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Elaboration of the Collaborative Model of the National Innovation System and Evaluation of the Efficiency of the Latvian Innovation Economy

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Abstract: *The analysis of the basic concepts of modern economics (global network theory, information, innovation economy, theories of knowledge economy, collaborative economics, etc.) shows that most scientists have a consensus in this opinion: qualitative changes in the post-industrial stage of development of society are connected with the transformation of theoretical (scientific) knowledge/ transformation into a fundamental factor in accelerated production and technological innovation. This is the result of an increase in the number of people - knowledge carriers that have radically changed the nature of work in the economy.*
The new paradigm of economic development is determined by the entrepreneurial innovation activity, the level of commercialization of the products, the demand for science in the understanding of the market - after the knowledge transfer. Researchers and entrepreneurs, the innovators, have a leading role in generating profits in the economy. At the same time, at the global level, the innovation economy is characterized by the dominant role of human capital. It should be emphasized that the main criterion for success in the realization of innovation potential is the efficiency of the National Innovation System (NIS) and infrastructure construction, which in turn ensures the economy of the total economy in the medium and long term perspective. In other words, the rapid development of the new economy, the growing interdependence between capital markets and new technologies, the creation and use of knowledge, technology, products and services on a large scale determine the role of NIS as an institutional basis for the development of national innovation.
The aim of the research is to develop a collaborative model of the Latvian innovation system that would promote the development of the national economy.

Keywords: *innovation, innovation development, innovation system, national innovation system concept, ecosystem approach, "quadruple helix" / quadruple helix concept, collaborative model.*

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I. Introduction

Research problem. The background of the intensification of the development of innovation schemes, structures and their management processes, both in developed and developing countries, saw a significant lag in Latvia, which is also confirmed by the competitiveness indicators of the Republic of Latvia in international ratings (Global Innovation Index, International Innovation Index, etc.).

So far, research information on the problems of the Latvian innovation system was only accumulated, monitoring of the situation in this field was carried out, the possibilities to use the experience of developed European countries in the development of the national innovation system were analyzed. But in some works, attempts have been made to explain theoretically the paths of Latvian innovation development, which explain the specifics of innovation activity from the point of view of modern theory with sufficient certainty.

The special features of the state's influence on the development of innovation, as well as the problems in the formation and conception of the national innovation system abroad have been addressed in their research by F. Lists (Das Nationale Systemder Politischen Ökonomie, 1841), T. Hegerstrand (Innovations för lopet ur korologisk synpunkt', 1953), by A.J. Toinbi (Comprehension of History 1934-1961), J. Juhansons (The Internationalization of the Firm - Four Swedish Cases and the Model of the Internationalization Process of the Firm - A Knowledge Development and Increasing Foreign Market, 1975) and 1977), K. Fremen ("Technology Infrastructure and International Competition" 1982), BO Lundvall ("Product Innovation and User-Producer Interaction", 1985), R. Nelson (1987, 1988), G. Dosi, K. Fremen and R. Nelson in "Technical Change and Economic Theory" (1988), M. Porters (The Competitive Advantage of Nations, 1990), K. Eklund (1991), Everett M. Rodgers (Diffusion of innovations, 1995), S. Edkvists (Systems Innovation: Technologies, Institutions and Organizations, 1997), R. Miettinens (National Innovation System: Scientific Concept or Political Rhetoric, 2002), N. Sharif (" Contributions from the Thesociology of Technology to the Study of Innovation Systems ", 2004), by I. V. Piipenko (" Context-based Transformation Study, 2005)etc.

The authors of such works in Latvia are V. Dimza ("Innovations in the World, Europe, Latvia", 2003), S. Bolshakov ("Innovative Activities in Latvia"), A. Vedlis ("Organization of Innovative Activities", 2007), Rector of the University of Latvia (2007). –2015) Professor M. Auziņš ("Latvia's Innovation Potential in the Context of the Baltic States", 2012) and Professor B. Šavriņa ("Social Capital and Employee Financial Participation for Promoting Company Competitiveness and Innovation", 2018), Academic Economist R. Karnīte ("Innovation Networks and Industrial Modernization - A Study on Armenia, Latvia and Russia, 1997", A. Vatkins and N. Agapitova ("The 21st Century National Innovation System for the Latvian 21st Century Economy", 2003), M. Luksa (" Non-Innovative Latvia: How to Promote the Competitiveness of the Latvian Economy? ", 2012), S. Jesiļevska and D. Šķiltere (" Innovations in Latvia. Reality and Challenges", 2018), T. Muravska and G. Prause (European Integration and Baltic Sea Region Studies: University-Business Partnership through the Triple Helix Approach, 2012), Z. Zeibote (Clusters as a Factor in Regional Policy and Competitiveness, 2017) and others unquestionable scientific contribution to the study of these issues. Previous research confirms the fact that national competitiveness cannot be increased without the establishment of a national innovation system.

The importance of the conceptual approach in developing a collaborative model for Latvia's national innovation system, as shown by the experience of small, highly developed European countries, will require reorganization, rationalization, and possibly its components and interconnections based on a new paradigm for economic development. However, the existing scientific theory and practice of purposefully designing, structuring and competing for the development of national innovation systems has so far failed to provide a comprehensive analysis of the system, comparative factors and competition.

The need for a new systemic approach to the development of the national innovation system, which would take into account the level of development of the national innovation system subjects and their specificities, as well as the peculiarities of the state in the implementation of the innovation change process and the generation of new institutes, determines the practical relevance of the doctoral thesis. Research on the problems of creation, functioning and improvement of the national innovation system in the aspect of development of its subjects is a relatively new direction of Latvian science, which determines the theoretical topicality of the doctoral thesis.

An important problem in the doctoral research and in the country as a whole is the strategic plan "NAP 2020" [1] realisation achievment, which is a critically important process. The established and functioning national innovation system will lead to the rise of social progress and the well-being of the people. The intensification of the innovation process in modern production will be accompanied by jobs with a higher level of training. In addition, there will be an acceleration of the process of updating the knowledge of the staff itself. Most workers will need to change their specialty and qualifications during their working lives in order to be able to keep up with the changes in production, but this will require an increase in education and specialization to increase staff mobility.

The object of the research – Latvian National Innovation System. **The subject of the research.** Importance of a conceptual approach for the creation, functioning and development of a collaborative model of the Latvian National Innovation System.

Research hypothesis. Developing a collaborative model of the Latvian National Innovation System is possible by applying the ecosystem approach in the "triple helix" concept, which describes the interaction between economic agents (state, business and science) and the new fourth factor - "human capital".

Objective of the study - to develop a collaborative model of the Latvian National Innovation System, and on this basis to evaluate the efficiency of the national innovation economy, to provide a forecast for the development of national innovation in the medium and long term perspective.

II. Elaboration of the Collaborative Model of the National Innovation System and Evaluation of the Efficiency of the Latvian Innovation Economy

High-quality human capital is a key factor in the development and growth of modern economies, both industrial and innovative [2]. The author's model (see Fig. 1) is showing a spiral in the form of a kernel inside the triangle, where a new actor, human capital, takes a new position.

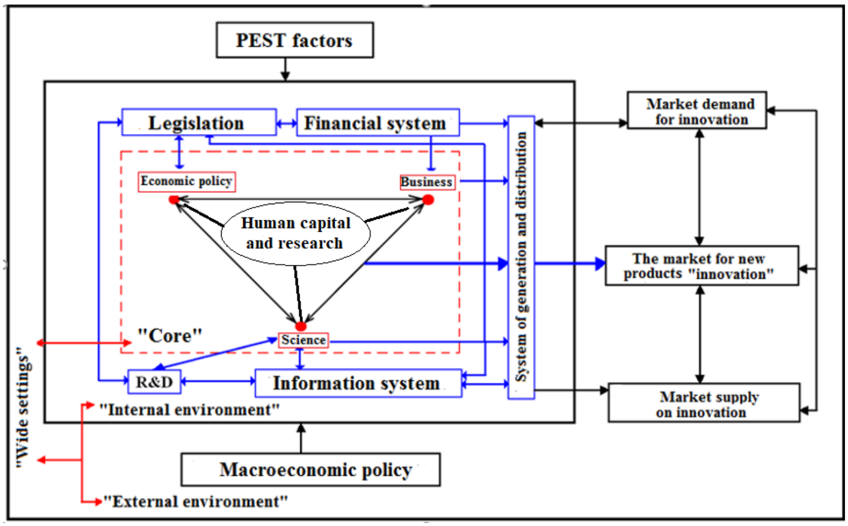


Fig. 1 Model of Latvian National Innovation System
Source: Created by author based on different sources

In the following we proposed to calculate this economic model and to make a forecast of the state innovation development in the medium term. The algorithm for assessing the effectiveness of the functioning of the Latvian national innovation system model was developed for the analysis (see Fig. 2.).
As can be seen in the figure, the analysis of the obtained results takes place in several stages: performing comparative analysis, carrying out regressive analysis and forecasting the medium-term perspective of the Latvian national innovation system model.

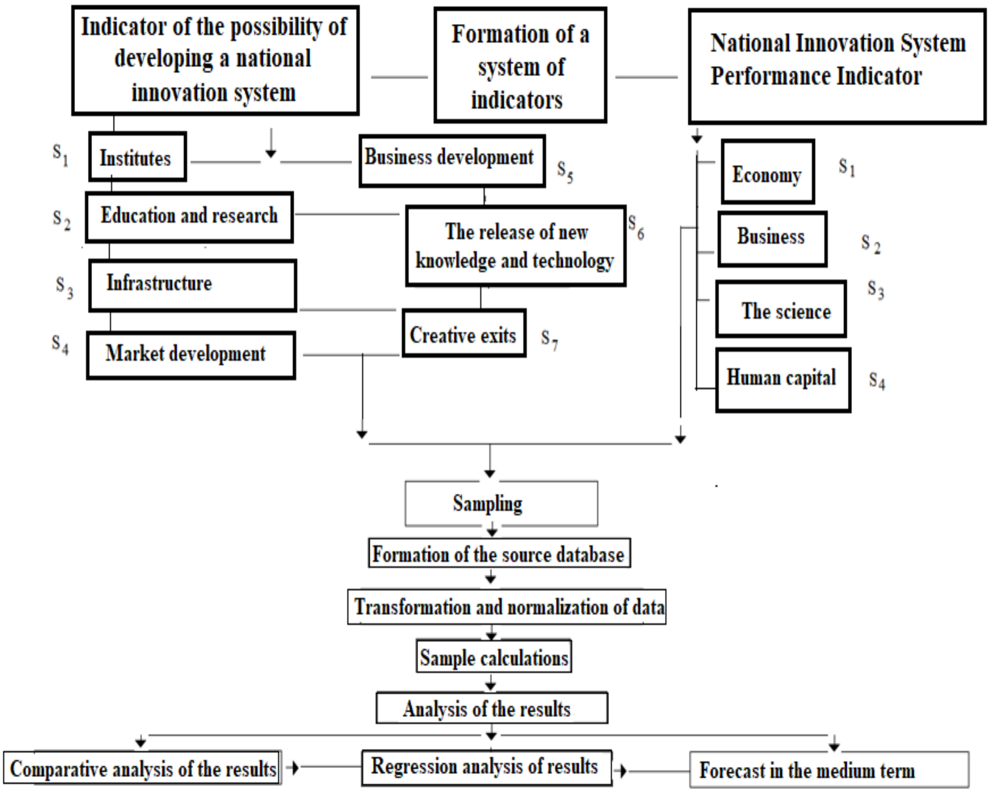


Fig. 2 Algorithm for assessing the effectiveness of the Latvian national innovation system model
Source: Created by author based on different sources

The methodology is based on the calculation of aggregate indicators, which allows to take into account as far as possible the factors influencing the efficiency of the innovation economy. Therefore, we will formulate the concepts of the main indicators of the proposed methodology. The efficiency of the innovation system can be defined as the ratio of innovation performance **(IDR)** indicators to the resources spent on the innovation process **(IPF)**. IPF consists of seven aggregated sub-indicators **(Sn)** that show the state of affairs: institutes, education and research, infrastructure, market development, business development, production of knowledge and technology, creative production. Each of the sub-indicators of the functioning of the innovation process shows the capacity of its or other Institute of Innovation Economics, because the main task of each institute is to accumulate the appropriate type of resources to use it in the most efficient way in the economy of innovation. The Innovation Process Functional Indicator **(IPF)** shows what innovation performance results were achieved using existing resources. **IPF** consists of four aggregated sub-indicators that characterize the results of the Latvian national innovation system.

Let's make a mathematical model for this methodology. So, the National Innovation Methodology Efficiency Ratio (NIMEk) against the Innovation Process Functioning **(IPF)** indicator is calculated using the formula:

$$\mathbf{NIMEK} = \frac{\mathbf{IDR}}{\mathbf{IPF}} \qquad (1)$$

In addition, if **NIMEk> 0.5**, the resources available to the economic system are used effectively. If **NIMEk = 0.5**, then the efficiency of using existing resources is zero, so you can talk about it, the innovation system works on the principle of simple reproduction. If **NIMEk <0.5**, resources are used inefficiently.

Noteiktie kritēriji kalpo par pamatu valsts izlases veidošanai tālākai analīzei.

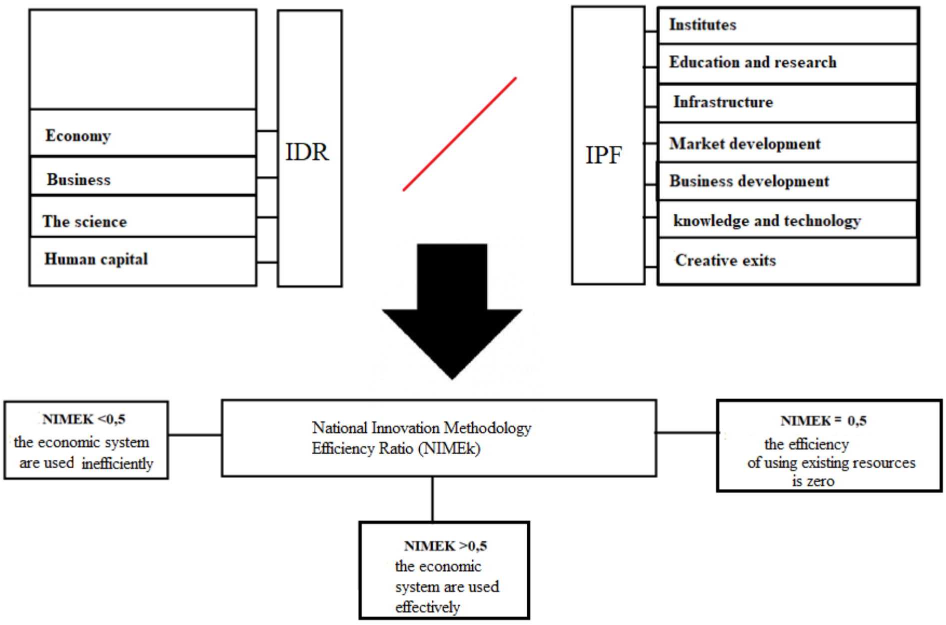


Fig. 3 General scheme for assessing the effectiveness of the national innovation economy (NIMEK)
Source: Created by author based on different sources

The author examines in more detail the stages of calculating the national innovation economy coefficient (NIMEK):

Step 1. In the first step, the composition of indicators (indicators) proposed for inclusion in the Latvian NIS model is analyzed.

In order to ensure the stability of the model and to avoid overloading it with a number of redundant indicators, the main indicators and the sub-indicators of the “Global Innovation Index 2017” included in the second chapter of this work are taken into account.

Step 2. In the second step, sub-indicators that are part of the indicators IPF and IDR are calculated. There are a total of 11 indicators: institute sub-label (Si inst), education and research sub-program (Si R&D), sub-infrastructure (Si inf), market development sub-indicator (Si mar), business sub-contractor (Si bus), sub-indicator of knowledge and technology (Sj sc), Subcontractor of Creative Production (Si cre) and Economic Sub-Contractor (Sj ec), Business Sub-Indicator (Sj bus), Scientific Sub-Score (Sj sc), Human Capital Sub-Indicator (Sj hc).

The innovation process performance (Si) sub-indicators and innovation performance sub-indicators (Sj) are calculated in a separate indicator block and show the potential of the economic system's resources and its effectiveness. The value of Si and Sj is calculated on the basis of statistical data provided by the Global Innovation Index for 2017.

The Global Innovation Index was chosen because all indicators have the same dimensions. Therefore, it is not necessary to give indicators (indicators) from absolute values to weighted values. Basically, scores from 0 to 100 will be taken from the Global Innovation Index report for 2017.

Step 3. In the third step, IPF and IDR are calculated for end-point values. The values of IPF and IDR are found as the sum of the weighted sub-indicators.

$$\mathbf{IPF} = \sum_{i=1}^{k_i} \frac{S_i}{100} \quad (2)$$

$$\mathbf{IDR} = \sum_{j=1}^{k_i} \frac{S_j}{100} \quad (3)$$

Where:
IPF – functioning of the innovation process
IDR – result of innovation
Ki and **Kj –** the number of indicators used to calculate the relevant sub-indicator
Si and **Sj –** sub-component within IPF and IDR
100 – constant size (const)
In this way:

$$\mathbf{IPF} = \frac{(71{,}8+80{,}7+80{,}6)}{100} + \frac{(52{,}6+34{,}9+11{,}7)}{100} + \frac{(68{,}3+35{,}3+48{,}4)}{100} + \frac{(44{,}5+26+86{,}7)}{100} + \frac{(41{,}6+40{,}4+32{,}7)}{100} + \frac{(18+53{,}6+33)}{100} + \frac{(50{,}3+45{,}5+39{,}2)}{100} = 9{,}957$$

IPF has a weighted factor of ~ 9.96. Now you need to find an IDR as a result (as a data output).

$$\mathbf{IDR} = \frac{(77{,}7+50{,}6)}{100} + \frac{(52{,}4+38{,}2)}{100} + \frac{(34{,}9+46{,}3)}{100} + \frac{33{,}1}{100} = 3{,}332$$

Step 4. In the fourth step, the calculation of the national innovation economy efficiency factor (NIMEk) is based on the formula 3.1.

$$\mathbf{NIMEK} = \frac{\mathrm{IDR}}{\mathrm{IPF}} = \frac{3{,}332}{9{,}957} = 0{,}3346$$

The efficiency ratio of the national innovation economy was ~ 0.335. Now, using the link at 1, it is safe to say that at the current stage of development Latvia's innovation activity is not developed and the economy is inefficient because **0.335 <0.5.**

Now, using the given methodology, we will analyze the indicators from 2013 onwards. until 2017 (see Table 1), as it is a five-year period and all data from 2013 is available. (The first edition came out in 2007 and does not contain all the indicators).

Table 1 Efficiency of the National Innovation Economy 2013 - 2017

Years	2013	2014	2015	2016	2017
NIMEK	0,3490	0,3347	0,3352	0,3340	0,3346

Source: Table created by author based on different sources

Now - graphically.

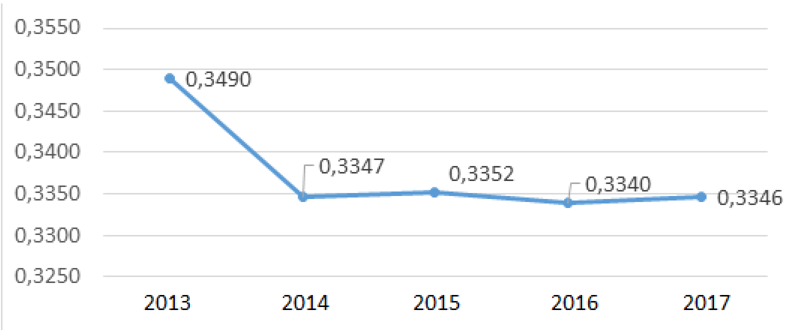


Fig. 4 Efficiency of the National Innovation Economy 2013 - 2017 g.
Source: Created by author based on different sources

The author sets up a linear one-factor regression model and its confidence corridor for a five-year forecast until 2022.

Table 2 Regression model

Initial data		Linear trends			
Year, X	**NIMEk**, Y	Y(X)	$S_{Y(X)}$	Y(X)-$tS_{Y(X)}$	Y(X)+$tS_{Y(X)}$
2013	0,35	0,34	0,01	0,32	0,36
2014	0,33	0,34	0,01	0,32	0,36
2015	0,34	0,34	0,01	0,32	0,36
2016	0,33	0,33	0,01	0,32	0,35
2017	0,33	0,33	0,01	0,31	0,35
2018		0,33	0,01	0,30	0,35
2019		0,33	0,01	0,30	0,35
2020		0,32	0,01	0,29	0,35
2021		0,32	0,01	0,28	0,36
2022		0,32	0,01	0,28	0,36

Source: Table created by author based on different sources

Number of data NIMEK (У) given from 2013 By 2017, the forecast will be made by 2020, for a five-year period (forecast).

Linear Regression Hypothesis

When creating a linear regression, the zero hypothesis that the regression line's general corner coefficient β is zero is tested. If the corner coefficient of the line is equal to zero, there is no linear relationship between x and y: x change does not affect y. The following algorithm can be used to test the zero hypothesis that the real corner coefficient β is zero.

statistics equal to the ratio $b/SE(b)$, exposed $t-$ sharing with $(n-2)$ degrees of freedom where $SE(b)-$ and the coefficient $b.$ standard error. [3]

$$b=\frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2}, \qquad (4)$$

$$SE(b)=\frac{s_{res}}{\sum(x-\bar{x})^2}. \qquad (5)$$

$$s_{res}^2=\frac{\sum(y-Y)^2}{(n-2)}, \qquad (6)$$

- Estimation of residual dispersion

Usually, if the value level is zero, the hypothesis is canceled.

You can calculate a 95% confidence interval for the general corner factor [3]:

$$b \pm t_{0,05} SE(b), \qquad (7)$$

where $t_{0,05}-$ percentage point $t-$ splitting with degrees of freedom $(n-2),$ which gives credibility to the bilateral criterion $0,05$.

This is the interval that contains the general corner coefficient with 95% confidence.

Table 3 Descriptive statistics

Designation	Parameter	Value
N	Number of initial values	5
X_{cp}	X average value	2015
P	Probability of trust	95%
t	Stjudent Criterion	3,182

Source: Author's calculations based on SPSS statistics

And so, the number of initial values is 5. The average arithmetic obtained by summing all the values and dividing this amount by the number of values in the set. Calculations were made using an algebraic formula. Formula for Average Arithmetic Calculation [3]:

$\bar{X} = (X_1 + X_2 + ... + X_n) / n$ (8)

The variable n observation set x can be displayed as x1, x2, x3, ..., xn.

From this, the average arithmetic observation will be 2015.

$$t = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}} \quad (9)$$

To compare average values, Stjudent's t-criterion is calculated using the following formula [3]:

Where:

M_1 - Average arithmetic of the first reference group

M_2 - Average arithmetic of the second comparative group

m_1 – first average arithmetic mean error

m_2 - second average arithmetic mean error

The value of the obtained Student's t-criterion must be correctly interpreted. For this purpose, we need to know the number of subjects in each group (n1 and n2). We find the number of degrees of freedom by the following formula:

$f = (n_1 + n_2) – 2$ (10)

We then determine the critical value of the critical value of the Student's t-criterion (eg p = 0.05) and the number of degrees of freedom f given in the table [3]

All initial Student's t-criterion data have a normal distribution. The student criterion is 3.182, at the value levels $\alpha = 0.05$. Since the value of the calculated criterion is more than critical, we conclude that the observed differences are statistically significant (value level is 3.182> 0.05).

Table 4 Regression Statistics I

Apzīmējums	Parametrs	Vērtība
a	Coefficient at X	-0,003
S_{ea}	Deflection standard error	0,002
R^2	Determination factor	0,524
F	F-statistics	3,304
Ssreg	Sum of squares regression	0,000
b	Permanent b	6,276
S_{eb}	Default standard error	3,267
S_y	Standard Y error in rating	0,005
df	Brīvības pakāpju skaits	3
Ssresid	Sum of squares remaining	0,000

Source: Author's calculations based on SPSS statistics

The regression (incline) standard error is considered as a standard observation scatter measure compared to the modeled values. Regression standard error is calculated as the square root of the unmeasured regression dispersion estimate [3]:

$$\hat{\sigma} = \sqrt{\widehat{\sigma^2}} = \sqrt{\frac{1}{(n-2)}\left[\sum_{i=1}^{n}(y_i - \bar{y})^2 - \frac{\left[\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})\right]^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right]}, \quad (11)$$

Where:

n – total number of observations,

y_i – values of observable variable,

x_i – values of explanatory variable,

$\bar{y}$ – average value of the sample under study,

$\bar{x}$ – the mean value of the explanatory variable in the sample,

$\widehat{\sigma^2}$ – undisturbed regression dispersion estimation.

In our case, $S_{ea} =$ 0,002, but as is known, the lower the regression standard error value, the higher the model quality. The standard error shows the contribution of each component to the overall statistical error.

Determination Factor - Another Quality Adjustment Score.$0 \leq R^2 < 1$, the closer R^2 at 1, the better the regression equation (i.e., the quality of the adjustment). From 4 table $R^2 = 0,524$, so the dependency is medium, where the factor x explains 52.4% of the dependent variable y, so the deviation of the actual values of the dependent variable from the calculated ones is small and the quality of the adjustment is normal.

Fisher statistics (F-statistics) are used to estimate the overall value of the model. There is a hypothesis H_0 the significance of all model coefficients (coefficients at all regressors are zero). The following F-statistics are used to evaluate this hypothesis [3]:

$$F = \frac{R^2}{1 - R^2} \cdot \frac{n - k - 1}{k} \quad (12)$$

Where:

R^2 – determination factor,

n – number of observations,

k – number of explanatory variables (number of parameters of regression equation without free member).

Using this formula, the calculated F-statistic value is compared to the Fischer criterion's critical value from the Fisher distribution table [3]:

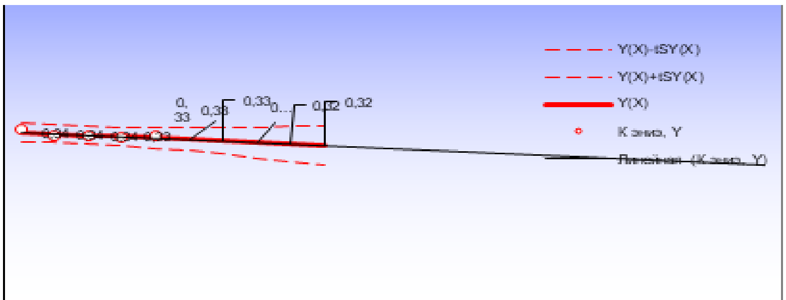
$$F_{1-\alpha}(k, n - k - 1) \quad (13)$$

Where:

α – value level,

$v_1 = k$ un $v_2 = n - k - 1$ - levels of freedom.

The comparison shows that in this case F = 3.304, at the set value level α = 0.05, the hypothesis of the model value is generally rejected (3.304 <7.81). The greater the sum of the regression squares (or the smaller the remaining amount), the better the regression equation approximates the original point cloud. In our case, the remaining amount is 0%. So the regression equation approximates the initial point cloud very strongly. The standard deviation error is 3,267 and the standard error of estimate is 0.005. These statistics are a measure of the distribution of observable values relative to the regression line.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Y(X)-tSY(X)	0,32	0,32	0,32	0,32	0,31	0,30	0,30	0,29	0,28	0,28
Y(X)+tSY(X)	0,36	0,36	0,36	0,35	0,35	0,35	0,35	0,35	0,36	0,36
Y(X)	0,34	0,34	0,34	0,33	0,33	0,33	0,33	0,32	0,32	0,32
[illegible], Y	0,35	0,33	0,34	0,33	0,33					

Fig. 5 Linear Forecasts of Latvian National Innovation Economy Efficiency and Correlation Correlation Schedule

Source: Author's calculations based on SPSS statistics

The number of degrees of freedom is 3 - this is the number of values in the final calculation of statistics that can vary. In other words, the number of degrees of freedom shows the vector dimension from different sizes, the number of "free" steps required to fully determine the vector.

Since one of the apriori hypotheses is about the relationship between the given variables, let's test it in the graph of the appropriate spreading chart.

The spreading diagram shows a visible negative correlation between two variables. It also shows a 95% confidence interval for the regression line i.e. with a 95% probability, the regression line runs between two dotted curves. And for Latvia the forecast is not satisfactory. By 2020, NIMEk ranges from 0.32 to 0.33. If we have to work in the same conditions, there will be no development of the national innovation system in Latvia and, as a consequence, there will be no economic development in general, only a small increase.

Therefore, we propose to increase the indicator "Human capital and research" three times and make sure that human capital and research in the long term will lead Latvia to the innovation

economy. Firstly, increase spending on education and R&D as a percentage of GDP. So let's imagine that the indicator of human capital and research in 2018 increases from 33.1 to 99.3. Exiting from it, NIMEk will not be as of 0.33346 in 2017, but in 2018 it will be 0.4011. Let's now create a linear one-factor regression model and its confidence interval.

Table 5 Regression Statistics II

Designation	Parameter	Value
a	Coefficient at X	0,007
S_{ea}	Deflection standard error	0,006
R^2	Determination factor	0,271
F	F-statistics	1,487
Ssreg	Sum of squares regression	0,001
b	Permanent b	-14,552
Seb	Default standard error	12,221
Sy	Standard Y error in rating	0,025
df	Number of degrees of freedom	3
Ssresid	Sum of squares remaining	0,003

Source: Author's calculations based on SPSS statistics

Descriptive statistics are as follows: number of initial values 6, average X = 2016, probability 95%, and Student Rating 3,182. Further, regression statistics are obtained (see Figure 6).

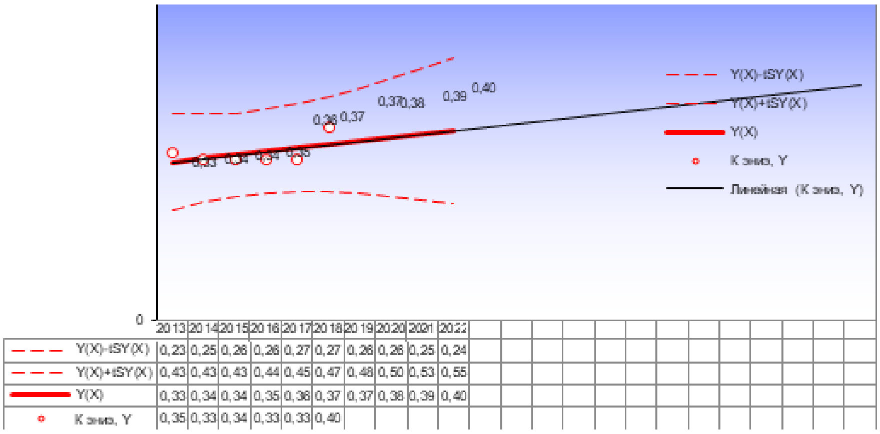


Fig. 6 Linear Forecasts of Latvian National Innovation Economy Efficiency and Correlation Correlation Schedule

Source: Author's calculations based on SPSS statistics

From the calculation, we can see the following: only by increasing one indicator - human capital and research, Latvia annually increases the NIMEs by 0.01 (see Figure 7).

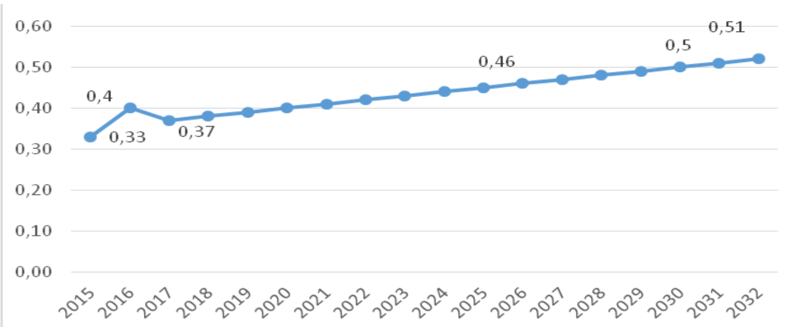


Fig. 7 Schedule of the linear forecast of Latvian national innovation economy efficiency until 2032

Source: Author's calculations based on SPSS statistics

Also in 2028, it will close to a factor of 0.5 when efficiency is zero. The starting point of the innovation economy will be in 2032, starting with 2033, the economy will become innovative (NIMEk = 0.51) and will work efficiently (0.51> 0.5).

II. Conclusion

Summarizing the results of the doctoral thesis, conclusions and suggestions have been made.

The hypothesis was confirmed, the development of the collaborative model of the Latvian national innovation system is possible by applying the ecosystem approach within the “triple helix”, which describes the interaction of economic agents (state, business and science) in cooperation with a new fourth factor - human capital, with a functioning environment.

The aim of the research is achieved - a collaborative model of the Latvian innovation system has been developed, which promotes the development of the national economy.

Research confirms the fact that Latvia's national competitiveness cannot be increased without the establishment of a national innovation system. In order to create a model of a collaborative national innovation system, it is necessary to restructure and rationalize all the components and interrelationships between the national innovation system participants

A new systemic approach to the modeling of the national innovation system is considered, which takes into account the impact of the level of development of the objects of the national innovation system and their specificity, as well as national features in the innovation implementation process and creation of new institutions.

The conceptual approach to the modeling and development of the Latvian National Innovation System is based on the experience of small EU countries by systematizing the indicators of the Global Innovation Index. In order to create a model of the Latvian National Innovation System, the concept of “quadruple helix” was used, introducing the fourth integral indicator - “human capital”, which was ignored in the previous concept (triad - triple helix). Based on the experience of small EU countries, systematizing and generating the Global Innovation Index indicators also identified the main opportunities for developing the Latvian NIS model.

The transition to the new paradigm goes hand in hand with a reappraisal of “human capital” as a key factor in production, as well as the core value of any country and even an individual company. At present, competition is moving from finished products to knowledge, scientific discovery and high technology. An information society and knowledge-based economy are emerging. The main generator of innovation and at the same time the consumer, as well as the supplier of national innovations to external markets, is science-intensive business. Thus, science-intensive business forms the basis of most developed countries' national competitiveness in foreign markets.

An economically mathematical model of the Latvian National Innovation System was constructed, which characterizes the functioning of the national economy and facilitates further economic growth by evaluating the contribution of innovative growth factors and based on the developed algorithm and the Global Innovation Index.

An economic model has been calculated and the country's medium-term projections for innovation have been made. An algorithm was developed to evaluate the performance of the innovation system model in Latvia. The Scatterplot showed a clear negative correlation, and Latvia's prospects are unsatisfactory (Enie ranges from 0.32 to 0.33 to 2022). Without creating new conditions for the development of innovations, there will be no development of the national innovation system in Latvia, as a result of which the economy will not be developed at all, only a small growth is possible. In order to improve the NIS model, the human capital and research indicator was increased 3 times (the increase should mainly be allocated to education expenditure and R&D / R & D expenditure as a percentage of GDP). Positive long-term development can only be seen in 2032, and from 2033 the economy will become innovative (Kenie = 0.51) and will work efficiently (since 0.51> 0.5). Thus, human capital and research will lead in the long term to an innovative economy.

References

[1]. National Development Plan of Latvia 2014.-2020. gadam. Available at: http://www.varam.gov.lv/lat/pol/ppd/ilgtsp_att/?doc=13858 (accessed: 10.09.2019.).

[2]. The broad concept of human capital (UNDP, WB, Competitiveness etc). Available at: http:// www.lerc.ru/? part=articles&art=3&page=22 (accessed: 25.09.2019.).

[3]. Formula for arithmetic mean observation. Available at: http://www.statistica.ru/theory/osnovy-lineynoy-regressii/ (accessed: 25.09.2019.).

Konstantīns Savenkovs. " Elaboration of the Collaborative Model of the National Innovation System and Evaluation of the Efficiency of the Latvian Innovation Economy." IOSR Journal of Economics and Finance (IOSR-JEF) , vol. 10, no. 5, 2019, pp. 11-20.