“Investment potential forecast and strategies for its expansion: case of Ukraine”

AUTHORS	Volodymyr Kasianenko https://orcid.org/0000-0001-8757-6632 Tetiana Kasianenko https://orcid.org/0000-0002-3595-669X Juliya Kasaeva https://orcid.org/0000-0001-6681-5366

ARTICLE INFO	Volodymyr Kasianenko, Tetiana Kasianenko and Juliya Kasaeva (2020). Investment potential forecast and strategies for its expansion: case of Ukraine. *Investment Management and Financial Innovations*, *17*(1), 329-347. doi:10.21511/imfi.17(1).2020.28
DOI	http://dx.doi.org/10.21511/imfi.17(1).2020.28
RELEASED ON	Monday, 06 April 2020
RECEIVED ON	Thursday, 27 February 2020
ACCEPTED ON	Thursday, 26 March 2020
LICENSE	This work is licensed under a Creative Commons Attribution 4.0 International License
JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
28	**5**	**7**

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

Volodymyr Kasianenko (Ukraine), **Tetiana Kasianenko** (Ukraine),
Juliya Kasaeva (Ukraine)

INVESTMENT POTENTIAL FORECAST AND STRATEGIES FOR ITS EXPANSION: CASE OF UKRAINE

Received on: 27th of February, 2020
Accepted on: 26th of March, 2020
Published on: 6th of April, 2020

Volodymyr Kasianenko, Doctor of Economics, Associate Professor, Vice-rector, Sumy State University, Ukraine.

Tetiana Kasianenko, Ph.D., Senior Lecturer, Department of Finance and Entrepreneurship, Sumy State University, Ukraine.

Juliya Kasaeva, Postgraduate Student, Sumy State University, Ukraine. (Corresponding author)

Abstract

In the current conditions of capital market liberalization, developing countries achieve a faster economic growth rate by actively attracting various types of foreign investment. The steady rise in the volume of foreign investment into the country could be achieved only due to its high investment potential.

Therefore, this study aims to develop the methodology for determining the dynamic changes in the country's investment potential, and its relevant medium-term indicators identify the degree of informational technology influence on Ukraine's investment potential. It is essential to define the position of Ukraine in the global context in terms of the level of information technologies as the catalyst for investment attractiveness.

The relevant indicators defining Ukraine's investment potential were forecasted using the Brown-Meyer exponential smoothing model. To calculate the integral indicator of the investment potential, the Hurst exponent was applied. Kohonen self-organizing maps were used to group the countries according to their informational technology parameters.

Ukraine's investment potential was found to decrease since 2019 and is equal to 0.6493 units in 2020 and 0.6407 units in 2021 due to the decline of the indicators describing the human capital, infrastructure, technological development, and socio-economic conditions. Technology has a significant influence on Ukraine's investment potential. Its impact is rising each year from 1.70% to 5.17% and 13.04% between 2019 and 2021, respectively. According to the level of technology, Ukraine is in the group with Spain, Romania, and Poland since 2017.

The decreasing investment potential forecast and the positive influence of technology level on it bring the opportunity to form the priority areas for expansion of investment potential based on the adaptation of world instruments to implement the investment policy within national economic conditions.

Keywords clustering, forecast, FDI, human capital, Hurst exponent, technology

JEL Classification C53, E22, P45

Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

Due to globalization processes, the development of international financial markets provides an opportunity for developing countries to attract investment for embarking on the highly innovative and technological national projects. It significantly reduces the time necessary to achieve high indicators of social and economic development and brings them opportunities to get all the advantages of modern society. However, every year, investors impose strict requirements for investment facilities and investment attractiveness of the countries they plan to invest in. Such a condition has led to the need for recipient countries' governments to develop effective investment strategies for certain sectors of the economy and the country in general.

For Ukraine, the activation of the investment activity is particularly important, as, according to the World Bank, foreign direct investment (FDI) has declined significantly since 2012. Thus, during 2012–2014, this figure decreased by almost twenty times and amounted to US$ 847 thousand in 2014, which is the lowest value of the FDI in Ukraine since 2003. This negative trend has resulted in the fact that the share of the FDI was at the level of 0.64% of GDP in 2014, which is unacceptable for a country that seeks to adhere to the European vector of development. Despite a slight increase in the FDI over the next three years to US$ 3.44 million in 2016, the volume of the studied indicator returned to a steady downward trend during 2017–2019. The unfavorable investment climate in Ukraine is confirmed by the value of the investment attractiveness index calculated by the European Business Association based on a survey of 122 executives of leading Ukrainian companies. Thus, in 2019, this indicator did not exceed the value of 3 points, which indicates that the country has negative investment attractiveness. During 2010–2019, this index did not exceed the value of 4 points, but it was negative (1-3 points – negative; 3-4 points – neutral; 4-5 points – positive) during six out of ten years.

Since 2014, Ukraine's investment potential has been influenced by military operations in the east of the country and the annexation of Crimea, but regular problems remain: corruption, mistrust of the judiciary, significant shadow economy, as well as new issues: outflow of labor force, inconstant tax reforms, the dependence of central bank policy on authorities (Kulish, Petrushenko, Reznik, & Kiselyova, 2018; Komarynska, 2019). However, along with overcoming these destructive factors, the government should form a set of effective focused steps to increase the investment potential in all areas of development, both the national economy and society. Therefore, it is essential to determine and make a forecast Ukraine's investment potential, which should serve as the basis for developing an effective investment strategy, both increasing the flow of foreign direct investment and intensifying the investment activity within the country.

1. LITERATURE REVIEW

Over the last decades, investment was the object of scientific research and a vector of social development for prominent political figures. In 2014, a report "Catalyzing a global market in impact investment", initiated by the Prime Minister of the United Kingdom David Cameron, was published. He has formed a group of more than 200 professionals from around the world to conduct surveys throughout the year to identify the potential impact of investment on improving society and the environment. As a result, conclusions were drawn about the leading role of investment in the process of becoming a modern society and development of all countries, and recommendations were made for managing the activities of governments, business, the social sector, and international funds. However, the role of investment in contemporary society has been explored differently in the works of Lagendijk and Hendrikx (2009). Thus, in parallel with determining the leading role of foreign direct investment in the structure of the global economy, the authors critically determine the strengthening role of neoliberal regulation in lobbying the investment interests of global corporations and their home countries. Therefore, it is fair to say that the topic under study is relevant.

The place of investment in the progressive development of the world economy and international economic relations was explored by Meltzer (2015). He analyzed the investment commitments in bilateral and regional free trade agreements. Moreover, this author pays special attention to the protection of investors' rights and emphasizes the impossibility of state expropriation of private investments, even directed at infrastructure objects. The development of international investment law theory was addressed by Desierto (2016) and Schill (2009) who attempt to summarize the existing practices of state-investor relations and to establish international rules for dispute resolution. Sauvant and Sachs (2009) narrowed the legal issue of investing in bilateral investment treaties (BITs) and double taxation treaties (DTTs). Researchers cite positive and negative aspects of the effect of BITs and DTTs on foreign investments. The researchers pay attention to the legal peculiarities of interaction between international investors and

http://dx.doi.org/10.21511/imfi.17(1).2020.28

the state, as there is a need to establish equal "rules of the game" in the international market. The solution to any national task of attracting investment into the economy is impossible without a clearly defined legal framework. The negative experience of legal settlement of investment disputes between investors and the state will lead to loss of the flow of international financial resources, even despite the effective national investment strategy. However, in this study, no attention is paid to the legal framework for the formation of the state's investment potential. It is considered a necessary condition for modeling.

In scientific research, it is also necessary to take into account that the investment occurs in the conditions of uncertainty. Chevalier-Roignant, Flath, Huchzermeier, and Trigeorgis (2011), as well as Abel and Eberly (2016), establish multidimensional factors that at different time intervals, can inequitably affect both the cost and the volume of investment. In the proprietary methodology for calculating the investment potential, it is taken into account using the Brown-Meyer model.

Exploring the priority areas of investment that the state should support, Perrotta (2018), Hu (2011), and Schultz (1961) define human capital as the most productive area of investment since its multiplication ensures the continuous growth of the national product. Richard, Holton, and Katsioloudes (2014) investigated the investment in human capital, such as in leadership development interventions. Scientists have analyzed the monetary return on investment in leadership development based on utility analysis (computer simulation modeling to generate random distributions of each utility analysis variable). Continuing to explore priority areas for investing, one should focus on the works of Bojanc, Jerman-Blažič, and Tekavčič (2012). These researchers have demonstrated the importance of investing in information technology. Thus, a mathematical model for optimal evaluation of an investment in security technology has been developed, based on which decisions are made on the feasibility of introducing innovative developments on bank risk identification. Giel, Issa and Olbina (2019) confirm the relevance of investing in the latest technologies. Thus, the authors compared two identical projects, but one of them was implemented with investment in innovative development, and the other was not. The analysis was based on the measurable cost benefits associated with reduced schedule overruns and reduced change order costs. Based on other numerous scientific works on relevant indicators of investment activity, in the framework of the original research, the following five groups of relevant indicators characterizing the investment potential were selected: socio-economic conditions, science and education, technologies, infrastructure, environment and human health.

Continuing the study of the mathematical formalization of various processes associated with the behavior of investment, and the implementation of investment activities, the works of the following scientists are used. Gomes (2001) formalizes the relationship between investment and cash flow when organizations face the cost of accessing external funds. Myers and Majluf (1984), representatives of behavioral theory, mathematically formalized the peculiarities of the firm's investment activities. They have proposed an equilibrium model of the issue-investment decision, which assesses the risk of non-issue of shares. In turn, Gourio (2015) quantifies the investment distortions created by managerial compensation and determines the correct behavior of the company's managers under the influence of various destructive factors. Dixit and Pindyck (2012) have developed a new approach to investing that recognizes the option value of waiting for better (but never complete) information. The proposed formalization of the investment process allowed forming a theory of improving the investment policy of firms and the government of the country. It is fair to point out that McDonald and Siegel (1986) developed a formula for the investment option value, and it allowed them to establish the optimal timing of an investment in an irreversible project. Mathematical interpretation of other features of the investment activity of firms and organizations was carried out by Lang, Ofek, and Stulz (1996). They quantified the relationship between leverage, investment, and firm growth.

2. DATA AND METHODOLOGY

Considering the analysis of the existing research on the priority areas of investment, as well as based on the opinion of experts in the Ukrainian investment industry, it is expedient to make the following conclusion. The state's investment potential must be studied within five vectors that comprehensively describe all aspects of this process. Thus, the socio-economic vector characterizes predominantly the general opportunities that are currently formed in the state for developing the investment activity. This group of indicators reveals the level of the state's economic development and the potential of its labor resources. The vector "infrastructure" describes the potential speed of human capital movement and the convenience of delivering goods in a global business environment. The indicators characterizing this vector describe the level of development of all types of transport in the country and energy security. The vector "science and education" is the basis for the creation and further development of high value-added high-tech business in the country. This group of indicators characterizes both the level of education of the population and their research activities, and the level of state support for these processes. The vector "environment and human health" has become relevant in the context of the sustainable development concept. The basis of this concept is that the development of any economic process in the long term is impossible without observing environmental requirements and maintaining public health. If the "science and education" vector acts as the basis for the potential creation of new high-tech industries and business processes, then the "technology" vector determines the initial conditions for using the existing human achievements in the country. Thus, the indicators characterizing this vector should give investors an answer to the question: "is it possible to develop advanced technology-based investment in the country, is it necessary to pass through a long development stage?"

Empirically, each of these groups can be described using the following indicators:

1) socio-economic conditions:

- Soc1 – foreign direct investment, net inflows (% of GDP);
- Soc2 – adjusted net national income (annual % growth);
- Soc3 – labor for participation rate, total (% of total population ages 15-64) (modeled ILO estimate);
- Soc4 – self-employed, total (% of total employment) (modeled ILO estimate);
- Soc5 – wages and salaried workers, total (% of total employment) (modeled ILO estimate).

2) infrastructure:

- In1 – electric power transmission and distribution losses (% of output);
- In2 – air transportation, passengers carried;
- In3 – fixed broad band subscriptions (per 100 people);
- In4 – quality of port infrastructure, WEF (1=extremely under developed to 7=well developed and efficient by international standards);
- In5 – railways, passengers carried (million passenger-km).

3) science and education:

- Ed1 – school enrolment, secondary (% net);
- Ed2 – patent applications, residents;
- Ed3 – research and development expenditure (% of GDP);
- Ed4 – government expenditure on education, total (% of GDP);
- Ed5 – revenue, excluding grants (% of GDP);

4) environment and human health:

- Ec1 – people using at least basic sanitation services (% of population);
- Ec2 – current health expenditure (% of GDP);
- Ec3 – survival to age 65, female (% of cohort);
- Ec4 – adjusted savings: particular tee mission damage (% of GNI);
- Ec5 – people using safely managed drinking water services (% of population);

5) technology:

- Tech1 – medium and high-tech industry (including construction) (% of manufacturing value-added);
- Tech2 – ICT service exports (% of service exports, BoP);
- Tech3 – ICT goods exports (% of total goods exports);
- Tech4 – high-technology exports (% of manufactured exports);
- Tech5 – secure Internet servers (per 1 million people).

http://dx.doi.org/10.21511/imfi.17(1).2020.28

Thus, socio-economic conditions and infrastructure ensure the formation of initial standards for developing the investment potential of the state. Thus, these indicators describe the conditions that are currently formed in the country for implementing the state's active investment policy for attracting foreign and domestic investment. Indicators related to science and education, as well as environment and human health, form the prerequisites for developing the human capital, which most scholars consider to be an indispensable prerequisite for developing the investment potential. Technology indicators are already describing the prospects of the country for developing the most current investment projects. Thus, technology in the conditions of the fourth industrial revolution is the most intensive catalyst for the growth of investment potential. The information for generating an array of input information is taken from the World Bank website for 1999–2018, and is grouped in Tables A1 and A2.

Taking into account the purpose of the article, which consists both in developing the methodology for the integral assessment of the investment market potential and forecasting this indicator, the prediction of 25 relevant indicators becomes relevant. Thus, the forecasting of non-linear (in the form of a second order polynomial) economic-mathematical models is constructed using Brown-Meyer modeling in the context of each of the 25 indicators characterizing the state's investment potential. The use of this model for forecasting the investment potential indicators is because Brown-Meyer modeling belongs to adaptive forecasting methods. This allows taking into account the main feature of relevant indicators – a constant change under the influence of external and internal factors, as well as the accumulation of the so-called "experience" in the development of each indicator (the model takes into account the variations in the external functioning conditions of the system under study, when the greatest weight is given to the last levels of the time series). The implementation of adaptive forecasting methods involves the following preparatory steps:

1) estimating the parameters of the regression model based on several first levels of the studied time series;
2) calculating the forecasted level of the time series one step further based on the model built at the previous step. The calculated forecasted level of the time series is used for the subsequent calculation of forecasting errors as deviations between the forecast and actual levels of the time series;
3) estimating the next level of the time series, calculated based on the application of the model with the corrected parameters, calculated considering the forecasting error.

Thus, one proceeds to the mathematical formalization of the stages of a nonlinear adaptive Brown-Meyer model construction, which will allow obtaining the value of relevant indicators characterizing the state's investment potential in 2019–2021.

The first stage describes the first levels of the input time series using the square parabola, which is as follows:

$$r_t = b_0 + b_1 \cdot t + b_1 \cdot t^2, \quad (1)$$

where r_t – the level of the time series under study for year t, b_0, b_1, b_2 – constants, parameters of the regression equation depending on the levels of the studied time series on the time factor (year).

At the second stage, the b_0, b_1, b_2 equation parameters are estimated based on the construction and solution of the equation system:

$$\begin{cases} n \cdot b_0 + b_1 \cdot \sum t + b_1 \cdot \sum t^2 = \sum r_t \\ b_0 \cdot \sum t + b_1 \cdot \sum t^2 + b_2 \cdot \sum t^3 = \sum r_t \cdot t \\ b_0 \cdot \sum t^2 + b_1 \cdot \sum t^3 + b_2 \cdot \sum t^4 = \sum r_t \cdot t^2 \end{cases} \quad (2)$$

where n – number of observations.

Thus, provided $\sum t = 0$, the formulae for calculating the parameters of the regression equation (1) will be as follows:

$$b_0 = \frac{\sum_{t=-m}^{m} r_t - b_2 \cdot \sum_{t=-m}^{m} t^2}{n},$$

$$b_1 = \frac{\sum_{t=-m}^{m} r_t \cdot t}{\sum_{t=-m}^{m} t^2}, \quad (3)$$

$$b_2 = \frac{n \cdot \sum_{t=-m}^{m} r_t \cdot t^2 - \sum_{t=-m}^{m} r_t \cdot \sum_{t=-m}^{m} t^2}{n \cdot \sum_{t=-m}^{m} t^4 - \left(\sum_{t=-m}^{m} t^2 \right)^2}.$$

Adaptive forecasting based on the second degree polynomial implies the need to describe the time series by the following equation:

$$r_t = f_0 + f_1 \cdot l + \frac{1}{2} f_2 \cdot l^2, \quad (4)$$

where l is the forecasting period.

The parameters f_0, f_1, f_2 of the predictive regression equation are determined by the following procedure:

1) evaluation of initial conditions:

$$\begin{cases} C_0^1(r) = b_0 - \frac{1-\beta}{\beta} \cdot b_1 + \frac{(1-\beta)(2-\beta)}{\beta^2} \cdot b_2 \\ C_0^2(r) = b_0 - \frac{2(1-\beta)}{\beta} \cdot b_1 + \frac{(1-\beta)(3-2\beta)}{2\beta^2} \cdot b_2 \\ C_0^3(r) = b_0 - \frac{3(1-\beta)}{\beta} \cdot b_1 + \frac{(1-\beta)(4-3\beta)}{2\beta^2} \cdot b_2 \end{cases} \quad (5)$$

2) calculation of exponential averages based on the formula (5):

$$\begin{cases} C_t^1(r) = \beta \cdot r + (1-\beta) \cdot C_0^1(r) \\ C_t^2(r) = \beta \cdot C_t^1(r) + (1-\beta) \cdot C_0^2(r) \\ C_t^3(r) = \beta \cdot C_t^2(r) + (1-\beta) \cdot C_0^3(r) \end{cases} \quad (6)$$

3) calculation of estimates of the parameters of the forecasted trend regression equation:

$$\begin{cases} f_0 = 3 \cdot \left[C_t^1(r) - C_t^2(r) \right] + C_t^3(r) \\ f_1 = \frac{\beta}{(1-\beta)^2} \begin{bmatrix} (6-5\beta)C_t^1(r) - \\ -2(5-4\beta)C_t^2(r) + (4-3\beta)C_t^3(r) \end{bmatrix} \\ f_2 = \frac{\beta^2}{(1-\beta)^2} [C_t^1(r) - 2 \cdot C_t^2(r) + C_t^3(r)] \end{cases} \quad (7)$$

Having received the data characterizing the state's investment potential, it is possible to build a model of its integral evaluation, which will be grouped on the Hurst exponent. The Hurst exponent (characteristics of time series persistence) is calculated based on the magnitude of the cumulative deviation of the indicators and reflects the economic essence of the concept of potential:

$$\frac{R}{S} = (\alpha \cdot N)^H, \quad (8)$$

where H – Hurst exponent, R – scope of cumulative deviation of the indicator, S – mean square deviation of the time series, N – number of observation periods, α – positive number given by a constant.

Whence:

$$H = \frac{\log(\frac{R}{S})}{\log(\alpha \cdot N)}, \quad (9)$$

where the magnitude of the accumulated deviation:

$$R = \max_{1 \le u \le N} Z_u - \min_{1 \le u \le N} Z_u. \quad (10)$$

$$Z_u = \sum_{1}^{u} (y_t - \bar{y}), \quad (11)$$

where $\bar{y}$ – the arithmetic mean of the time series, y_t – the level of the time series.

Considering the fact that the Hurst exponent provides for the construction of the regression equation, which consists of an effective indicator and factor attributes, and the potential one is looking for is the degree of the number, it is necessary to introduce an effective indicator in the model. It was proposed to choose the global index of attractiveness of foreign direct investment, as such an indicator (calculated by the World Bank as part of the Doing Business ranking), and the factor attributes of the regression model will be 25 relevant indicators related to the socio-economic conditions, infrastructure, science and education, environment and human health, and technology. It is suggested to choose not the absolute value of the global index of attractiveness of foreign direct investment, presented in the form of ranks, but the derived indicator, determined by applying Savage normalization, as an effective attribute:

http://dx.doi.org/10.21511/imfi.17(1).2020.28

$$Y_t = \frac{\max_t y_t - y_t}{\max_t y_t - \min_t y_t}. \tag{12}$$

Comparing the results of the ranking with factor attributes will allow obtaining the adequate results of calculations.

Considering the fact that the hypothesis that information technologies play the most important role in shaping the state's investment potential has been put forward in the process of studying the peculiarities of investment activity, one of the stages of mathematical formalization of the process of assessing the state's investment potential is proposed to compare two development scenarios: the projected level of the state's investment potential at the projected level of information technology and the projected level of the state's investment potential, provided that the development of information technology at the current level is established.

However, it is fair to point out that the calculations received form a limited information database for adopting a well-considered and effective investment strategy for the development of the state. Therefore, it is necessary to supplement this information base with the specific tools for the activation of investment potential used by other countries. However, it should be noted that it is not effective to use the experience of any, even successful, country, as all countries differ in terms of initial conditions of investment potential development. Therefore, to accomplish this task, it is proposed to group the countries according to the level of investment potential and to adapt the best practices to national conditions. Thus, first, the investment potential of each country is calculated according to the proposed methodology, and second, the cluster for Ukraine is specified based on the self-organizing map (SOM) construction. Moreover, the most successful country is identified and its best achievements in the field of investing are adapted to national economic conditions.

3. RESULTS AND DISCUSSION

Before practical testing of the methodology described earlier, some additional calculations will be made. Thus, one calculates the first levels of the input time series using a second-order parabola, evaluates the initial conditions for the formation of an integral indicator, determines the exponen-

Table 1. Interim calculations of the trend equation of adaptive forecasting in terms of socio-economic conditions and infrastructure for 1999–2018

Indicators	Description of the first levels of the input time series using the square parabola	Adaptive forecasting regression equation
Soc1	$Soc1_t = 5.08 - 0.05 \cdot t - 0.09 \cdot t^2$	$Soc1_t = 3.14 - 0.27 \cdot l - 0.09 \cdot l^2$
Soc2	$Soc2_t = 3.50 - 0.29 \cdot t + 0.06 \cdot t^2$	$Soc2_t = 7.53 + 1.51 \cdot l + \frac{1}{2} 0.11 \cdot l^2$
Soc3	$Soc3_t = 66.60 - 0.0226 \cdot t + 0.0039 \cdot t^2$	$Soc3_t = 66.48 - 0.0327 \cdot l - \frac{1}{2} 0.0003 \cdot l^2$
Soc4	$Soc4_t = 18.48 - 0.16 \cdot t - 0.04 \cdot t^2$	$Soc4_t = 15.53 + 0.18 \cdot l - \frac{1}{2} 0.0001 \cdot l^2$
Soc5	$Soc5_t = 81.52 + 0.16 \cdot t + 0.04 \cdot t^2$	$Soc5_t = 84.47 - 0.18 \cdot l - \frac{1}{2} 0.0001 \cdot l^2$
In1	$In1_t = 11.90 - 0.50 \cdot t + 0.06 \cdot t^2$	$In1_t = 11.02 - 1.71 \cdot l - \frac{1}{2} 0.01 \cdot l^2$
In2	$In2_t = 3596596.96 + 340189.13 \cdot t + 9084.55 \cdot t^2$	$In2_t = 5454002.78 + 1072691.75 \cdot l - \frac{1}{2} 11994.40 \cdot l^2$
In3	$In3_t = 4.12 + 0.91 \cdot t - 0.09 t^2$	$In3_t = 10.65 + 2.62 \cdot l + \frac{1}{2} 0.04 \cdot l^2$
In4	$In4_t = 3.52 + 0.0112 \cdot t - 0.0057 \cdot t^2$	$In4_t = 3.47 + 0.0635 \cdot l + \frac{1}{2} 0.0002 \cdot l^2$
In5	$In5_t = 51450.13 - 1215.08 \cdot t - 331.53 \cdot t^2$	$In5_t = 37292.19 - 6133.13 \cdot l - \frac{1}{2} 0.193.58 \cdot l^2$

tial average values, and identifies the parameters of the regression trend equation for adaptive forecasting. Therefore, the adaptive forecasting study results of socio-economic conditions and infrastructure will be presented in Table B1 and Figure B1 (Appendix B).

The equations obtained in Table 1 allow determining the patterns of development and consequently predicting ten relevant indicators characterizing Ukraine's investment potential in terms of socio-economic conditions and infrastructure (Figure B1).

Based on the data in Figure B1, it is fair to note that only five of the ten relevant studied indicators show a positive prediction. They are air transportation, fixed broad band subscriptions, quality of port infrastructure, adjusted net national income, and self-employed. These consistencies indicate that there are no prerequisites for developing the investment potential in Ukraine.

The corresponding mathematical calculations within science and education, as well as environment and human health, are given in Table B2 and Figure B2 (Appendix B).

The analysis of the regression equations parameters characterizing the first levels of the input time series using the square parabola and the adjusted parameters of the regression equation of adaptive forecasting shows a slight variation of their values for most of the time series in terms of science and education, as well as environment and human health. Thus, only for indicators of research and development expenditure, government expenditure on education, people using at least basic sanitation services, current health expenditure, limited savings: particulate emission damage, there is a dramatic change of signs (directions of impact) to the opposite during the implementation of the adaptive mechanism.

Analyzing the data presented in Figure B2, it should be noted that the environmental and health indicators of Ukrainians create a positive situation for the development of human capital, which is defined at the theoretical level as the basis for the growth of Ukraine's investment potential. At the same time, three out of five relevant indicators characterizing the science and education group in 2020–2021 show a downward trend. This confirms the situation in Ukraine that has been

Table 2. Interim calculations of the trend equation of adaptive forecasting in the context of science and education, as well as environment and human health, for 1999–2018

Indicators	Description of the first levels of the input time series using the square parabola	Adaptive forecasting regression equation
Ed1	$Ed1_t = 85.86 - 0.44 \cdot t + 0.09 \cdot t^2$	$Ed1_t = 86.03 - 1.70 \cdot l - \frac{1}{2} 0.01 \cdot l^2$
Ed2	$Ed2_t = 2641.41 - 138.07 \cdot t + 26.80 \cdot t^2$	$Ed2_t = 2621.48 - 529.02 \cdot l - \frac{1}{2} 2.73 \cdot l^2$
Ed3	$Ed3_t = 6.59 + 0.03 \cdot t - 0.05 \cdot t^2$	$Ed3_t = 0.41 - 0.01 \cdot l - \frac{1}{2} 6.42 \cdot 10^{-6} \cdot l^2$
Ed4	$Ed4_t = 6.59 + 0.03 \cdot t - 0.05 \cdot t^2$	$Ed4_t = 4.64 + 0.57 \cdot l + \frac{1}{2} 0.0006 \cdot l^2$
Ed5	$Ed5_t = 35.81 + 0.32 \cdot t - 0.18 \cdot t^2$	$Ed5_t = 33.15 + 1.61 \cdot l - \frac{1}{2} 0.0011 \cdot l^2$
Ec1	$Ec1_t = 95.48 + 0.09 \cdot t - 0.001 \cdot t^2$	$Ec1_t = 95.85 + 0.30 \cdot l + \frac{1}{2} 0.0044 \cdot l^2$
Ec2	$Ec2_t = 6.47 + 0.09 \cdot t - 0.01 \cdot t^2$	$Ec2_t = 6.63 + 0.28 \cdot l + \frac{1}{2} 0.0016 \cdot l^2$
Ec3	$Ec3_t = 80.40 + 0.40 \cdot t + 0.03 \cdot t^2$	$Ec3_t = 82.82 + 1.60 \cdot l + \frac{1}{2} 0.04 \cdot l^2$
Ec4	$Ec4_t = 0.26 - 0.004 \cdot t + 0.0011 \cdot t^2$	$Ec4_t = 0.27 - 0.02 \cdot l - \frac{1}{2} 7.5 \cdot 10^{-5} \cdot l^2$
Ec5	$Ec5_t = 80.75 + 2.09 \cdot t + 0.01 \cdot t^2$	$Ec5_t = 91.11 + 7.97 \cdot l + \frac{1}{2} 0.15 \cdot l^2$

http://dx.doi.org/10.21511/imfi.17(1).2020.28

Table 3. Intermediate calculations of the trend equation of adaptive forecasting in the context of information technologies for 1999–2018

Indicators	Description of the first levels of the input time series using the square parabola	Adaptive forecasting regression equation
Tech1	$Tech1_t = 34.86 + 0.18 \cdot t - 0.16 \cdot t^2$	$Tech1_t = 30.24 + 1.83 \cdot l + \frac{1}{2} 0.026 \cdot l^2$
Tech2	$Tech2_t = 3.60 + 0.18 \cdot t + 0.22 \cdot t^2$	$Tech2_t = 15.84 + 7.40 \cdot l + \frac{1}{2} 0.27 \cdot l^2$
Tech3	$Tech3_t = 0.91 - 0.008 \cdot t + 0.004 \cdot t^2$	$Tech3_t = 0.94 - 0.19 \cdot l - \frac{1}{2} 4.00 \cdot 10^{-4} \cdot l^2$
Tech4	$Tech4_t = 4.92 + 0.06 \cdot t + 0.014 \cdot t^2$	$Tech4_t = 5.00 + 0.13 \cdot l + \frac{1}{2} 0.002 \cdot l^2$
Tech5	$Tech5_t = -318.57 + 190.95 \cdot t + 61.47 \cdot t^2$	$Tech5_t = 3890.65 + 2807.58 \cdot l + \frac{1}{2} 145.63 \cdot l^2$

observed for many years when domestic scientists and inventors either go abroad as they do not have the equipment to implement their innovative developments or their qualification does not meet the modern requirements of management.

As for analyzing the dynamic changes and further tendencies in the development of information technology indicators, Table 3 and Figure 3 will be built. The analysis of retrospective data in the context of the indicator of medium and high-tech industry indicates the description of this data set with the second degree polynomial with the branches down, i.e., this indicator tends to increase to a certain turning point 56.22% of the average level, after which it decreases over time. In the context of all other information technology characteristics (ICT service exports, ICT goods exports, high-technology exports, secure internet servers), nonlinear trends have been identified to describe retrospective data, which show a general tendency to decline over time to a certain threshold level (2.6512%, 0.9634%, 2.3043%, 1.5532 %, respectively) over which the value of the indicator increases with time.

The transition to constructing regression equations for adaptive forecasting of information technology characteristics (the last three rows of Table 3) indicates the need for dramatic changes in the parameters of the equation in the context of the medium and high-tech industry. In the context of other indicators of information technology characteristics, in addition to ICT goods exports, there is a growing trend for the future in 2020 and 2021 (Figure 3). Thus, technologies currently provide the prerequisites for increasing the investment potential, but the proportion of this impact in the overall investment structure is unknown and needs further research.

Considering the practical implementation of the methodology for calculating the integral index of investment potential and its prediction based on the Hurst index, several intermediate calculations were performed: 1) normalization of 25 indicators of the input information base by the relative method; 2) weighting of indicators estimating investment potential of the country by the method of relative dispersion; 3) determination of integral indicators in the section of each group by the arithmetic mean method; 4) construction of nonlinear multiplicative multifactor regression equation of dependence of GFICA index on the integral indices for each of 5 groups; 5) convolution of 5 integral indicators in the context of 5 groups to a single integral indicator by the equation developed in the previous study (Kasaeva, 2019); 5) predicting 25 indicators based on Brown-Meyer models; 6) determination of integral forecasts in the context of each group for 2019–2021 using the arithmetic mean method; 7) calculation of the Hurst exponent from 2013 to 2019 to assess the investment potential of Ukraine in 2019; from 2013 to 2020, respectively, to assess Ukraine's investment potential in 2020; from 2013 to 2021, respectively, to assess Ukraine's investment potential in 2021 (Table 4).

Having forecasted the generalizing indicators of groups characterizing components of the investment potential of Ukraine, it becomes possible to calculate it directly based on the Hurst exponent, as well as to test the hypothesis regarding the level

Source: Developed by the authors.

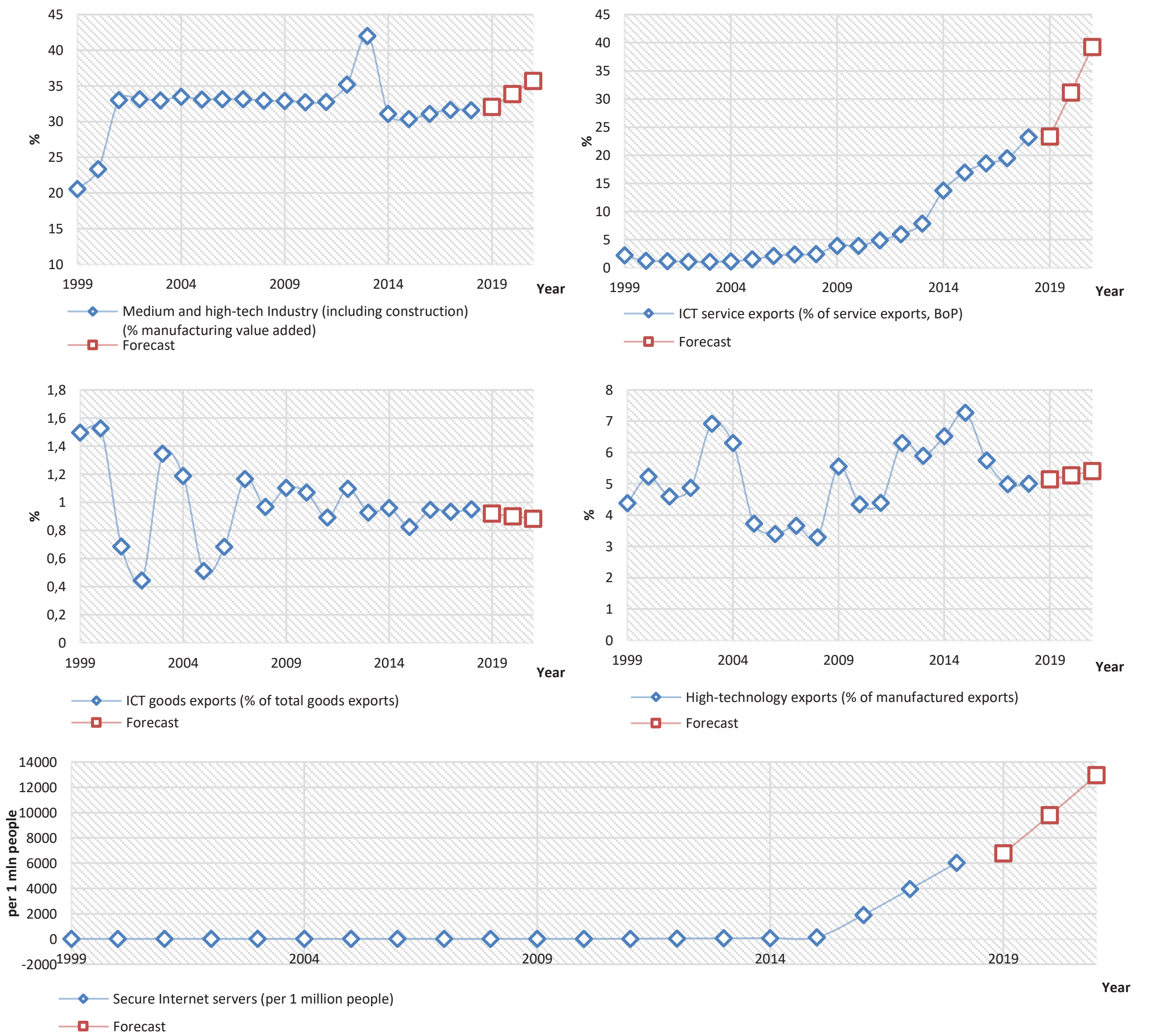


Figure 1. Graphical interpretation of retrospective and forecasted values of time series in the context of information technologies for 1999–2018

of influence of technologies on the integral indicator of Ukraine's investment potential. Therefore, we construct regression equations in two scenarios and set the integral value. Thus, the three graphs on the left in Figure B2 characterize the value of the integral index of investment potential for 2019–2021 considering the growth of technologies, and the left on the contrary. Exploring Ukraine's investment potential, taking into account the growth rate of technology, a certain cyclic nature is observed for the three studied years, namely the increase of the level of the indicator to 0.6594 units in 2019 compared to 2018 with a further decrease to 0.6493 units in 2020 and 0.6407 units in 2021, respectively.

Determining the level of influence of technologies on Ukraine's investment potential, one compares the value of the degree near the variable within each year (Figure B3, Appendix B). Thus, the level of investment potential is assumed to be 0.6484 in 2019, 0.6174 in 2020, 0.5668 in 2021. So, the formalization of the impact of information technology on Ukraine's investment potential is as follows: in 2019, 0.6594–0.6484 = 0.011 unit or 1.70%; in 2020, 0.6493–0.6174 = 0.0319 units or 5.17%, and in 2021 0.6407–0.5668 = 0.0739 units or 13.04%. Therefore, it is fair to conclude that the hypothesis of the significant impact of technology on investment potential is correct, and the gap be-

http://dx.doi.org/10.21511/imfi.17(1).2020.28

Table 4. Estimated and forecasted values of the components of Ukraine's investment potential based on the Hurst exponent in 2013–2021

Year	Socio-economic conditions	Infrastructure	Science and education	Environment and human health	Technology	GFICA index prediction
2013	0.726	0.830	0.754	0.865	0.627	0.380
2014	0.669	0.832	0.740	0.860	0.649	0.435
2015	0.711	0.836	0.736	0.849	0.663	0.444
2016	0.777	0.840	0.720	0.851	0.705	0.463
2017	0.852	0.843	0.720	0.859	0.721	0.454
2018	0.845	0.852	0.718	0.862	0.741	0.472
Forecasting taking into account the technology growth						
2019	0.843	0.850	0.718	0.863	0.745	0.545
2020	0.856	0.870	0.721	0.872	0.773	0.497
2021	0.869	0.886	0.723	0.882	0.797	0.459
Forecasting without taking into account the technology growth						
2019	0.843	0.850	0.718	0.863	0.741	0.508
2020	0.856	0.870	0.721	0.872	0.741	0.288
2021	0.869	0.886	0.723	0.882	0.741	0.180

tween investment potential with and without technology is only increasing every year.

The final stage of the study is countries grouping according to their level of technology. It is based on SOMs construction and identification of the Ukrainian cluster, which let us gain relevant international experience to implement the national investment policy. The given data depicts the past and current grouping according to the countries' level of technology and its changes during the last years (Figure 2).

Having transformed the obtained graphical results into a tabular form (Table 5), it is fair to note that the results of using the SOMs tool have iden-

Source: Developed by the authors using Deductor Studio.

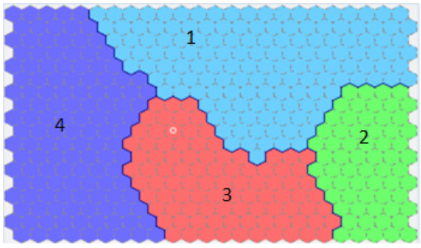
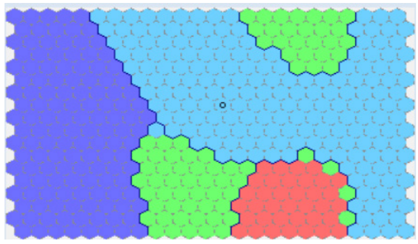
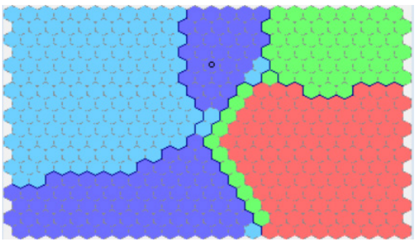
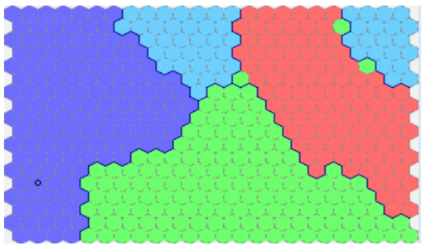
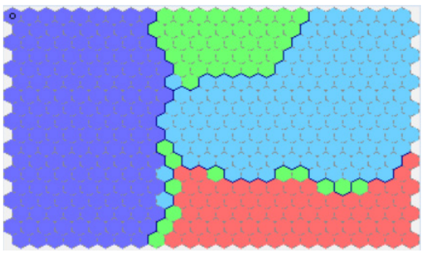
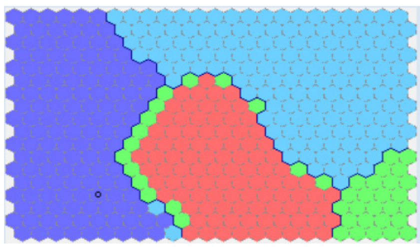
Year	Clusters	Year	Clusters
2018		2017	
2016		2015	
2008		2003	

Figure 2. SOMs in the context of the grouping the countries according to their level of technology

Table 5. Grouping of the countries according to their level of technology using SOMs

Year	Cluster 1	Cluster 2	Cluster 3	Cluster 4
2018	Czech Republic	United Kingdom	Slovak Republic	Ukraine
	USA	France	China	Spain
	Germany			Romania
	Estonia			Poland
2017	United Kingdom	Slovak Republic	China	Ukraine
	USA	Czech Republic		Spain
	Germany			Romania
	Estonia			Poland
	France			
2016	Ukraine	Czech Republic	United Kingdom	Slovak Republic
	Spain	Germany	USA	China
	Romania		France	Estonia
	Poland			
2015	USA	Slovak Republic	United Kingdom	Ukraine
	Estonia	Czech Republic	France	Spain
		China	Germany	Romania
				Poland
2008	United Kingdom	Germany	China	Ukraine
	USA		Slovak Republic	Spain
	France		Czech Republic	Romania
				Poland
				Estonia
2003	United Kingdom	China	Czech Republic	Ukraine
	USA		Estonia	Spain
	France			Romania
	Germany			Poland
				Slovak Republic

tified that Ukraine was in cluster 4, where Spain, Romania, and Poland were in 2017 and 2018. The study of the dynamics of this group indicates that in previous years, such countries as Estonia and Slovakia, which are currently classified as belonging to cluster 2, belong to this cluster.

Thus, it is fair to point out that state executive and legislative authorities should draw on the experience of countries such as Poland and Spain in the process of shaping Ukraine's newest investment strategy, which will be based on increasing investment potential. The opportunity to replicate the breakthrough of Estonia, which is now one of the leaders in living standards in Europe, was lost in 2008, when Ukraine was in the same cluster with the country, and thus had similar starting conditions.

CONCLUSION

This paper presents the framework of determining and forecasting Ukraine's investment potential with regard to 25 relevant indicators from the following areas: socio-economic conditions, infrastructure, science and education, environment and human health, technology. Furthermore, it provides the influence of information technology on the general parameter that describes the investment potential.

The implementation of the developed methodology showed the declining trend in the level of investment potential for 2019–2021, 0.6594 units in 2019, 0.6493 units in 2020, and 0.6407 units in 2021. The main reason for this is unsatisfactory indicators of socio-economic development and the lack of extensive modern infrastructure. Despite sufficiently high initial positions of the indicators responsible for the multiplication of human capital, it does not ensure the development of Ukraine's investment potential. Since highly qualified specialists go abroad or do not create an innovative product being unable to

http://dx.doi.org/10.21511/imfi.17(1).2020.28

uncover their potential in Ukraine fully. This requires the urgent intervention of the state authorities in intensifying the reforms related to the investment climate improvement and ensuring the progressive development of the innovative growth of all spheres of society.

Based on the clustering of the countries according to their level of information technologies for 2003–2018, Ukraine was found to lose the opportunity to recreate the development trajectory of Estonia since 2008 because that year, they were in the same group with the characteristics of investment activity components. At present, Ukraine is in the same cluster with Poland, Spain, and Romania, so one believes that adapting the instruments of these countries for increasing the level of information technologies and investment potential in general is a priority for the executive and legislative branches of Ukraine.

Further scientific research should be aimed at the analysis of instruments for intensifying the technological component of investment activity in the country and creating favorable conditions for attracting the external investment in the innovation activities of Poland and certain territories of Spain. Besides, it is important to develop an optimal mechanism for adapting the technologies of Poland and Spain to the current situation in Ukraine to improve its investment attractiveness.

AUTHOR CONTRIBUTIONS

Conceptualization: Juliya Kasaeva.
Data curation: Volodymyr Kasianenko, Tetiana Kasianenko.
Formal analysis: Juliya Kasaeva.
Funding acquisition: Volodymyr Kasianenko, Tetiana Kasianenko.
Investigation: Juliya Kasaeva.
Methodology: Juliya Kasaeva.
Project administration: Volodymyr Kasianenko, Tetiana Kasianenko.
Resources: Volodymyr Kasianenko, Tetiana Kasianenko.
Software: Juliya Kasaeva.
Supervision: Volodymyr Kasianenko, Tetiana Kasianenko.
Validation: Juliya Kasaeva.
Visualization: Juliya Kasaeva.
Writing – original draft: Juliya Kasaeva.
Writing – review & editing: Volodymyr Kasianenko, Tetiana Kasianenko.

REFERENCES

1. Abel, A. B. (1983). Optimal investment under uncertainty. *American Economic Review, 73*(1), 228-233. Retrieved from http://www.jstor.org/stable/1803942
2. Abel, A. B., & Eberly, J. C. (2016). A Unified Model of Investment under Uncertainty. *American Economic Review, 84*(5), 1369-1384.
3. Benhabib, J., & Spiegel, M. M. (2000). The role of financial development in growth and investment. *Journal of Economic Growth, 5*(4), 341-360. https://doi.org/10.1023/A:1026599402490
4. Bojanc, R., Jerman-Blažič, B., & Tekavčič, M. (2012). Managing the investment in information security technology by use of a quantitative modeling. *Information Processing and Management, 48*(6), 1031-1052. https://doi.org/10.1016/j.ipm.2012.01.001
5. Chevalier-Roignant, B., Flath, C. M., Huchzermeier, A., & Trigeorgis, L. (2011). Strategic investment under uncertainty: A synthesis. *European Journal of Operational Research, 215*(3), 639-650. https://doi.org/10.1016/j.ejor.2011.05.038
6. Desierto, D. A. (2016). State controls over available remedies in investor-state arbitration. In *Reassertion of Control over the Investment Treaty Regime* (pp. 259-282). Cambridge University Press. https://doi.org/10.1017/9781316779286.012
7. Dixit, A. K., & Pindyck, R. S. (2012). *Investment under Uncertainty* (468 p.). Princeton University Press. https://doi.org/10.2307/2329279
8. European Business Association (2019). *Indeks investytsiinoi pryvablyvosti Ukrainy [Index of investment attractiveness of Ukraine]*. (In Ukrainian). Retrieved from https://eba.com.ua/wp-content/uploads/2019/12/EBA-Investment-Attrativeness-Index-2H2019-ukr.pdf

9. Fama, E. F., & French, K. R. (2006). Profitability, investment and average returns. *Journal of Financial Economics, 82*(3), 491-518. https://doi.org/10.1016/j.jfineco.2005.09.009
10. Giel, B., Issa, R. R. A., & Olbina, S. (2019). Return on investment analysis of building information modeling in construction. In *EG-ICE 2010 - 17th International Workshop on Intelligent Computing in Engineering*. Nottingham.
11. Gomes, J. F. (2001). Financing investment. *American Economic Review, 91*(5), 1263-1285. https://doi.org/10.1257/aer.91.5.1263
12. Gourio, F. (2015, January 1). Discussion of "uncertainty, investment and managerial incentives" by Glover and Levine. *Journal of Monetary Economics*. https://doi.org/10.1016/j.jmoneco.2014.11.003
13. Hu, X. (2011). *The Tension of the Concept of Human Capital and the Evolution of Its Scope of Investment in the Creative Economy Times* (6 p.). Institute of Electrical and Electronics Engineers (IEEE). https://doi.org/10.1109/icmss.2011.5998015
14. Kasaeva, J. (2019). Developing the Methodology of Assessing the Potential of Countries to Attract Foreign Direct Investment. *Marketing and Management of Innovations, 4,* 292-307. http://doi.org/10.21272/mmi.2019.4-23
15. Komarynska, Y., Kryshevych, O., Linnyk, N., Karelin, V., & Kofanova, O. (2019). Public-private partnership as an effective mechanism for attracting private investment in achieving the aims the socio-economic development of Ukraine. *Problems and Perspectives in Management, 17*(4), 469-479. https://doi.org/10.21511/ppm.17(4).2019.38
16. Kulish, A., Petrushenko, M., Reznik, O., & Kiselyova, E. (2018). The relations unshadowing in business activities: The economic and legal factors of security at the macroeconomic level. *Problems and Perspectives in Management, 16*(1), 428-436. https://doi.org/10.21511/ppm.16(1).2018.40
17. Lagendijk, A., & Hendrikx, B. (2009). Foreign Direct Investment. In *International Encyclopedia of Human Geography* (pp. 243-254). Elsevier Inc. https://doi.org/10.1016/B978-008044910-4.00167-X
18. Lang, L., Ofek, E., & Stulz, R. M. (1996). Leverage, investment, and firm growth. *Journal of Financial Economics, 40*(1), 3-29. https://doi.org/10.1016/0304-405X(95)00842-3
19. McDonald, R., & Siegel, D. (1986). The Value of Waiting to Invest. *Quarterly Journal of Economics, 101*(4), 707. https://doi.org/10.2307/1884175
20. Meltzer, J. P. (2015). Investment. In *Bilateral and Regional Trade Agreements: Commentary and Analysis* (pp. 245-298). Cambridge University Press. https://doi.org/10.1017/CBO9781107501461.011
21. Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics, 13*(2), 187-221. https://doi.org/10.1016/0304-405X(84)90023-0
22. Perrotta, C. (2018). Investment in human capital. In *Unproductive Labour in Political Economy* (pp. 102-115). Routledge. https://doi.org/10.4324/9781315620893-12
23. Richard, B. W., Holton, E. F., & Katsioloudes, V. (2014). The use of discrete computer simulation modeling to estimate return on leadership development investment. *Leadership Quarterly, 25*(5), 1054-1068. https://doi.org/10.1016/j.leaqua.2014.03.002
24. Sauvant, K. P., & Sachs, L. E. (2009). *The Effect of Treaties on Foreign Direct Investment: Bilateral Investment Treaties, Double Taxation Treaties, and Investment Flows* (794 p.). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195388534.001.0001
25. Schill, S. W. (2009). *The Multilateralization of International Investment Law* (451 p.). Cambridge University Press. https://doi.org/10.1017/CBO9780511605451
26. Schultz, W. T. (1961). American Economic Association Investment in Human Capital. *American Economic Review, 51*(1), 1-17. Retrieved from https://www.jstor.org/stable/pdf/1818907.pdf
27. Social Impact Investment (2014). *Impact Investment: the Invisible Heart of Markets*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/gx-ps-impact-investment-report.pdf
28. World Bank. (2019). *World Development Indicators*. Retrieved from https://data.worldbank.org/indicator

http://dx.doi.org/10.21511/imfi.17(1).2020.28

http://dx.doi.org/10.21511/imfi.17(1).2020.28

APPENDIX A

Table A1. Information base for the study of investment potential of Ukraine in 1999–2008

Indicators	Year									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ec1	94.59	94.66	94.75	94.84	94.93	95.02	95.12	95.21	95.30	95.39
Ec2	5.23	5.31	5.51	5.77	6.30	5.94	6.11	6.18	5.80	5.29
Ec3	78.22	78.28	78.35	78.42	78.46	78.50	78.54	78.58	78.62	79.46
Ec4	0.36	0.35	0.32	0.32	0.30	0.29	0.30	0.29	0.28	0.29
Ec5	63.24	64.65	64.74	64.83	64.92	67.67	70.44	73.21	75.98	78.76
In1	17.44	18.08	19.71	19.30	17.80	15.00	13.34	12.36	11.70	11.61
In2	910,100.00	950,697.00	986,022.00	1,119,889.00	1,652,632.00	2,200,094.00	2,512,910.00	2,801,992.00	1,736,018.00	3,456,288.00
In3	0.07	0.07	0.08	0.08	0.10	0.14	0.28	1.12	1.72	3.46
In4	3.26	3.26	3.26	3.27	3.27	3.28	3.29	3.31	3.36	3.47
In5	47,600.00	51,767.00	49,661.00	50,544.00	52,558.00	51,726.00	52,655.00	53,230.00	53,089.00	53,056.00
Ed1	94.07	93.60	94.65	90.50	91.06	90.23	85.67	86.91	86.74	86.44
Ed2	5,401.00	5,620.00	7,208.00	1,601.00	1,635.00	4,090.00	3,538.00	3,474.00	3,440.00	2,825.00
Ed3	0.97	0.96	1.02	1.00	1.11	1.08	1.03	0.95	0.85	0.85
Ed4	3.62	4.17	4.68	5.43	5.60	5.31	6.06	6.21	6.15	6.43
Ed5	23.33	26.78	26.60	29.26	29.91	30.74	35.14	36.24	34.35	35.86
Soc1	1.57	1.90	2.09	1.64	2.84	2.65	9.07	5.21	7.15	5.95
Soc2	3.73	5.64	9.22	6.22	8.63	15.72	4.04	10.80	15.40	7.57
Soc3	66.23	67.24	66.39	66.55	66.75	66.80	66.76	66.74	66.63	66.49
Soc4	18.27	18.42	18.54	18.49	18.43	18.42	18.27	18.17	18.12	18.22
Soc5	81.73	81.58	81.46	81.51	81.57	81.58	81.73	81.83	81.88	81.78
Tech1	20.57	23.34	33.01	33.14	32.98	33.48	33.12	33.15	33.15	32.92
Tech2	2.23	1.22	1.21	1.09	1.07	1.14	1.50	2.09	2.39	2.45
Tech3	1.50	1.52	0.69	0.44	1.35	1.19	0.51	0.68	1.16	0.97
Tech4	4.38	5.23	4.60	4.86	6.92	6.30	3.72	3.40	3.65	3.29
Tech5	7.29	7.29	7.30	7.30	7.32	7.35	7.41	7.53	7.79	8.32

Table A2. Information base for the study of the investment potential of Ukraine in 2009–2018

Indicators	Year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ec1	95.48	95.57	95.66	95.75	95.84	95.93	95.94	96.02	96.11	96.19
Ec2	6.36	6.98	6.82	7.12	7.36	6.64	6.96	6.73	6.83	6.92
Ec3	80.29	81.13	81.96	82.80	83.06	83.31	83.57	83.83	84.09	84.46
Ec4	0.28	0.25	0.23	0.22	0.22	0.22	0.33	0.30	0.26	0.25
Ec5	81.55	84.35	87.15	89.95	92.34	92.06	92.16	94.36	96.61	99.06
In1	11.92	11.49	10.91	10.80	10.69	10.78	10.46	10.11	9.69	9.29
In2	3,427,818.00	3,956,053.00	5,477,654.92	5,828,107.61	5,218,814.57	4,503,610.00	4,620,530.00	5,756,509.00	6,821,095.00	7,636,538.46
In3	4.15	6.45	6.96	8.04	8.86	9.31	11.81	12.22	12.55	17.19
In4	3.71	3.64	3.70	4.00	3.70	3.30	3.16	3.20	3.50	3.52
In5	48,327.00	50,240.00	50,569.00	49,203.00	48,876.00	37,065.00	37,577.00	37,360.00	28,001.00	26,986.25
Ed1	85.70	85.94	84.18	84.71	85.49	86.38	85.92	85.46	84.92	84.58
Ed2	2,434.00	2,556.00	2,649.00	2,491.00	2,856.00	2,457.00	2,271.00	2,233.00	2,283.00	2,124.71
Ed3	0.86	0.83	0.74	0.75	0.76	0.65	0.61	0.48	0.45	0.43
Ed4	7.31	6.74	6.16	6.69	6.67	5.87	5.44	5.01	5.07	5.10
Ed5	34.61	34.44	36.31	37.49	36.13	33.68	35.76	31.20	32.54	32.95
Soc1	4.07	4.74	4.42	4.65	2.46	0.63	3.35	3.69	2.52	1.89
Soc2	-24.81	7.85	8.36	6.04	0.64	-3.82	-10.35	2.92	10.39	10.47
Soc3	66.40	66.44	66.78	66.42	67.24	65.79	66.21	66.21	66.38	66.44
Soc4	18.48	18.91	19.27	18.77	19.12	15.87	15.93	15.64	15.71	15.70
Soc5	81.52	81.09	80.73	81.23	80.88	84.13	84.07	84.36	84.29	84.30
Tech1	32.91	32.74	32.79	35.20	42.01	31.10	30.36	31.11	31.67	31.59
Tech2	3.92	3.92	4.89	5.98	7.88	13.72	16.92	18.56	19.48	23.18
Tech3	1.10	1.07	0.89	1.10	0.93	0.96	0.82	0.95	0.93	0.95
Tech4	5.55	4.34	4.39	6.30	5.89	6.51	7.27	5.75	4.98	5.00
Tech5	9.49	12.36	20.96	40.93	54.03	74.70	141.80	1,905.47	3,948.26	6,027.81

http://dx.doi.org/10.21511/imfi.17(1).2020.28

APPENDIX B

Source: Developed by the authors.

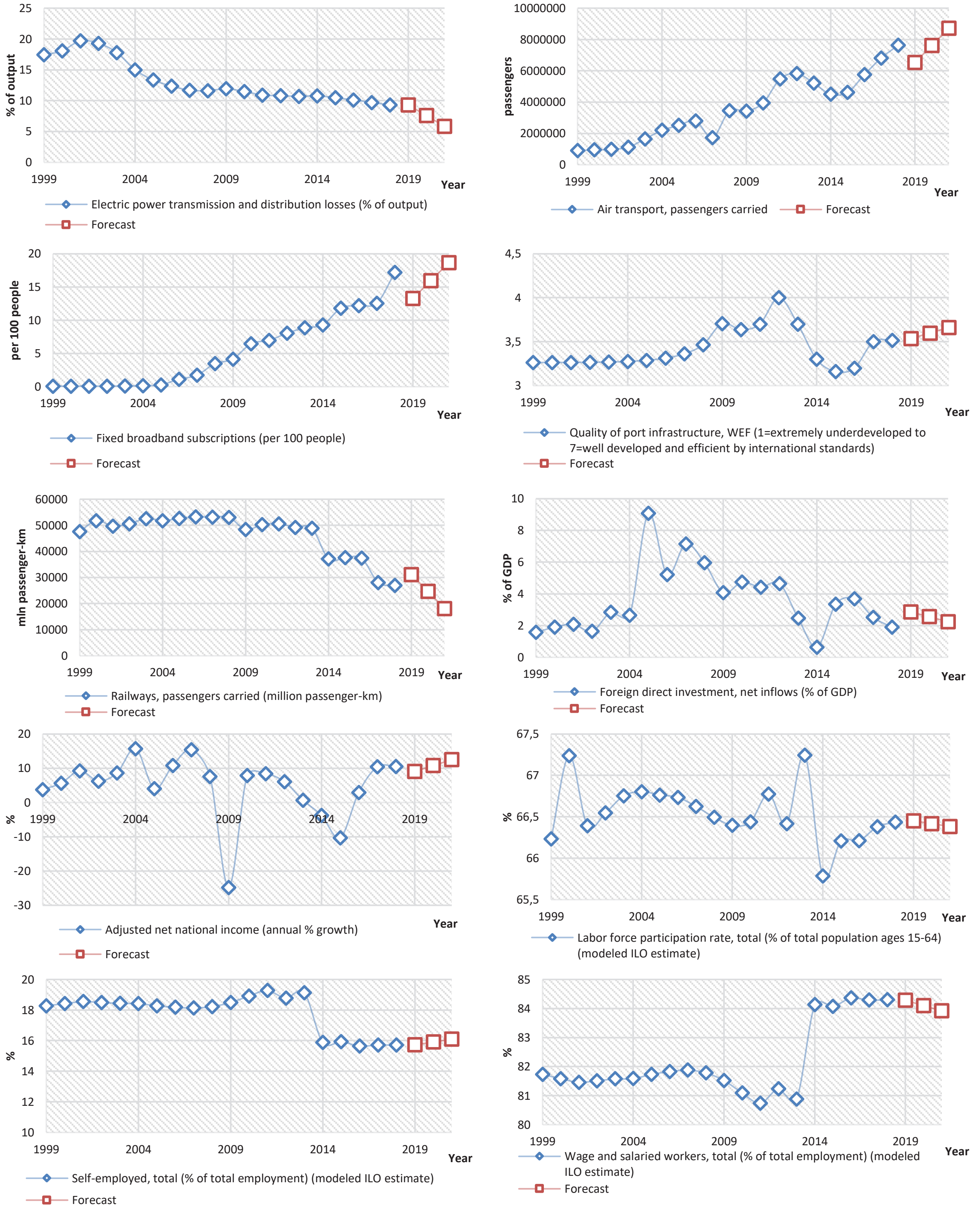


Figure B1. Graphical interpretation of retrospective and forecasted values of time series in terms of socio-economic conditions and infrastructure for 1999–2021

Source: Developed by the authors.

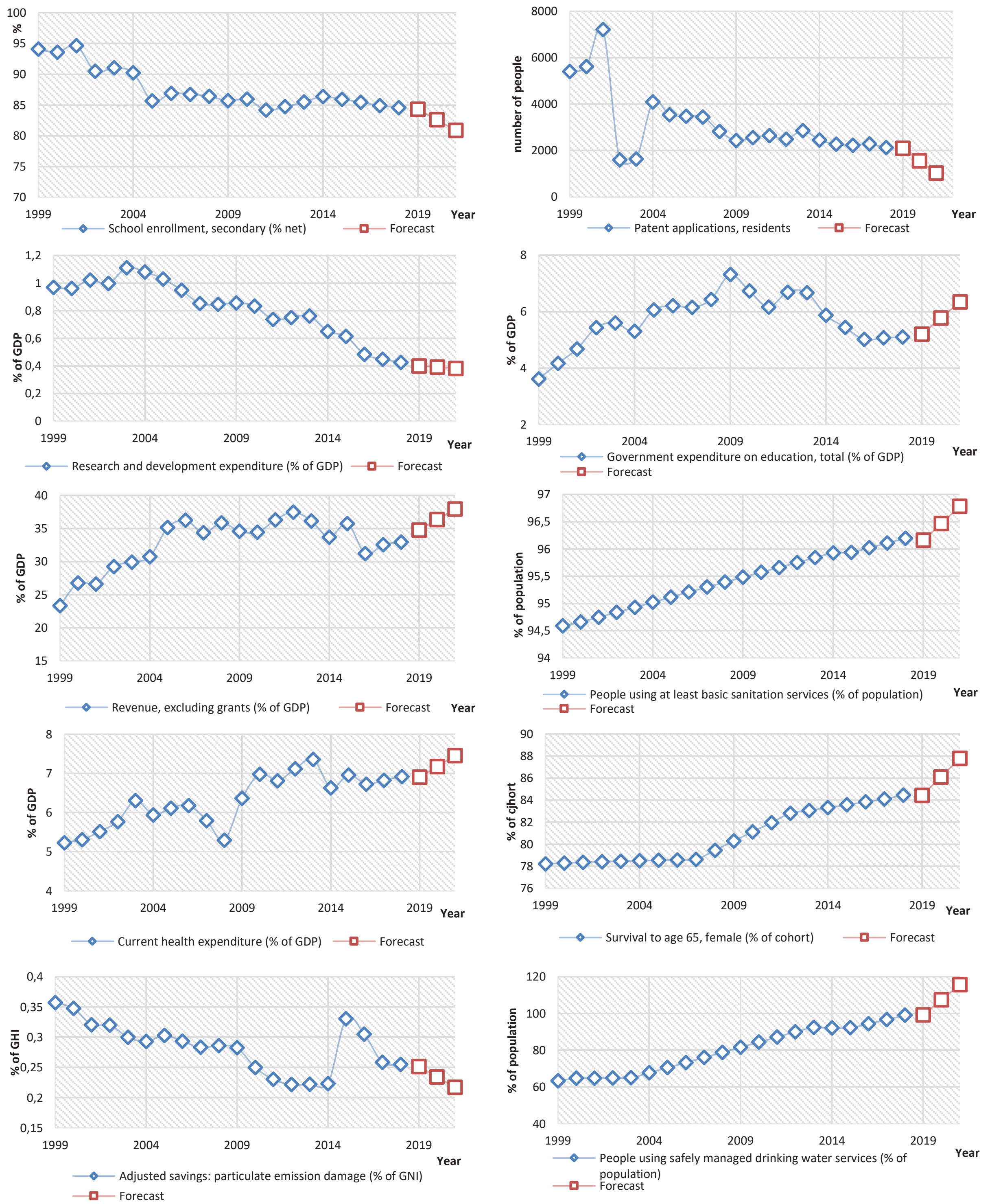


Figure B2. Graphical interpretation of retrospective and forecasted values of time series in the context of science and education, as well as environment and human health, for 1999–2021

http://dx.doi.org/10.21511/imfi.17(1).2020.28

Source: Developed by the authors.

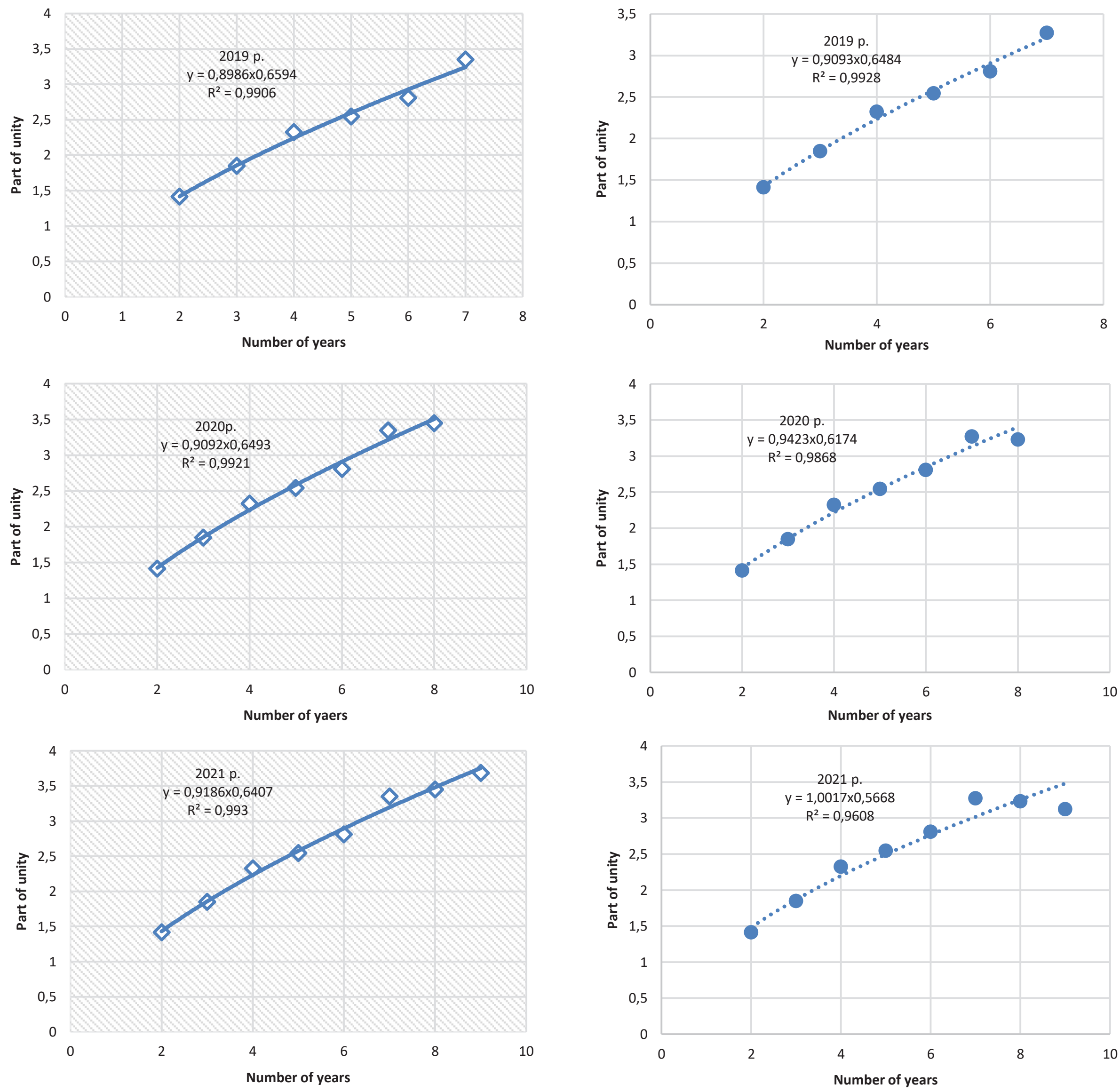


Figure B3. Forecasted levels of investment potential of Ukraine based on the Hurst exponent, taking into account the dynamics of technology growth and without it for 2019–2021