forming factors of the innovative potential.

## LITERATURE REVIEW

Innovative activity can be considered in technological and non-technological aspects. The first aspect is associated with the creation of new products (finished products, technologies, services) and the introduction of new technological processes by the enterprise, and the second one is based on the creation of innovations in the organizational dimension [2,5]. The first attempt to model eco-innovative technologies within a regulatory scheme using modelling software [1] has been successfully made. Understanding the applicability of modelling to eco-innovation would be of great interest, especially for complex innovative technologies and functions [3]. A comparative analysis of methods for assessing international and interregional innovations was also carried out in order to determine the system of indicators to be included in the program "Economic Development" for the effectiveness of executive authorities' activities [4]. However, the actions taken so far have not led to the implementation of global innovation solutions that would significantly increase the level of development [7].

We propose to construct a generalizing concept as a set of various steps, not only the selection of subjective indicators but various methods of analysis that are non-standard for this area of theories. In this context, the foundations of the problem of capacity building in the field of innovation have been modelled and analyzed, which now makes it possible to cope not only with single emerging problems but also analytically compare entire sets of tasks in the same direction [5]. The formation of the anti-crisis potential of innovative enterprises is due to a complex of factors. One of the important factors in the realization of this potential is the solution to the problem of modern economic formation and "innovative" thinking with the state support of the company [6]. Companies often lack common ground in the characteristics of innovation potential, which is necessary to expand the existing base of indicators and factors [27; 32] to enable the successful implementation of innovations [22]. As a result, companies may have to look for alternatives to manufacturing processes, resources or materials that are not necessarily within their core competencies, further exacerbating problems in understanding and implementing a new process or input [23]. Innovation requires knowledge from many and varied sources [28, 29]. The researchers also propose a more reasonable proxy for R&D volume, using a concentration index to quantify regional innovation capacity inequality based on regional economic levels in China and to dynamically decompose changes in regional innovation capacity inequality [3]. Researchers emphasize that the use of artificial intelligence will open up new opportunities for innovation management and change the practice of innovation in organizations [10, 16]. A preliminary study of 150 AI-savvy innovation managers identified four distinct clusters in terms of how organizations can use and implement AI in their innovation management [4]. Based on the opinions outlined above, we use the predictive cooperation approach as an element of strategic planning of a joint business environment in order to identify further potential partners and, as a result, to obtain a positive impact on economic performance as a result of their integration into the company's innovative activities.

The formation of the status of an innovative economy in the context of globalization is very important from the point of view of macro-, meso- and microeconomics. Improving the quality of innovative products and thus ensuring economic

security are key effects that are perceived in the context of implementing strategies and plans related to innovative development [8]. The innovative model of the economy is largely based on modern technologies in all sectors, which make it possible to increase the efficiency of the entire production and socio-economic system. Then, all actions to achieve this goal should be integrated with social policy measures [9]. The adoption of innovative solutions in production will contribute to the creation of new jobs. An important element in the formation of an innovative economy is the subjective potential of each company and industry separately [10, 11]. Despite the risk associated with co-innovation in both products and services due to increased resource use and effort, few studies have focused on performance itself without considering changes in inputs [5]. Innovation is usually interpreted as the successful application of new ideas resulting from organizational processes that combine different resources [26]. This combination of different resources is a multi-step process leading to the creation of improved or new products, services or processes by which firms seek to stand out in the market [27].

We focus on increasing the investment attractiveness of the company, respectively, on planning and increasing investment flows as a source of input resources [12, 13, 14].

There are the hypotheses which are put forward in this study:

- stakeholders in the development and implementation of innovations have a limited understanding of the essence of investment attractiveness, regarding a certain influence of the potential of micro-subjects of the state economy on the state of the potential of the macro environment, which hinders investment;
- a common system for assessing innovation potential, used by global policymakers and individual stakeholders in developing the concept of innovative growth, can align R&D priorities with the priorities and preferences of each individual country;
- substantiation of the correlation between the selected variables and R and TPF descriptors by OECD (2022).

We also emphasize that the presented UKDIP includes model variables chosen by us subjectively according to our scientific views and may vary in further research.

## METHODS

Innovative potential is a specific multiplier for the development of both individual business entities and the national economy as a whole. Taking into account the constant processes of globalization taking place in modern realities, the acceleration of the growth of innovative potential will have a positive impact on the state of the world of the production and economic system in general. The state of the innovative potential directly correlates with the choice and implementation of innovative strategies, in this regard, the search for ways to form and increase its reliability is essential.

We will present the generalized theoretical and methodological basis of the process of forming innovative potential as a foundation for the development of a company in the following sequence.

Using the method of predetermination, we propose to build in the form of a concept an approach to the study of innovative potential and the prospects for its increase (as a set of views that are interconnected, forming a single system and a certain way of interpreting the scientific problem we are studying). The method of predetermination allows us to present the solution of a scientific problem as an extremely debatable issue, on which opinions in the main discussions of scientists can differ significantly.

We rely on the basic foundations of the implicit theory - the essence of which is the construction of subjective explanatory schemes of objective reality. As a result, we obtain analytically confirmed managerial compromises for decision-making. Using the selective theses of the method of system dynamics (as a direction in the study of complex systems, investigating their behaviour in time and depending on the structure of the system elements and the interaction between them), we single out the components - descriptors (or criteria) of influence and evaluate their state for each subject of research in the time period.

Using the method of latent clusters, we determine the latent, (not visible), heterogeneity in the sample, based on the basis of response patterns after measuring the variables of investment attractiveness for the subjects under study, as a result, we get  $n$  number of clusters with different qualitative characteristics.

With the help of cluster analysis methods, the necessary splitting of samples of multidimensional information into groups of objects that are close in the sense of the set established measure of similarity is achieved. Such limited groupings are

designated as clusters, classes, or taxa. Cluster analysis methods are also called unsupervised learning methods, mechanical grouping, or taxonomy. Cluster analysis methods are used as additional tools for troubleshooting modelling or recognition problems. Thus, reference objects can be selected by means of grouping. However, often a grouping can have an independent meaning.

Usually, cluster analysis tasks are distinguished, for which the number of cluster classifications and tasks in which the number of clusters should be indicated at the time of making a conclusion about clustering.

K-Means Clustering is a popular clustering method, which is the arrangement of a set of objects into relatively homogeneous groups. The purpose of the method is to divide  $n$ -observations into  $k$ -clusters so that each observation belongs to the cluster with the closest average value to it. The method is based on minimizing the sum of squared distances between each observation and the centre of its cluster, or the function

$$\sum_{i=1}^N d(x_i, m_j | (x_i))^2 \quad (1)$$

where  $d$  is the metric,  $x_i$  is the  $i$ -th data object and  $x_i, m_j$  is the centre of the cluster, to which the element  $x_i$  is assigned at the  $j$ -th iteration.

There is a cluster of observations (objects), each of which has certain values for a number of features. according to these values, the object is placed in a multidimensional space.

The researcher assigns the number of clusters to be formed.  $K$ -observations are selected randomly, which at this step are calculated by the cluster centres. Any observation is "assigned" to one of the  $n$ -clusters - the one with the shortest distance.

The newly invented centre of each cluster is calculated as an element whose properties are calculated as the arithmetic mean of the features of the objects included in this cluster. It turns out a similar number of iterations (steps 3–4 are repeated), until the cluster centres become stable (i.e., the same objects will be found in any cluster at each iteration), the variance within the cluster will be minimized, and between clusters it will be maximized.

The selection of the number of clusters is based on an experimental hypothesis. The principle of the algorithm is to search for such cluster centres and sets of components of each cluster in the presence of a certain function, which expresses the property of the current partition of the set into  $k$ -clusters if the final discrepancy between cluster components from cluster data centres is the smallest.

$$V = \sum_{i=1}^k \sum_{x_i \in S_i} P(x_j - \mu_i)^2 \quad (2)$$

$k$  - is the number of clusters,  $S_i$  is the obtained clusters,  $i = 1, 2, \dots, k$ ,  $\mu_i$  are the centres of mass vectors  $x_i \in S_i$ .

The key advantages of the  $k$ -means method are its simplicity and speed of execution. The  $k$ -means method is more comfortable for clustering a large number of observations than the hierarchical cluster analysis method (in which dendrograms become overloaded and lose visibility).

One of the shortcomings of the elementary method is the violation of the connectivity of the cluster elements, therefore, all kinds of modifications are formed.

To describe a process or phenomenon, the operation of a complex system or object, as a rule, a certain set of indicators is used that characterize these processes or objects from different angles. Over time and under the influence of various objective and subjective conditions, these indicators change, moreover, in different ways. The moment of feature extraction can be executed from a set of publicly available private characteristics by many technologies, depending on the fundamental task. The algorithm of the presented method is as follows: a group of  $n$  - experts, in the area under study, gives their assessment of the significance of  $m$  - partial indicators. The most significant indicator corresponds to the rank  $m$ , the next -  $(m - 1)$ , etc., the rank equal to 1 has the minimum important indicator. the results of the survey of experts are summarized by summing up the sum of the ranks given by the experts.

The next stage of the study was to evaluate the innovative potential, in the context of investment attractiveness, to carry out qualitative features by conducting detailed analytical work by an expert method, using the theory of weight coefficients.

Based on the data obtained, a conclusion is made about the current level of innovative potential in the company and the identification of factors affecting its state.

## RESULTS

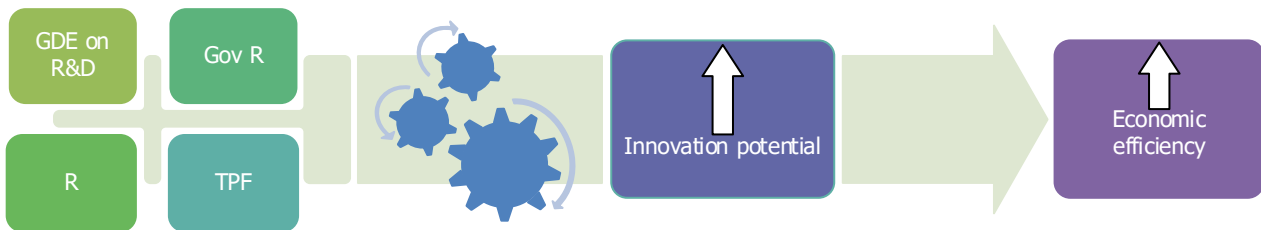
We offer the author's concept of building innovative potential by enterprises, unified on the basis of basic indicators of differential entities - a sample of world economies - Unified concept of building innovation potential - (UKDIP). We propose to consider the economy of a certain country as a whole, without singling out specific enterprises, since the spheres and types of economic activity in each country have wide differentiation. With this approach, we will be able to see the directions of investment policy in each analyzed state, because the economy consists of many economic entities. The original UKDIP approach assumes that economic failures in the development and implementation of innovative products and technologies, due to the asymmetry of information between countries and researchers, directly depend on the decision to choose innovative activities at the national level and can often depend on various influencing factors. Cost, availability of competitive technologies, lack of system analysis, and other characteristics of a product can affect the effectiveness of an innovative technology program, especially in terms of cost savings and equitable coverage of the economic sector. On a global level, because innovative technologies often have a higher price tag to recoup investment in product development, pricing decisions pose a significant risk to developers who need to ensure sufficient demand and impact from implementation. In addition, if there is no clarity about the desired characteristics of new technologies obtained from government programs and private users, it is difficult to obtain appropriate product specifications for innovative products, which makes technology developers reluctant to invest in innovation. Therefore, the essence of UKDIP is to determine a limited narrow circle of descriptors of influence on innovation potential and the correlation between them at the level of national economies of the world, using implicit theories that are non-standard for this area of science - the essence of which is to build subjective explanatory schemes of objective reality - building up the innovative potential of enterprises. The UKDIP concept compares different descriptors of innovation potential from a systemic perspective, with the aim of supporting stakeholders in the technology development process (including government support programs) and presents analytical management trade-offs for decision-making. This approach is a comprehensive analytical framework that includes a common and comprehensive set of elements for analyzing trade-offs between attributes of innovation capacity. Multicriteria decision analysis can also be applied as a structured explicit way to take into account many factors when making decisions [14, 15]. The content of the UKDIP is formed from four descriptor components (or criteria) and creates a system for quantifying managerial trade-offs. A substantive review of the state of innovation potential as a factor in accelerating the development of enterprises was carried out for 12 subjects - countries of the world economy and made it possible to identify the following indicators of influence (Table 1).

**Table 1. Components of the original UKDIP\* Innovation Potential Concept.**

Name of the component - descriptor	Conv. designation	Path to information storage	Subject essence
Gross domestic spending on R&D	GDE on R&D	OECD (2022), Gross domestic spending on R&D (indicator). doi: 10.1787/d8b068b4-en (Accessed on 26 April 2022) <a href="https://data.oecd.org/chart/6HbP">https://data.oecd.org/chart/6HbP</a>	Gross domestic R&D expenditure is defined as the total expenditure (current and capital) on R&D by all resident companies, research institutes, universities and government laboratories, etc. in the country. It includes R&D financed from abroad but does not include domestic funds for R&D performed outside the domestic economy. This indicator is measured in constant US dollar prices using the base year 2015 and purchasing power parity (PPP), and as a percentage of GDP.
Researchers	R	OECD (2022), Researchers (indicator). doi: 10.1787/20ddf0f0f-en (Accessed on 26 April 2022) <a href="https://data.oecd.org/chart/6HbW">https://data.oecd.org/chart/6HbW</a>	Researchers are individuals who conceptualize or create new knowledge, products, processes, methods and systems and manage related projects. This indicator is measured per 1000 employees and in the number of scientific workers; data are available in total and disaggregated by sex.
Government researchers	Gov R	OECD (2022), Government researchers (indicator). doi: 10.1787/c03b3052-en (Accessed on 26 April 2022) <a href="https://data.oecd.org/chart/6HbX">https://data.oecd.org/chart/6HbX</a>	These are government professionals who develop or create new knowledge, products, processes, methods and systems and manage related projects. This indicator is measured per 1000 employees and in the number of scientific workers; data available in total and disaggregated by sex.
Triadic patent families	TPF	OECD (2022), Triadic patent families (indicator). doi: 10.1787/6a8d10f4-en (Accessed on 26 April 2022) <a href="https://data.oecd.org/chart/6HcQ">https://data.oecd.org/chart/6HcQ</a>	A ternary patent family is defined as a set of patents registered in different countries (i.e. patent offices) to protect the same invention. Triadic patent families are a set of patents registered with three major patent offices: the European Patent Office (EPO), the Japan Patent Office (JPO), and the United States Patent and Trademark Office (USPTO). The triad counts of patent families refer to the country of residence of the inventor and the date of first registration of the patent. This indicator is measured as a number.

From the point of view of a global approach to the global challenges of our time, UKDIP plays an important role in shaping the priorities for the development of innovative potential in accordance with the factors that characterize the content essence of the concept of "innovative potential" and the practical component of the application of the proposed conceptual framework by countries at the macro level and enterprises at the micro level. It was envisaged that countries could use the UKDIP system with their own local data to explore trade-offs between existing and those under development and to plan investments. This would serve as a tool for country management decision-making and for stakeholders involved in the development of innovative technologies to model the impact of various factors. At the same time, the UKDIP vision at the global level of solving a scientific problem is to change the paradigm of the investment attractiveness of innovative products in such a way that the preferences and demand of countries are clearly articulated for making investment decisions. By clearly identifying the value that a new product can offer to decision-makers in companies and globally in the early stages of the development process, UKDIP will be able to build innovation capacity as a tool to increase the overall development potential of the business entity.

In Figure 1, the UKDIP concept's own vision of functioning is modelled with the forecasting of the growing economic effect of innovative potential, however, the calculation of economic efficiency will be relevant for specific enterprises, which is one of the directions of further research.



**Figure 1. Schematic essence of the perception of the UKDIP functioning model.**

As a result of building this model, there is a need for a predictable pilot implementation of the UKDIP concept with stakeholders at the country level, that is, national world economies.

In order to predict whether the UKDIP will be a useful tool for selected countries, a country-focused project should be initiated to further develop and test the UKDIP concept using twelve randomized subjects as a test case (Austria, Belgium, France, Germany, Israel, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey). The aim is to determine the usefulness of using a multi-criteria decision-making approach using country data on four selected descriptors to compare their impact on the growth of innovation capacity.

The analytical characteristics of the selected indicators are presented in Figures 2-5, taken for the period 2000-2022. The visualization presented in Figures 2-5 was built using the online constructor on the official website of the OECD and can be viewed by following the link [32, 33, 34, 35]. The trend of changing the characteristics of these descriptors, indicating the peak points with the maximum value, has a consistently even character for all subjects of the sample. Only Turkey does not provide data on the number of researchers both in general and separately in the public sector.

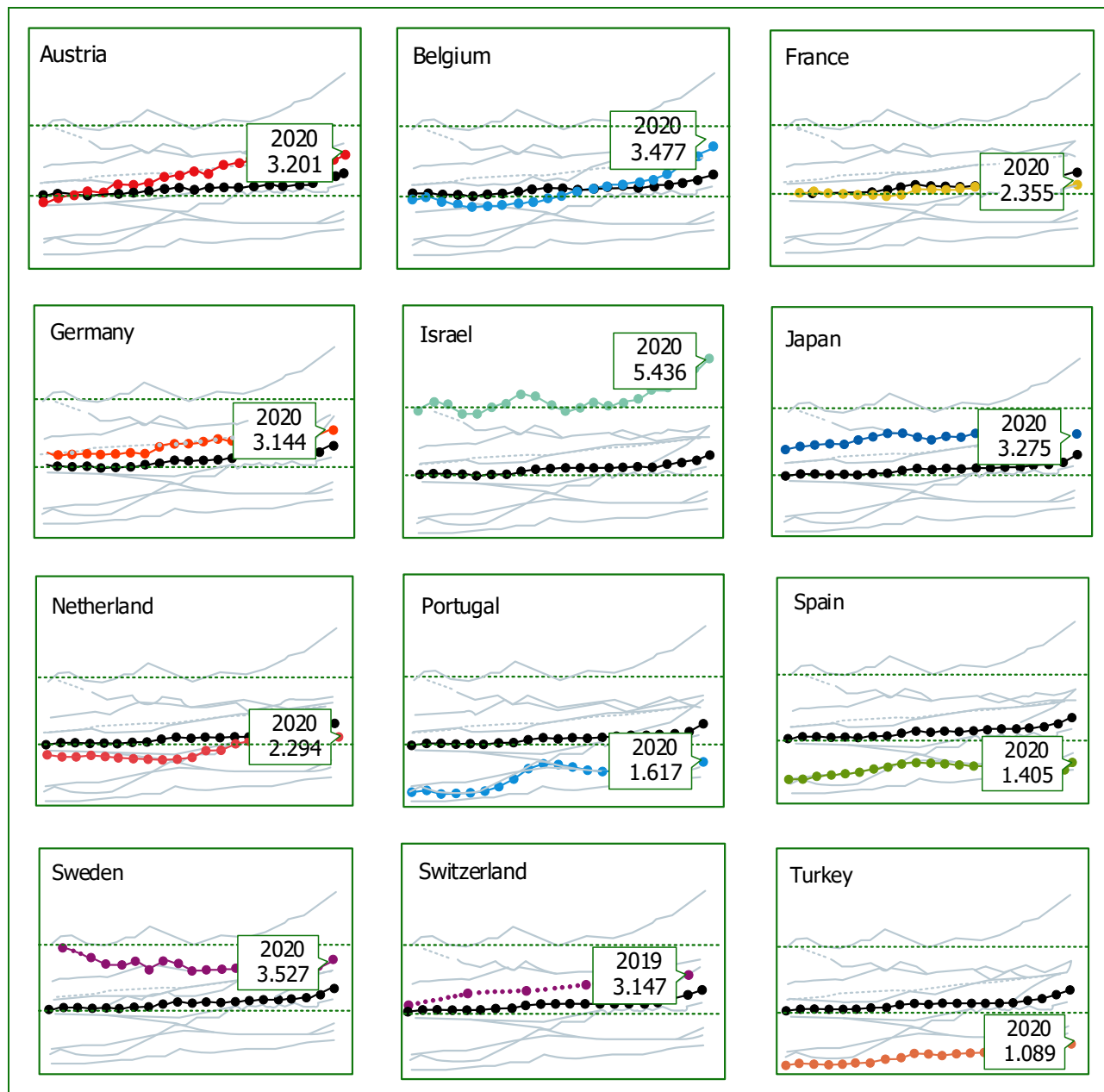


Figure 2. GDE on R&D descriptor dynamics, USD million. (Source: [33])

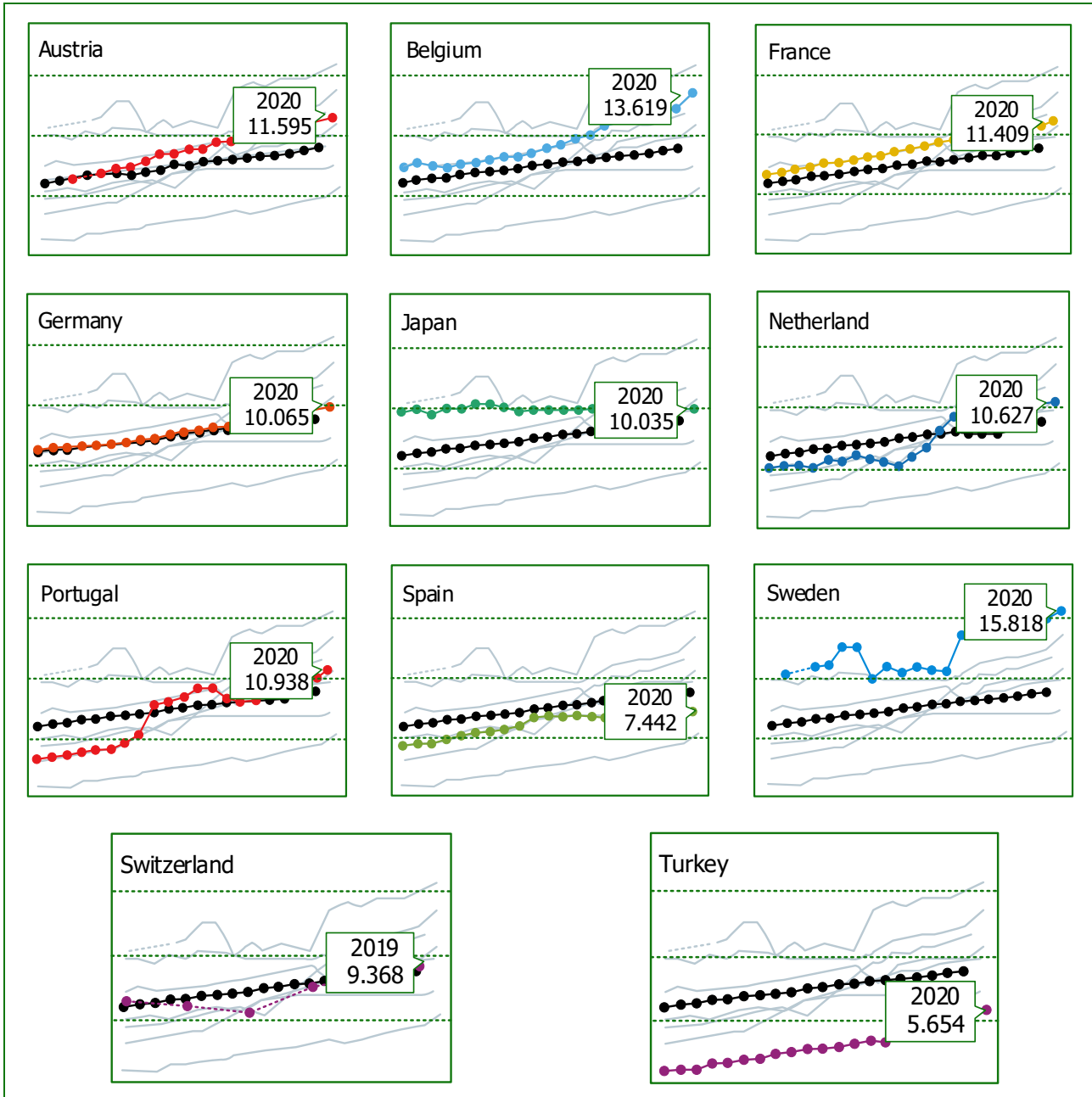


Figure 3. Dynamics of R descriptor change, pers. per 1000 employed. (Source: [34])

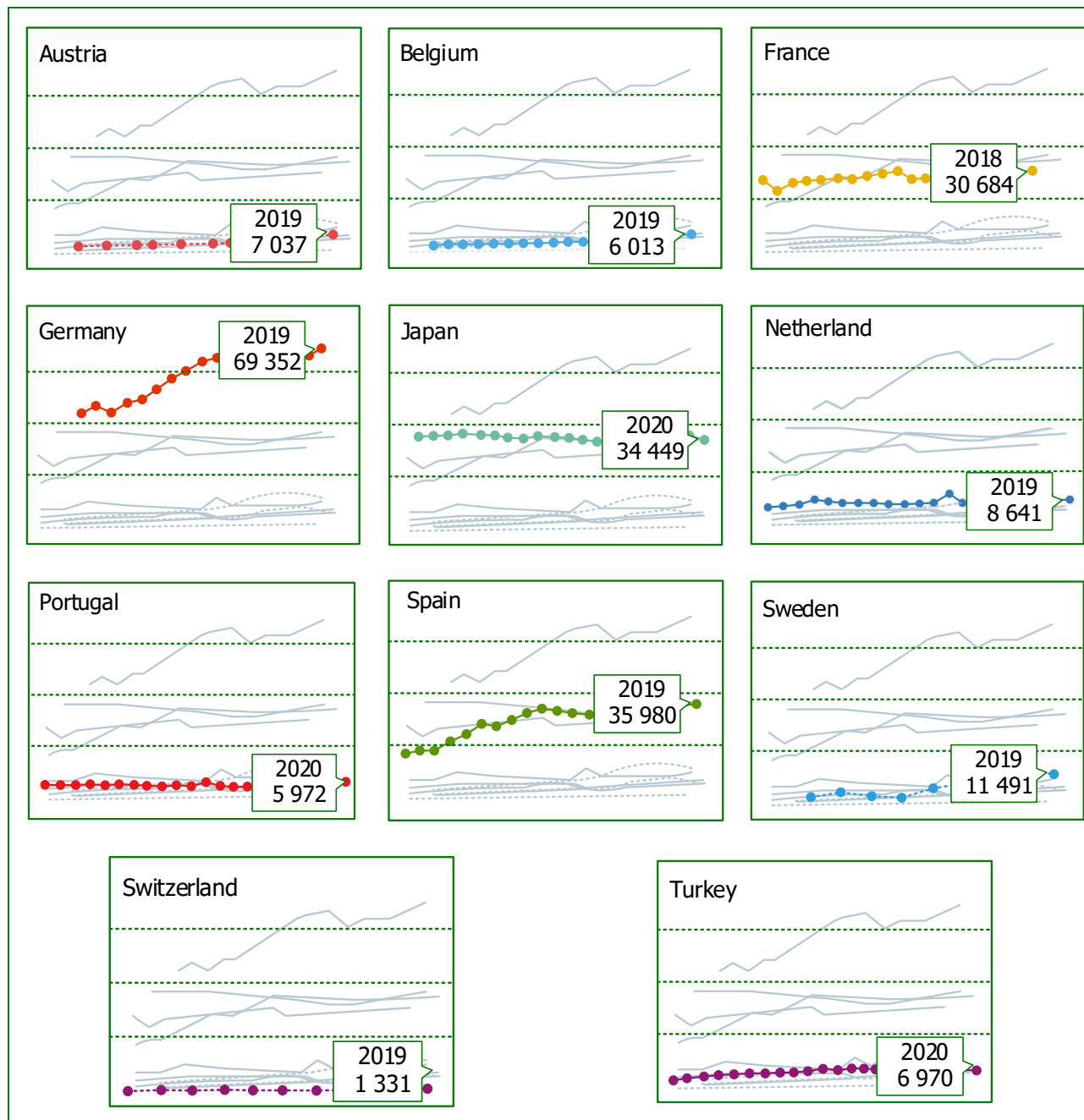


Figure 4. Gov R descriptor dynamics, pers. per 1000 employed. (Source: [35])

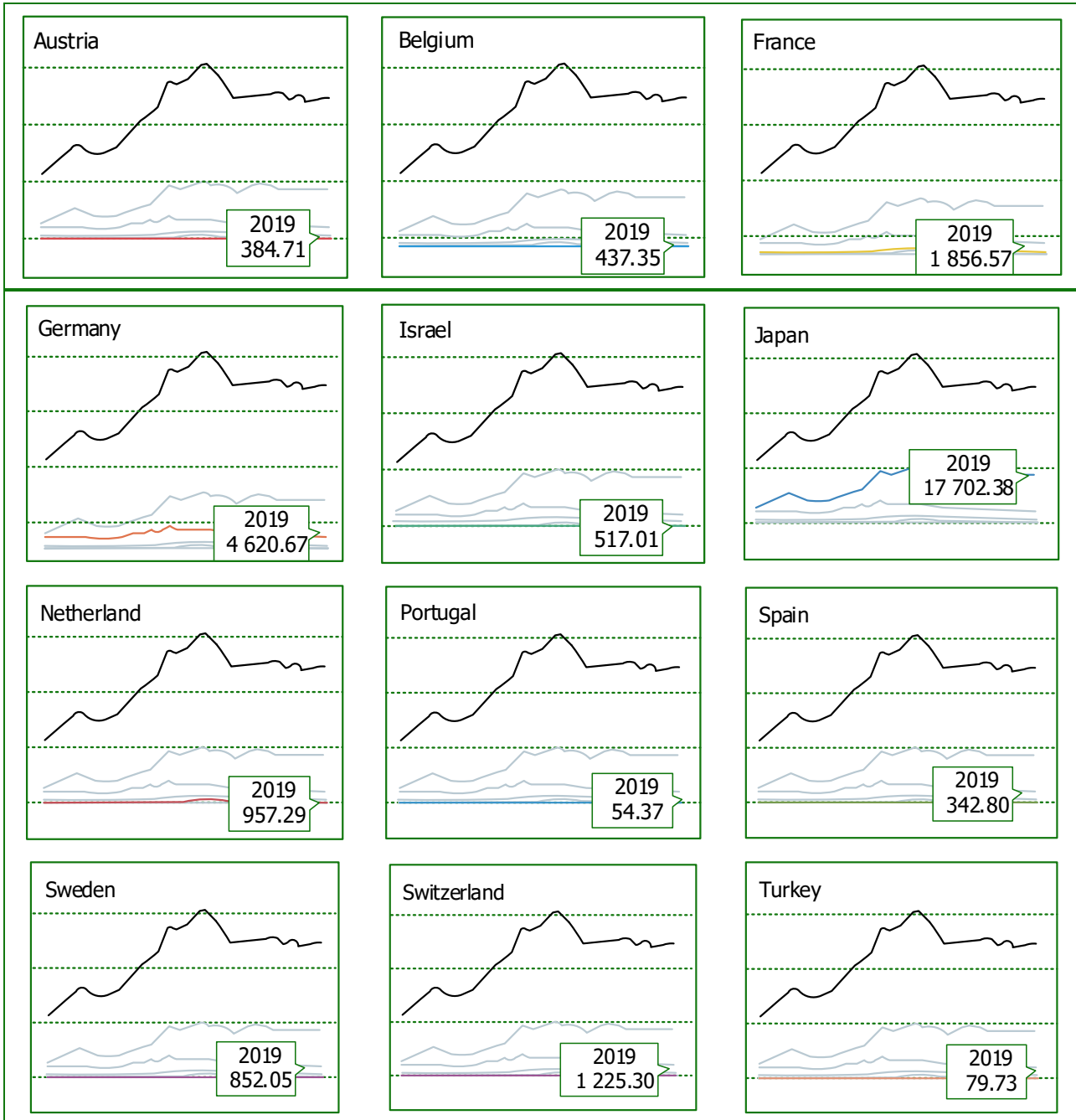


Figure 5. Trends in TPF descriptor, number. (Source: [36])

The architectonics of the presented study involves non-standard use of the foundations and essence of the implicit theory in building the UKDIP concept, thus comparing data on their involvement in innovation regulation when solving managerial problems of building up innovative potential.

As a step, it is proposed to present in a complex connection an implicit theory with innovative attractiveness, intelligence, qualitative characteristics of the sample and the allocation on their basis of meta-factors of plasticity and stability in relation to probabilistic uncertainty.

The final step is to determine the links between implicit theories and components of innovative potential - and motivational qualitative characteristics in a sample of 12 countries.

The previously defined descriptors of innovation potential are affirmatively related to innovation indicators, relying on the foundations of the implicit theory (Table 2). The subjects of the sample, according to the implicit theory, have rather high values of indicators and are characterized by a target orientation towards increasing the overall innovative potential.

Indicators of constant potential are positively associated with high investment attractiveness, respectively, and also positively with a focus on performance. Investment and innovation potential are positively related ( $p < 0.05$ ).

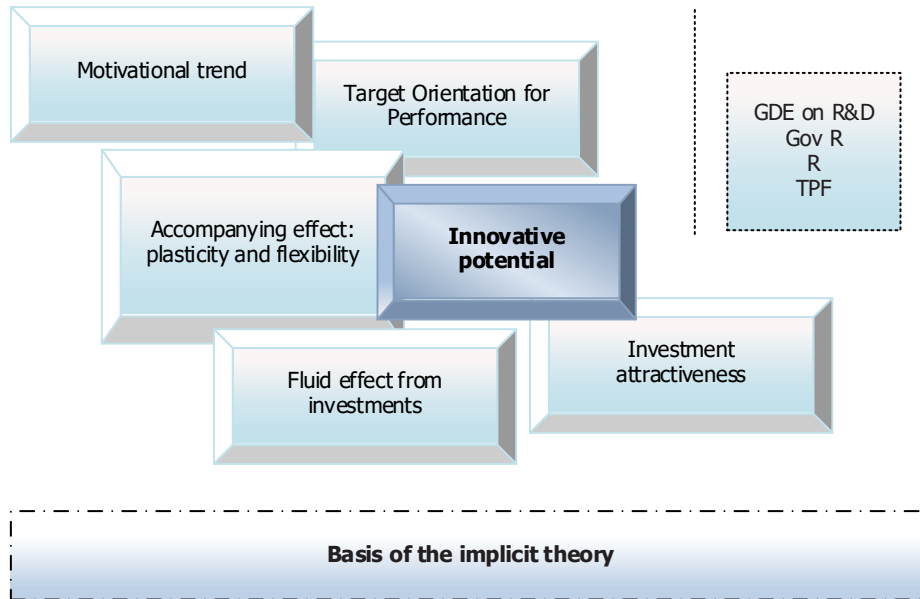
**Table 2. Intercorrelations of indicators based on implicit theories, potential and UKDIP descriptors in the sample.**

De-scriptors	Sub-ject 1	Sub-ject 2	Sub-ject 3	Sub-ject 4	Sub-ject 5	Sub-ject 6	Sub-ject 7	Sub-ject 8	Sub-ject 9	Sub-ject 10	Sub-ject 11	Sub-ject 12
GDE on R&D	1											
R	- <b>0.57**</b> 263	1										
Gov R	<b>0.37**</b> 263	- <b>0.32**</b> 263	1									
TPF	0.07 263	- <b>0.22**</b> 263	<b>0.13*</b> 207	1								
GDE on R&D	0.09 263	- <b>0.17**</b> 263	<b>0.12*</b> 207	<b>0.30**</b> 207	1							
R	0.03 206	-0.09 206	-0.01 138	<b>-0.16*</b> 138	-0.12 138	1						
Gov R	-0.03 203	-0.08 203	-0.08 138	<b>0.18*</b> 138	0.15 138	<b>0.16*</b> 161	1					
TPF	-0.08 192	-0.06 192	-0.02 122	0.10 122	<b>0.20*</b> 122	0.09 112	<b>0.20**</b> 112	1				
GDE on R&D	0.01 192	0.01 192	0.12 122	-0.12 122	<b>0.27**</b> 122	-0.02 112	0.09 112	-0.11	1			
R	-0.02 192	0.02 192	-0.03 122	0.03 122	- <b>0.23**</b> 122	0.003 112	-0.15 112	-0.06 120	<b>-0.33**</b> 120	1		
Gov R	0.07 192	-0.01 192	0.11 122	0.03 122	-0.11 122	0.05 112	-0.08 112	<b>-0.26**</b> 120	0.05 120	-0.02 120	1	
TPF	.05 192	0.003 192	-0.03 122	0.03 122	0.07 122	0.13 112	-0.12 112	-0.08 120	<b>-0.27**</b> 120	-0.005 120	<b>-0.23**</b> 120	1
GDE on R&D	-0.11 192	0.12 192	-0.02 122	-0.16 122	-0.13 122	-0.01 112	0.12 112	-0.12 120	0.16 120	<b>-0.35**</b> 120	-0.01 120	<b>-0.27**</b> 120
R	0.07 192	-0.06 192	-0.002 122	<b>0.29**</b> 122	<b>0.33**</b> 122	<b>-0.18*</b> 112	0.03 112	-0.02 120	0.09 120	-0.16 120	<b>-0.23**</b> 120	<b>-0.19*</b> 120
Gov R	-0.08 192	-0.06 192	-0.16 122	-0.12 122	- <b>0.30**</b> 122	-0.08 112	-0.10 112	-0.17 120	<b>-0.51**</b> 120	<b>0.22*</b> 120	-0.15 120	<b>0.26**</b> 120
TPF	-0.11 192	0.12 192	-0.02 122	-0.16 122	-0.13 122	-0.01 112	0.12 112	-0.12 120	0.16 120	<b>-0.35**</b> 120	-0.01 120	<b>-0.27**</b> 120

Algorithm:

- the correlation coefficient  $\rho$  Spearman was used;
- significance limit:  $**p < 0.01$ ,  $*p < 0.05$ ;
- implicit theories - high values correspond to the target orientation to increase potential, low values correspond to performance, flexibility in achieving goals, and fluid effect from innovations.

A generalized diagram of the relationship between the implicit theory and other components of the UKDIP is shown in Figure 6.



**Figure 6. Schematic construction for intellectual perception of the relationships of the implicit theory with other components of the UKDIP.**

The above allows us to state the research idea that the descriptor components, or influence variables, or meaning determining factors are associated with the formation of investment potential, which is also associated with the investment effect in the sample of subjects and with the attitude to probabilistic uncertainty (in terms of the implicit theory).

Conscious regulation at the level of goal orientation is associated with both the potential and the subjective properties of each participant in the sample.

A fair explanation of these observations can be the independence of these characteristics from each other - that is, the ability to develop the potential and the current level of the potential of the subject. Probably, the point is that the implicit theory makes it possible to predict the trajectories of further development - an upward (maintainers) and opposite, or downward (decliners) trend, while their simultaneous relationship with real achievements in building a positive potential trend may not be fixed [17]. This can be explained by the fact that, according to the implicit theory, the subjects of the sample receive an incremental potential and, accordingly, have a higher productive rate of development, which follows a "steeper" trajectory than subjects with a constant state, which is characterized by saving the current point of opportunities and achievements or lowering this level. The negative search for these connections between the implicit theory and positive achievements was previously described by scientists in their studies [18]. However, there are no results in solving the scientific problem of solving deterministic problems with a point reference to the rule. In our study, we propose to consolidate the identification of the relationship between the characteristics of different levels of implicit theory: motivational trend, plasticity and stability, and their influence in the regulation of innovation potential, using the foundations of the deterministic mental task of Peter Wason [19].

Modelling the conditions of probabilistic uncertainty in tasks with an assumed orientation, a description of the situation, involves the study of the existing individual experience of the subject, proactive control - as an intuitive or predictable receipt of the expected positive results of the choice [20, 21].

When determining the designation of predictors of innovation potential, a regression analysis was carried out for variables that correlate with the UKDIP concept.

The results of linear regression are as follows: the most significant predictor of innovation potential, explaining 52% of the variance in UKDIP, was the cost of gross domestic expenditure on R&D ( $R^2 = 0.516$ ,  $F = 81.242$ ,  $B = 0.054$ ,  $p < 0.001$ ), if this predictor is included in the model, the following variables will have the status of insignificant predictors. If we imagine the opposite model in direction, then the UKDIP descriptors highlight the number of triad families of patents in the subject as a significant predictor.

Also significant for the approval of hypotheses in solving the scientific problem of increasing the innovative potential, we consider models that include as predictors other components-descriptors of the innovative and investment potential, and not just the concepts specifically indicated in the content.

One of the most significant and important aspects of the functioning of enterprises at the present stage is investment activity. In order for investors to invest their money, an enterprise must meet a certain number of characteristics, that is, be investment-attractive.

We propose to evaluate the innovative potential in the financing of qualitative features  $Y_1$  ( $n_1 \dots n_6$ ) by conducting detailed analytical work using the expert method, using the theory of weight coefficients.

Weighting coefficients of qualitative features for assessing the investment attractiveness of enterprises are presented in Table 3.

**Table 3. Information basis for modelling: weighting coefficients of qualitative features for assessing investment attractiveness.**

Name of variable	Indicator	Intervals of change of weight coefficients	Bali
Profitability of activity	$\psi(x_1)$	$0 < n_1 \leq 0.05$	0.25
Liquidity of assets	$\psi(x_2)$	$0 < n_2 \leq 0.05$	0.25
Cost of credit obligations	$\psi(x_3)$	$0 < n_3 \leq 0.25$	2.0
Incoming investments for the period	$\psi(x_4)$	$0 < n_4 \leq 0.15$	1.0
Outgoing investments for the period	$\psi(x_5)$	$0 < n_5 \leq 0.15$	0.5
Reserve fund for uncertainty conditions	$\psi(x_6)$	$0 < n_6 \leq 0.10$	1.0

We will assign to each variable the appropriate weighting coefficients  $n_i$  ( $i=1..6$ ) and present in Table 4 the hierarchy of degrees of investment attractiveness assessment. The sum of points of qualitative assessments is  $Y(n_1 \dots n_6) = 6.9$  points (Table 4).

**Table 4. Hierarchy of evaluation of investment attractiveness.**

Degree	Low state	Satisfactory state	High state
Gap	$2 \leq Y \leq 4$	$4 < Y \leq 8$	$8 < Y \leq 10$

Let us conclude that the investment attractiveness of the studied subjects of the sample is satisfactory.

Of the qualitative indicators of investment attractiveness, the following are significant predictors: profitability of operations ( $R^2 = 0.065$ ,  $F = 11.054$ ,  $B = -0.051$ ,  $p < 0.001$ ), Liquidity of assets ( $R^2 = 0.047$ ,  $F = 6.035$ ,  $B = 0.034$ ,  $p < 0.05$ ), Cost of credit obligations ( $R^2 = 0.039$ ,  $F = 4.816$ ,  $B = 0.045$ ,  $p < 0.05$ ), outward investment for the period ( $R^2 = 0.051$ ,  $F = 8.547$ ,  $B = 0.038$ ,  $p < 0.01$ ), incoming investment for the period ( $R^2 = 0.067$ ,  $F = 3.979$ ,  $B = 0.027$ ,  $p < 0.05$ ) and the Reserve Fund for Uncertainty Conditions ( $R^2 = 0.027$ ,  $F = 4.382$ ,  $B = 0.029$ ,  $p < 0.05$ ).

The modelling performance, which was carried out on the basis of the selected predictors indicated above (some do not have a level of significant significance) explains 21.4% of the variance of the investment attractiveness variable ( $F = 7.654$ ,  $p < 0.001$ ) and includes indicators of profitability of operations ( $B = 0.070$ ,  $p < 0.001$ ), incoming investments for the period ( $B = 0.027$ ,  $p < 0.001$ ), cost of credit obligations ( $B = 0.054$ ,  $p < 0.001$ ) and Reserve fund for conditions of uncertainty ( $B = 0.029$ ,  $p < 0.05$ ).

Afterwards, to further confirm the significance and content of the content of the UKDIP concept, we will carry out analytical actions to determine latent clusters, based on the variables of investment attractiveness. This method of latent clusters will help to identify latent, (not visible), heterogeneity in samples, based on the basis of response patterns after measuring variables. At the end of the performed actions, classes (clusters) of the subjects of the sample are indicated that have similarities in analytical indicators. The fundamental basis of this technique is the estimation of the probability of including a subject in a particular cluster.

Indicator (AIC) - information criterion Akaike, a criterion that evaluates the quality of the prediction of a particular model on the tested sample. Indicator (BIC) when conducting empirical studies is an indicator that demonstrates the adaptation

of the model - Indicator (A-BIC) is a criterion showing the correlation between the adaptation index and prediction. The score (ENT) denotes a measure of the irreversible utility of the model.

The lowest value of the BIC indicator characterizes the most optimal model; an increase in the entropy index ENT indicates a more accurate classification of modelling subjects into clusters [10].

It was determined that Cluster III has the most optimal characteristics (AIC = 638.605, BIC = 670.94, A-BIC = 639.124, ENT = 0.630) (Table 5).

**Table 5. Alternative interpretation of models with the allocation of latent clusters, a sign of suitability.**

Model	AIC	BIC	A- BIC	ENT
CLat, cluster I	631.922	644.013	633.518	-
CLat, cluster II	630.617	651.83	631.674	0.549
CLat, cluster III	638.605	670.94	639.124	0.630
CLat, cluster IV	632.505	640.95	632.214	0.590

Cluster I include subjects (Germany, Israel, Japan, the Netherlands, Sweden, Switzerland) with the highest values of the entire set of variables. Cluster II - III - IV included entities (Austria, Belgium, France, Portugal, Spain, Sweden, Switzerland) with an equivalent level of investment attractiveness, with a higher level of profitability and a reserve fund formed for uncertainty conditions (cluster II), more interesting for partners-investors. Note that as a result, clusters are formed as differential types of regulation of the innovation potential process by influencing the investment attractiveness of the subject.

## DISCUSSION

While the problem of determining how to build innovation capacity that will be able to accelerate economic development and rationalize economic efficiency, and how to invest in innovation is not new, assessing the value of innovation is becoming increasingly important as R&D funding becomes scarce and as countries seek to eliminate gaps in capital by searching for new sources [21].

More than ever, countries must be ready to consider whether it is worth investing in innovations that can improve the performance of a particular sector of activity, but at a higher cost. Similarly, innovators need to understand the types of technologies worth investing in to meet market demand. This is especially important in the context of today's negative global challenges, as countries face decisions about which economic stabilization measures should be prioritized and which should target the potential for growth in innovation capacity while ensuring that any innovative technology that enters the market should be suitable for implementation with a guaranteed positive output Y [22].

Researchers of the innovation paradigm present analytical results of the successful experience of different economies as benchmarking, which allows for a structured system comparison in order to optimize the subjective state of a business entity. It was concluded that any decision support tools and processes in countries should be adaptable in terms of alignment with existing local policy processes, applicability across policy issues, flexibility in choosing criteria that reflect different levels of values, and the ability to function in different countries with different data availability and analytical potential [23].

There is also a need to manage within the outlined process to develop a consensus recommendation, including the identification of stakeholders, and the need for their state programs to be discussed, guiding the discussions in such a way as to have a common understanding of the issue of decision making, evidence and data in order to receive recommendations.

It is also important to ensure the credibility of this approach.

To do this, the developed tools and processes must be consistent and intuitive for the end user, as well as applicable to policy issues related to innovative programs.

Academic literature on the existence of good practice in innovation draws a distinction between evidence synthesis and evidence use [24]. This pilot project identified a gap in processes and tools to support contextualization in investment and innovation decisions.

A number of initiatives are also indicated in support of the stage of assessing the prospects for building up innovative potential, political recommendations are given for developing the trend of accumulating innovative and investment attractiveness, first of all, these are tools for strengthening the state of an active innovator [25]. However, preliminary findings on innovation sector prioritization and reviews of R&D revitalization policies in various economic sectors around the world confirm the need to support countries in using evidence to make recommendations based on their specific priorities and needs.[11]

This is consistent with calls to take into account the perspectives of stakeholders at the international level in the context of decision-making when considering the value of developed innovative products [22, 9].

There is currently no established platform for interacting with innovation programs to assess the extent to which technologies can meet their needs, or to take advantage of future products and how they will be used. The UKDIP concept can enhance communication with stakeholders on the totality of work aimed at generating new knowledge and its practical application, needs, requests and preferences of innovative capacity-building programs for future innovation. To be successful, UKDIP must include a mechanism to share this information with stakeholders who control innovation and monitor changes in preferences over time.

The premise of supporting countries to make concrete and evidence-based decisions is consistent with the principles of the World Intellectual Property Organization [8], with the principles of the INSEAD International Business School [19], the Organization for Economic Co-operation and Development, which emphasize the importance of country-led decision making, and relied on subjective data [24]. To be successful, it is essential that the UKDIP concept be included in decision-making processes for building innovation capacity, and an appropriate approach has been developed to this end. At the country level, this is likely to include determining where UKDIP tools fit into the existing decision-making infrastructure, both within the innovation capacity-building program and within wider economic sector priority-setting mechanisms such as technology assessment. At the global level, UKDIP should play an additional role as a tool in the development of global guidance for the development of innovative products [18].

There are a number of questions regarding the feasibility of introducing a tool for use by stakeholders at the country level, given the significant differences and differences in each national economy.

In the studies carried out to date, the concept of UKDIP may be of interest in a pilot project; it remains to be seen whether the managerial will to use it will be provided and whether the necessary resources will be provided for the continued use of this tool outside of the pilot project. The concept of UKDIP can certainly bring benefits at the micro level, for an individual company, especially given the growing awareness of the need to build innovative capacity in the face of today's challenges.

The UKDIP concept can play a role in enhancing the ability to determine which combination of approaches will best meet the needs of actors to optimize innovative programs and reduce costs in balance with increasing the impact of the resources spent.

## CONCLUSIONS

In this study, an attempt was made to design the UKDIP concept, the essence of which is to find ways to increase the innovative potential of business entities. The unification of the concept involves the use of selected indicators-descriptors as factors of influence that characterize the state of the innovation sector (Gross domestic expenditure on R&D, the number of researchers, the number of government researchers, the number of triad families of patents) to study the trade-off between existing and those that are under development technologies, as well as for investment planning. The information base of the study is a sample of 12 countries selected by random selection.

Also, in the architectonics of the concept, we relied on the foundations of the implicit theory, thus comparing data on their involvement in innovation regulation when solving managerial problems of building up innovative potential. As a result of the conducted intercorrelations, the existing links between the meta-factors of stability and plasticity as the incremental foundations of the implicit theory in relation to innovations are confirmed.

Using the foundations of P. Wason's deterministic mental task, we confirmed the relationship between the characteristics of different levels of implicit theory, motivational trend, plasticity and stability - and their influence in the regulation of innovation potential.

The results of linear regression revealed the most significant predictor of innovation capacity, explaining 52% of the variance UKDIP, a measure of the cost of gross domestic expenditure on R&D. We propose to evaluate the innovative

potential in financing qualitative features by conducting detailed analytical work using the expert method, using the theory of weight coefficients, which confirmed the sufficient investment attractiveness of the subjects of the study.

Modelling results based on sample predictors explain 21.4% of the variance of the investment attractiveness variable and include the profitability of operations, inward investment, cost of credit obligations and reserve fund for conditions of uncertainty.

To further confirm the significance and content of the content of the UKDIP concept, analytical actions were carried out to identify latent clusters, based on the variables of investment attractiveness. As a result, 4 clusters were formed, one of which has a higher degree of investment attractiveness.

We would like to note that when confirming the advanced hypotheses about the concept of building innovative potential, the difficulty was that the obtained results turned out to be generalized to the macro level, which does not allow us to draw conclusions about the level of innovative potential, for example, of enterprises in a specific branch of the economy.

In this regard, further analysis will be focused on solving the following issues:

- decision-making processes according to UKDIP do not currently take into account the systemic structural perspective of the evaluation and selection of innovative products. Policymakers in countries should be interested in introducing a systems perspective;
- stakeholders in the development of innovations have a limited understanding of the needs, preferences and demand for these products as a separate type of "commodity portfolio" of a business entity, which hinders investment;
- calculation of economic efficiency for specific enterprises as a result of the functioning of the UKDIP concept with the forecasting of the growing economic effect of innovative potential.

Also, further work should be aimed at monitoring the behaviour of the modelled concept in the microenvironment of the economy, on specifically designated business entities.

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## ADDITIONAL INFORMATION

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### AUTHOR CONTRIBUTIONS

*All authors have contributed equally.*

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### CONFLICT OF INTEREST

*The Authors declare that there is no conflict of interest.*

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## **АЛЬТЕРНАТИВА МОДЕЛЮВАННЯ ІННОВАЦІЙНОГО ПОТЕНЦІАЛУ КОМПАНІЙ**

Сучасні економічні умови вимагають апробації та впровадження нових методів для пошуку шляхів досягнення пролонгованого ефекту щодо власності та інвестиційної привабливості. Інноваційний потенціал як тренд підприємства, що дозволяє залишатися конкурентним, може бути специфічним мультиплікатором розвитку як суб'єкта господарювання й національної економіки загалом. Існуючі методики встановлення кореляцій між змінними впливу прийнятні для тимчасових рішень, але, маючи вузьку спрямованість, вимагають упровадження нових рішень для досягнення пролонгованого ефекту. Метою дослідження є розробка теоретично-методичних засад щодо шляхів досягнення максимізації інвестиційної привабливості компаній, використовуючи зовнішній пошук інформації про стан інноваційного потенціалу компаній із різним рівнем розвитку економіки та вибірку логічно обґрунтованих дескрипторів впливу. Визначено принципи авторської концепції – Unified concept of building innovation potential (UKDIP), суть якої полягає в пошукові уніфікованих шляхів збільшення інноваційного потенціалу суб'єктами господарювання за рахунок дескрипторів стану інноваційного сектора (валові внутрішні витрати на НДДКР, кількість дослідників, кількість державних дослідників, кількість тріадних сімейств патентів). Підтверджено зв'язок між метафакторами інновацій, використовуючи основи імпліцитної теорії. Обґрунтовано достатню інвестиційну привабливість суб'єктів шляхом проведення аналітичних процедур експертним методом, використовуючи теорію вагових коефіцієнтів. Методом кластеризації сформовано 4 латентні кластери з різним ступенем інвестиційної привабливості, підтверджуючи, що цілі інновацій у галузі економіки та сталого розвитку досягаються одночасно. Підхід, що визначається нами, може служити чинним способом обліку безлічі факторів при ухваленні управлінських рішень, що сприяють нарощуванню інноваційного потенціалу, розкриваючи, які моделі господарювання найкраще підходять для підвищення ефективності інновацій, а також роз'яснюючи взаємозв'язок між економічними та стійкими інноваційними показниками.

**Ключові слова:** інновації, концепція, облік, інвестиційна привабливість, потенціал

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