




RESEARCH ARTICLE

Sustainability of quality of life investments based on the digital transformation [version 1; peer review: awaiting peer review]

Sergey Evgenievich Barykin¹, Sergey Mikhailovich Sergeev²,
Irina Vasilievna Kapustina¹, Elena de la Poza³,
Larisa Nikolaevna Borisoglebskaya⁴, Daria Varlamova⁵,
Marianna Serezhaevna Ovakimyan ⁶, Anna Evgenievna Karmanova¹

¹Graduate School of Service and Trade, Peter the Great St. Petersburg Polytechnic University, St. Petersburg, 195251, Russian Federation

²Graduate School of Industrial Management, Peter the Great St. Petersburg Polytechnic University, St. Petersburg, 195251, Russian Federation

³Universitat Politècnica de València, Valencia, Spain

⁴Orel State University, Orel, 302026, Russian Federation

⁵Faculty of Technological Management and Innovations, Saint Petersburg National Research University of Information Technologies, Mechanics and Optics University ITMO, 197101 St. Petersburg, 197101, Russian Federation

⁶International Economy Department, Moscow State Institute of International Relations (University), Moscow, 119454, Russian Federation

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Abstract

Background: In this paper, the problem of sustainability of investment activity in the direction of the high yield investment program is considered. In these financial instruments, large amounts of money are accumulated, consisting of contributions from the vast majority of the population. For example, pension funds inherent in most developed countries, insurance institutions, *etc.*, can be indicated. Accordingly, the social significance of their activities and the impact on the quality of life of all segments of the population increase.

Methods: This article outlines the methods and results aimed at the digital transformation of methods for forecasting long-term institutional investments. The authors use the method of mathematical modeling of the dynamics considering that the sustainability calculation must assume that the life cycle of citizens providing contributions is limited. The parameters of the distribution of the duration of the accumulation phase over the array of people and the time of life in the subsequent period are known. For mathematical modeling, the researchers divide the players by the time they have been present on the market.

Results: The authors have developed a mathematical model in the

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form of a set of algorithms for calculating the sustainability of long-term institutional investments with reference to life quality indicators.

Conclusions: The need to develop a methodology for assessing sustainability is dictated by the increased role of digital technologies and the ability to receive the most relevant information for analysis online.

Keywords

Investment Activity, Investment Project, Financial Risk, Financial Markets



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Corresponding author: Sergey Evgenievich Barykin (sbe@list.ru)

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Introduction

Mathematical models designed to forecast the dynamics of investment projects with risky returns are necessary for socially responsible activities.¹ The considered activities aimed at maintaining or improving the quality of life of the population. This applies, primarily to certain groups of society such as the elderly, and others in need of social protection, youth, women, and minors.^{2,3}

Long-term planning distinguishes the operation of such institutional investors like pension funds. These financial players differ in their incomparably longer business cycles from other market participants such as the manufacturing sector, trade in goods and services to the population.² In addition, being socially oriented subjects and the tasks of making a profit, they consider the sustainability of development of the society and maintenance of the quality of life to be the most critical priority.¹⁻³ Such institutional investors in the world have a significant impact on the business climate due to the scale of their activities.⁴ Over the following decades, they are among the top participants in NYSE (The New York Stock Exchange), SSE (Shanghai Stock Exchange), and LSE (London Stock Exchange) securities markets and stand out on the Tokyo Stock Exchange. This research outlines the methods and results aimed at the digital transformation of methods for forecasting long-term institutional investments.¹⁻³ The considered global institutional investors could include such as BlackRock Vanguard Asset Management, State Street Global Advisors, BNY (Bank of New York) Mellon Investment Management EMEA (Europe, the Middle East and Africa) Limited, J.P. Morgan Asset Management, PIMCO (Pacific Investment Management Company), Capital Group, Prudential Financial, Inc., Goldman Sachs Asset, Management International, Amundi Asset Management etc.

The most significant benefit to the study is brought by mathematical modeling with the use of computer calculations. This is because it becomes possible to replicate the results and implement the obtained algorithms as part of expert systems and automated software systems for consulting specialists and helping in making decisions. Regardless of their activity area, the sustainability calculation must assume that the life cycle of citizens providing contributions is limited. Also, from statistical reports regularly maintained by governmental organizations, the parameters of the distribution of the duration of the accumulation phase over the array of people and the time of life in the subsequent period are known.⁴ The authors are trying to show that the point of the maximum value of profit is one of the reference indicators. The considered indicator makes the great impact on the relevant investment decision.

Methods

When developing a mathematical description of the activities of institutional investors, it is necessary to consider the fundamental factor related to the business planning horizon. The basis of mathematical formalisms in this paper is the dynamic analysis of projects classified as the high yield investment program (HYIP).

The main similarity in digital transformation is noticeable in such criteria as the global use of Internet platforms using Web 4.0 technologies.⁵ An additional driver was transferring the services online during the pandemic and the resulting new opportunities to attract the broad masses of citizens to the activities of institutional investors. Also, the development of such projects is facilitated by the widespread introduction of online money transfer systems, anonymous payment systems, cryptocurrency technologies, and the availability of investment programs of the leading banks.⁶⁻⁸

The next feature of the operation conditions of an institutional financial player is the significant values of dispersion when calculating the distribution function of the time of reaching the threshold for payments to investors of HYIP projects. Consequently, a part of the assets must have high liquidity. But on the other hand, institutional participants use the second feature, which is the most extended activity horizon in terms of time, and can use low liquidity instruments due to the low probability of occurrence of circumstances forcing them to sell ahead of schedule. Combining these factors increases sustainability through risk diversification. The authors assume that a significant number of investors needs the assessment of the risks of entering the project. The authors are trying to show that the point of the maximum value of profit is one of the reference indicators. Meanwhile, the investor's choice depends on this indicator.

Results

For our mathematical modeling, we will divide the players by the time they have been present on the market. A very high percentage of profitability distinguishes the so-called fast HYIPs, but the duration of their activity is minimal. This puts them in the category of risky investments, more like gambling. More common is the long-term HYIP type with a meager interest rate and terms of deferred payment.⁹

We define the arguments of the mathematical model as:

$i\%$ is the regular rate of return; k means the sequence number of the payment period, meets the condition $k = 1, 2, \dots, K$; p is the volume of investment; $F(k)$ is the number of participants making contributions to the project; $S(k)$ is the total

amount of the project; $P(k)$ is the amount of project funds available during the period of activity with the sequence number k ; K means the overall planning horizon of the project. In this presentation, the indicator i is not the traditional annual interest rate but the widely varying interest rate for the period specified by the investment conditions adopted in HYIP calculations. If it is necessary to compare the requirements provided by different projects, we use the calculation of the practical value according to the nominal value by the following formula that returns the effective annual interest rate:

$$EFFECTIVE(i^*360/\omega;360/\omega),$$

where ω indicates the period of compounding interest in days in the 360 days year using the American NASD method (National Association of Securities Dealers).¹⁰

Let's calculate the variant of the linear dependence number of participants $F(k)$, while the number of investors involved in the project on an accrual basis is equal to M , then the following expression for the total amount $S(k)$ is true:

$$S(k) = M^*p - M^*p^*(k - 1)*i\%$$

Since the break-even operation is necessary, (because it is necessary to avoid losses with a negative ratio of attracted and paid funds) it follows the restriction $S(k) > 0$ that the inequality $k < 1 + i^{-1}$ is satisfied. We take the integer part of this result to calculate the project's duration because the calculation needs an integer: $K = entier(1 + i^{-1})$.¹¹ This is the break-even time of the project. Accordingly, it is possible to calculate the maximum possible total amount of money at the project's disposal P_{max} . To do this, we use the well-known formula for calculating an arithmetic progression for the considered sum.¹²⁻¹⁴

$$P(k) = \sum_{t=1}^k S(t) = \sum_{t=1}^k (M^*p - M^*p^*(t - 1)*i).$$

where t means summation index.

Since this progression is equal to: $P(k) = M^*p^* \left[k - i^{\frac{k*(k-1)}{2}} \right]$, then using the available duration K , as a result we get the value of maximum possible total amount of money P_{max} :

$$P_{max} = M^*p^* entier(1 + i^{-1})/2.$$

The distinctive features distinguishing the fast and long term HYIPs are immediately visible.¹⁵ Indeed, when $i\%$ decreases, the income increases. But on the other hand, the attractiveness of such projects is decreasing, limiting the possibility of lowering the rate.^{13,14}

For an ordinary participant, an unprepared investor, a methodology for assessing the risks of entering such projects is necessary.¹⁶⁻¹⁸ For this, a mathematical model of the dynamics of HYIP programs is proposed. For illustration purposes, Figure 1 shows the calculation of $P(K)$ in the case of linear modeling of number of investors (participants) for a quantity

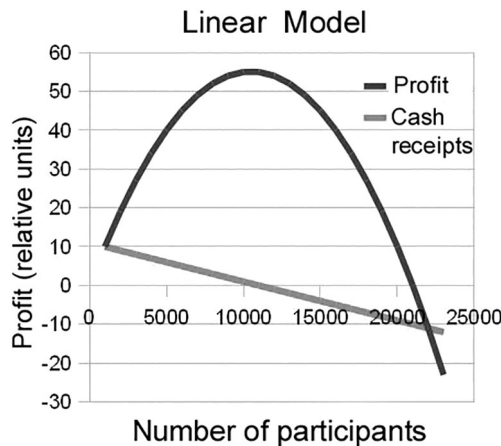


Figure 1. Maximum possible total amount of money using computer linear model of increasing number of participants.

of participants below 20 000. Cash receipts line reflects the difference between the income of the investors' sums and the amounts payable to investors.

Such a simple approximate calculation gives a general idea of the process dynamics and allows to estimate the period of profit zeroing. This point of the maximum value of profit calculated either by taking the first derivative, or on a computer, is essential for decision-making and risk assessment.¹⁹⁻²¹ For long periods of project operation, it is recommended to use other calculation conditions. For example, the Verhulst method is standard in economic calculations.^{22,23}

We then carried out the analysis with two types of dependency of changes in the number of investors of the following type:

1. growth in geometric progression, the denominator of which is equal to q ($q > 1$)
2. by Verhulst's S-dependency $F(k) = \theta F_0 e^{\gamma k} / [\theta + F_0 (e^{\gamma k} - 1)]$ where (F_0 is the starting pool of participants, γ reflects the equivalent of the value q , which allows comparing two types of processes, θ is the potential volume of the pool of investors).

The calculation results are shown in Figure 2 and show that these two types of dependencies show similar dynamics at the initial stage (both curves could look similar). The calculation was carried out using a computer for a geometric progression and for Verhulst's S-dependency.

So, the obtained result allows one to carry out the calculation using a geometric progression and present the formulas in an analytical form. The analysis begins with determining the volume of funds in the amount of $F_0 * p^k * q^{k-1}$ raised during the period k . Next, we determine the payments in the period k to the project participants.^{24,25} Their number for the previous $k - 1$ periods is calculated^{22,23} using the well-known formula for geometric progression: $F_0 \sum_{t=1}^{k-2} q^t$. Profitability condition is formulated as:

$$F_0 * p^k * q^{k-1} > i^* p^* F_0 \sum_{t=1}^{k-2} q^t \tag{1}$$

where t means summation index.

For a significant number of investors, it is necessary to be able to assess the risks of entering the project. One of the reference indicators is the point of the maximum value of profit. Knowing this indicator makes it possible to take a balanced approach to choosing the investment direction. For determination, the following calculation method can be used.

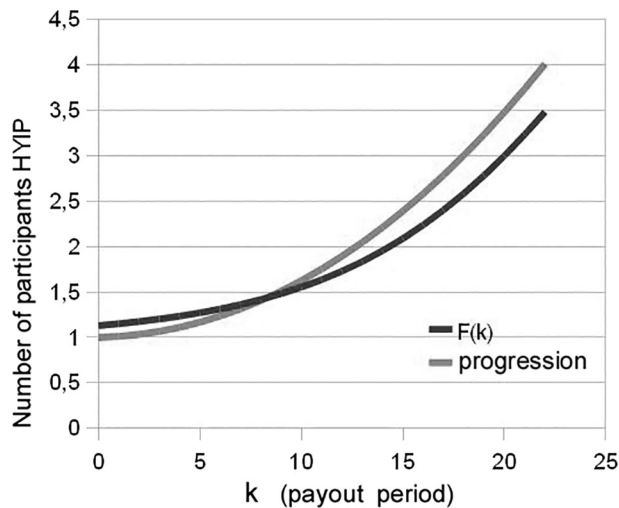


Figure 2. Comparison of non-linear dependencies for geometric progression and for Verhulst's S-dependency $F(k)$.

Calculating the sum of the progression in the equation by using the well-known formula for geometric progression:

$$i^* p^* M \sum_{t=1}^{k-2} q^t = i^* p^* M^* \frac{q^{k-1} - 1}{q - 1}.$$

Then we can formulate the break-even condition:

$$\frac{1}{q^{k-1} - 1} > \frac{i}{q - 1} - 1 \quad (2)$$

Additionally, from the conditions $q > 0$ and $k > 1$, it follows that: $q^{k-1} - 1 > 0$.

Hence, it is clear that the left side of [equation \(2\)](#) is always greater than zero. Let's carry out the transformation and analysis of its right side.^{26–29}

In case if the relation is fulfilled: $\frac{i}{q-1} - 1 < 0$, or, which is the same: $i < q - 1$, the break-even indicators are always met. In reality, this corresponds to an increase in money that exceeds the amount of interest paid. The sum $P(k)$ increases as long as the relation is fulfilled: $i < q - 1$.

On the other hand, the number of investors, especially those interested in a particular project, is limited. This condition is met only at the initial stage.^{30–32}

In the case $i > q - 1$, for a sufficiently large k , inequality² is no longer fulfilled due to the growth of the summand q^{k-1} included in the denominator. The solution of [equation \(2\)](#) concerning an unknown argument k leads to the following calculations:

$$q^{k-1} > i^* \frac{q^{k-1} - 1}{q - 1}$$

from this expression, carrying out a conversion of type:

$$q^{k-1} > \frac{i}{q-1} q^{k-1} - \frac{i}{q-1},$$

we obtain: $q^{k-1} \left(\frac{i-q+1}{q-1} \right) < \frac{i}{q-1}$.

By an algebraic substitution, we have the following condition: $k - 1 < \log_q \left(\frac{i}{i-(q-1)} \right)$.

This makes it possible to calculate the break-even parameters by solving the inequality:

$$k < \frac{\ln \frac{i}{i-(q-1)}}{\ln q} + 1. \quad (3)$$

Calculation by [formula \(3\)](#) gives the desired value of the considered point of the maximum value.

Conclusions

The article outlines the methods and results aimed at the digital transformation of methods for forecasting long-term institutional investments. The mathematical formalisms^{1–3} are of great practical importance. To restore the dynamics of HYIP projects, it is enough to get several slices of economic indicators. This can be implemented in software in the form of a decision-making system. The advanced planning algorithm can be immediately applied since payments are made online and using the digital trail in most high-yield projects. On the one hand, this will reduce the risks for investors.

On the other hand, carrying out such analysis regarding its sustainability will enable project organizers to conduct business more confidently. Since this segment of economic relations affects a significant proportion of the population, the confident operation also has a severe social effect. It belongs to the system of life quality indicators.

Author contributions

Sergey Evgenievich Barykin; Original draft, conceptualization, methods; Sergey Mikhailovich Sergeev: Formal analysis, investigation; Irina Vasilievna Kapustina: validation, visualization; Elena de la Poza: Data curation, reviews, editing,

formal analysis; Larisa Nikolaevna Borisoglebskaya: Resources, supervision, visualization; Daria Varlamova: Resources, software; Marianna Serezhaevna Ovakimyan: Data curation, formal analysis, software; Anna Evgenievna Karmanova: software, validation, formal analysis. All author agreed to the published version of the manuscript.

Data availability statement

Underlying data

figshare: Barykin, Sergey (2022): Figures (Linear & Non-linear).xlsx. <https://doi.org/10.6084/m9.figshare.20407509.v1>.³³

This project contains the following underlying data:

- Figures.xlsx

References

1. Kurochkina A, Semenova Y, Lukina O, et al.: **Digital totalitarianism - from Homo sapiens to "one-button man."** Kankhva V, editor. *E3S Web Conf.* 2021 May; **258**: 07055.
2. Korchagina E, Bochkarev A, Bochkarev P, et al.: **The treatment of optimizing container transportation dynamic programming and planning.** Rudoy D, Murgul V, editors. *E3S Web Conf.* 2019 Dec 4; **135**: 02016. [Publisher Full Text](#)
3. Bril A, Evseeva S, Kalinina O, et al.: **Personnel changes and labor productivity in regulatory budget monitoring.** *IOP Conf Ser Mater Sci Eng.* 2020 Sep 1; **940**(1): 012105. [Publisher Full Text](#)
4. Daniali SM, Barykin SE, Kapustina IV, et al.: **Predicting Volatility Index According to Technical Index and Economic Indicators on the Basis of Deep Learning Algorithm.** *Sustainability.* 2021 Dec 19; **13**(24): 14011. [Publisher Full Text](#) | [Reference Source](#)
5. Sergeev S, Kirillova T.: **Information support for trade with the use of a conversion funnel.** *IOP Conf Ser Mater Sci Eng.* 2019 Oct; **666**(1): 012064.
6. Zabala AF: **Impact of international organizations on the institutional development of investment activity.** *Eur Res Manag Bus Econ.* 2022 Sep; **28**(3): 100191. [Publisher Full Text](#)
7. Čamaj J, Nedeliaková E, Šperka A, et al.: **The Planning of Investment Activities in Field of Railway Transport with Support of Simulation Tools.** *Transp Res Procedia.* 2021 Jan; **53**: 39–49. [Publisher Full Text](#)
8. Przybyla K, Kachniarz M, Ramsey D: **The investment activity of cities in the context of their administrative status: A case study from Poland.** *Cities.* 2020 Feb; **97**: 102505. [Publisher Full Text](#)
9. Kalinina O, Buniak V, Golubnichaya G, et al.: **Economic features of investment nature of energy-saving projects in Russia.** Kalinina O, editor. *E3S Web Conf.* 2019 Aug; **110**: 02089.
10. Konopik J, Jahn C, Schuster T, et al.: **Mastering the digital transformation through organizational capabilities: A conceptual framework.** *Digit Bus.* 2022; **2**(2): 100019. [Publisher Full Text](#)
11. Arribas I, Espinós-Vañó M, García F, et al.: **The Inclusion of Socially Irresponsible Companies in Sustainable Stock Indices.** *Sustainability.* 2019 Apr; **11**(7): 2047. [Publisher Full Text](#)
12. Espinoza R, Presbitero AF: **Delays in public investment projects.** *Int Econ.* 2021 Oct. [Publisher Full Text](#)
13. Qiao H, Wen S, Wu L, et al.: **Research on wind power project investment risk evaluation based on fuzzy-gray clustering trigonometric function.** *Energy Rep.* 2022 Aug; **8**: 1191–1199. [Publisher Full Text](#)
14. Bangjun W, Feng Z, Feng J, et al.: **Decision making on investments in photovoltaic power generation projects based on renewable portfolio standard: Perspective of real option.** *Renew Energy.* 2022 Apr; **189**: 1033–1045. [Publisher Full Text](#)
15. Martin K, Shilton K, Smith J: **Business and the Ethical Implications of Technology: Introduction to the Symposium.** *J Bus Ethics.* 2019; **160**: 307–317. Springer. [Publisher Full Text](#)
16. Todorov TS: **Evaluating Project and Program Management as Factor for Socio-economic Development within EU.** *Procedia Soc Behav Sci.* 2014 Mar; **119**: 819–828. [Publisher Full Text](#)
17. Kaklauskas A, Zavadskas EK, Radzeviciene A, et al.: **Quality of city life multiple criteria analysis.** *Cities.* 2018 Feb; **72**(June 2017): 82–93. [Publisher Full Text](#)
18. Mostafa F, Dillon T, Chang E: **Computational Intelligence Approach to Capturing the Implied Volatility.** *IFIP Advances in Information and Communication Technology.* New York LLC: Springer; 2015; pp. 85–97.
19. Gilchrist S, Wei B, Yue VZ, et al.: **Sovereign risk and financial risk.** *J Int Econ.* 2022 Mar; **136**: 103603. [Publisher Full Text](#)
20. Edin P-A, Selin H: **Financial Risk-Taking and the Gender Wage Gap.** *Labour Econ.* 2022 Apr; **75**: 102144. [Publisher Full Text](#)
21. Liu F, Zhang Y, Li L: **Review of Systematic Financial Risk Research Based on Knowledge Map.** *Procedia Comput Sci.* 2022 Jan; **199**: 315–322. [Publisher Full Text](#)
22. Rădulescu CZ, Rădulescu M, Alexandru A, et al.: **A multi-criteria weighting approach for Quality of Life evaluation.** *Procedia Comput Sci.* 2019; **162**(Ictqm 2019): 532–538. [Publisher Full Text](#)
23. Menzefricke JS, Wiederkehr I, Koldewey C, et al.: **Socio-technical risk management in the age of digital transformation-identification and analysis of existing approaches.** *Procedia CIRP.* 2021; **100**: 708–713. [Publisher Full Text](#)
24. Waschull S, Bokhorst JAC, Wortmann JC, et al.: **The redesign of blue- and white-collar work triggered by digitalization: collar matters.** *Comput Ind Eng.* 2022 Mar; **165**(January): 107910. [Publisher Full Text](#)
25. Duygan M, Fischer M, Pärli R, et al.: **Where do Smart Cities grow? The spatial and socio-economic configurations of smart city development.** *Sustain Cities Soc.* 2022 Feb; **77**(April 2021): 103578. [Publisher Full Text](#)
26. Chen Z, Zhuang X, Liu J: **A Sustainability-Oriented Enhanced Indexation Model with Regime Switching and Cardinality Constraint.** *Sustainability.* 2019 Jul; **11**(15): 4055. [Publisher Full Text](#)
27. Patel R, Goodell JW, Oriani ME, et al.: **A bibliometric review of financial market integration literature.** *Int Rev Financ Anal.* 2022 Mar; **80**: 102035. [Publisher Full Text](#)

28. Crimmel J, Elyasiani E: **The association between financial market volatility and banking market structure.** *Q Rev Econ Finance.* 2021 Nov; **82**: 335–349.
[Publisher Full Text](#)
29. Boamah NA: **Segmentation, business environment and global informational efficiency of emerging financial markets.** *Q Rev Econ Finance.* 2022 May; **84**: 52–60.
[Publisher Full Text](#)
30. La Torre M, Sabelfeld S, Blomkvist M, *et al.*: **Rebuilding trust: sustainability and non-financial reporting and the European Union regulation.** *Meditari Account Res.* 2020 Aug; **28**(5): 701–725.
[Publisher Full Text](#)
31. Lorentzen A-CR: **Digital transformation as distributed leadership: Firing the change agent.** *Procedia Comput Sci.* 2021; **2022**(196): 245–254.
32. Ullah S, Khan U, Rahman KU, *et al.*: **Problems and Benefits of the China-Pakistan Economic Corridor (CPEC) for Local People in Pakistan: A Critical Review.** *Asian Perspect.* 2021; **45**(4): 861–876.
[Publisher Full Text](#)
33. Barykin S: **Figures (Linear & Non-linear).** .xlsx. figshare. [Dataset]. 2022.
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