

MANAGING EDUCATIONAL DETERMINANTS OF FINANCIAL INCLUSION AS A KEY FACTOR OF SUSTAINABLE DEVELOPMENT: LOGIT-PROBIT MODELING

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Abstract: This article is devoted to the question of identifying the relationship between the dimensions of formal education in the country and the level of its financial inclusion. To achieve it, logit-probit modeling was used between the integral indicator of financial inclusion, based on principal-component factors calculation, and various dimensions of education. Ninety-three countries with different levels of socio-economic development were chosen as the object of the study. As a result, the positive statistically significant influence of such determinants as financial literacy, duration of compulsory education, government expenditure on education, pupil-teacher ratio, school enrollment at the secondary level was confirmed. School enrollment at the primary level had a negative influence on financial inclusion. This vector of research will allow to form the main directions of management of educational determinants of financial inclusion, which are important vectors of reforming the education system and ensuring financial inclusion at the national level.

Keywords: managing, education, financial inclusion, sustainable development goals, logit-probit modeling

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Introduction

Financial inclusion is a complex concept that identifies the use of financial services and the willingness of consumers to be active users of the financial services market. Their financial decisions, among other things, depend on the population's income and the country's welfare. For any state, ensuring financial inclusion is one of the

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most critical issues because it improves social well-being and provides economic resilience. In addition, many studies note the unique role of financial inclusion in achieving most of the goals of sustainable development, which is one of the main guidelines of this millennium.

According to the World Bank, about 80% of the world's population now has a bank account. In addition, more than 70% use a mobile phone or other digital devices to carry out various financial transactions. However, these quantitative indicators do not guarantee the correctness of financial decisions. The critical factor in this context is the level of financial literacy.

Financial literacy of the population involves a set of knowledge and skills that will help a person make effective financial decisions with minimal risks. At the same time, the formation of financial literacy is usually given insufficient attention in formal education, usually relying on unsystematic informal educational activities.

All this allows us to formulate the purpose of this study, which involves identifying the relationship between the dimensions of formal education in the country and the level of financial inclusion using logit-probit modeling. The revealed regularities will make it possible to form the main directions of managing educational determinants of financial inclusion, which are essential vectors of reforming the education system and ensuring financial inclusion at the country level.

Literature Review

The problem of lack or limited access to financial services among the population, primarily due to low financial literacy, has been widely discussed in recent years in the scientific community (Bakari et al., 2018; Stefan et al., 2020). Its solution is possible by ensuring the so-called "financial inclusion" of the population (Kuzmenko et al., 2021b) which is associated with achieving of sustainable development goals (Kobushko et al., 2021). Its implementation depends on the level of the country's financial system development (Kaya, 2020; Kliestik et al., 2018; Lyulyov et al., 2021, Rekunen et al., 2022) and its macroeconomic and institutional stability (Kliestik et al., 2020b), economic and marketing attractiveness, investment position (Moskalenko et al., 2022), migration drivers (Kwilinski et al., 2022; Kuzior and Lobanova, 2021) and HR management in different areas (Ziabina et al., 2021, Kuzior et al., 2022). The situation became especially relevant in the conditions of the spread of the COVID-19 pandemic, which, due to numerous restrictions, required more active financial inclusion of the population to maintain business activity (Boronos et al., 2020, Kuzior et al., 2022b).

In order to manage financial inclusion, it is necessary to identify its main determinants. A study by Bakari, Idi and Ibrahim on identifying key determinants of financial inclusion for ten African countries identified the following: mobile banking, bank branch, political stability, interest rate and inflation (Bakariet et al., 2018). In addition, domestic and international remittances (Gatsi, 2020) are among the individual factors in the development of financial inclusion.

At the same time, the rapid development of the financial market and its instruments only deepens the illiteracy of the population in the use of financial services. These include the digitalization of most services in the context of industry 4.0 development and Smart City (Andrulevicius et al., 2020; Wang et al, 2022, Kuzior et al., 2021, 2022a, Bagińska 2022. Mańka-Szulik and Krawczyk, 2022) and additive economy establishment (Melnyk et al, 2022), the emergence of new forms interactions: microfinance (Abeysekera, 2020; Samusevych et al., 2021; Tiutiunyk et al., 2021), blockchain technologies, artificial intelligence (Bilan et al., 2022; Kuzmenko et al., 2021a, Kwilinski, 2019) and the Internet of Things (Lopez and Alcaide, 2020), responsible forms of investment (Yelnikova and Golochalova, 2020, Serpeninova et al., 2020), insurance market indices (Kozmenko et al., 2009) etc.

To solve the problem of financial inclusion and ensure financial literacy of the population, scientists propose to develop the educational component. Also, the role of education cannot be underestimated, as numerous works confirm its positive impact on socio-economic relations (Krajňáková et al., 2020) and achieving the goals of sustainable development (Kuznyetsova et al., 2022; Djalilov and Hartwell, 2021; 2022). In this context, numerous works are devoted to the modernization of the existing educational system due to the development of knowledge economy (Polyakov et al., 2019) and deterioration of the quality of educational services provided (Artyukhov et al., 2021, 2022; Volk et al., 2021, Polyakov et al., 2020, Ulewicz 2014). The main proposed areas of transformation are the transition to a model of lifelong learning (Voronkova et al., 2018;), the development of forms of distance education (Nazneen et al., 2020; Ober and Kochmańska 2022), the establishment of a dual relations system (Buchynska et al., 2020) and innovative ecosystems (Gontareva et al., 2022, Grebski and Mazur, 2022), prioritization of internal performance appraisal changing socio-psychological approaches in the learning process (Voronkova et al., 2019; Yu Sing, 2018; Smiiianov et al., 2020), strengthening control over the distribution of budget funds (Kuznyetsova et al., 2021), etc. Thus, in separate researches both development of financial (Świecka et al., 2019, Mihalcova et al., 2020) and general education is considered. The significant influence of education on the financial inclusion of the population is especially evident in developing countries. This is confirmed in the studies of Bakhshi and Agarwal (2020) in the example of India and Kehinde and Phillip (2020) in Kenya.

On the basis of these studies, it is proposed to form the following working hypothesis:

H1: the development of key formal educational determinants determines the positive dynamics of the financial inclusion of the population in European countries.

This analysis will be conducted using the integral indicator of financial inclusion and the binary logit-probit model.

Fernando et al., 2012 used the method of modified factor analysis to calculate the integral indicator of the financial inclusion of the population. A group of scientists determined the urbanization index of a specific region using this approach. With the

help of modified factor analysis, specific weights were obtained for each indicator variable. An index of the territory's urbanization level was also determined. OECD experts in 2008 used the method of modified factor analysis for construction and use of integrated indicators for politicians, scientists, the media, and other interested parties.

It is very convenient to use binary models when estimating the occurrence or non-occurrence of a particular event when one of the independent factors is changed or added. Generally, there are two main choice models: a threshold model and a model based on determining the usefulness of the studied alternatives. The second model is reduced to the appearance of the first. Many studies by such scientists as Davis and Karim, 2008a, 2008b; Demirgüç-Kunt and Detragiache, 2005 used threshold models with a logistic distribution of deviations to assess the relationship between the onset of a financial crisis and a change in the leading economic indicators. A model of this type began to be called a logit model in contrast to models with a normal distribution of deviations, called probit models. In our situation, the objective function can take on only two values: 1 – in the case of above-average importance of financial inclusion of the population or 0 – in the opposite case, so the model will be called a "binary logit model".

Research Methodology

The following array of input data was formed to achieve the set goal and test the working hypothesis (Table 1). The first block includes nine indicators of financial inclusion, which will be transformed into an integral indicator in the form of a binary variable.

Table 1. Array of input data

Parameter	Symbol	Source
Financial inclusion indicators		
Account (% age 15+)	<i>f1</i>	World Bank database
ATMs per 100,000 adults	<i>f2</i>	World Bank database
Branches per 100,000 adults	<i>f3</i>	World Bank database
Deposit accounts per 1,000 adults	<i>f4</i>	World Bank database
POS terminals per 100,000 adults	<i>f5</i>	World Bank database
Outstanding loans per 1,000 adults	<i>f6</i>	World Bank database
Used the internet to pay bills or to buy something online in the past year, older adults (% age 25+)	<i>f7</i>	World Bank database
Credit card ownership, older adults (% age 25+)	<i>f8</i>	World Bank database
Made or received digital payments in the past year, older adults (% age 25+)	<i>f9</i>	World Bank database
Educational determinants		
Compulsory education, duration (years)	<i>comped</i>	World Bank database
Government expenditure on education, total (% of GDP)	<i>govexp</i>	World Bank database

Pupil-teacher ratio, primary	<i>ptrpr</i>	World Bank database
Pupil-teacher ratio, secondary	<i>ptrsec</i>	World Bank database
Pupil-teacher ratio, tertiary	<i>ptrter</i>	World Bank database
School enrollment, primary (% gross)	<i>sepr</i>	World Bank database
School enrollment, secondary (% gross)	<i>sesec</i>	World Bank database
School enrollment, tertiary (% gross)	<i>seter</i>	World Bank database
Financial literacy	<i>FL</i>	World Bank database

Source: World Bank Databases (G20 Financial Inclusion Indicators, Global Findex Database, World Development Indicators)

As practice confirms, it is always technically quite challenging to model a binary function that depends on continuous arguments. In this case, an uncertain variable is used to predict a binary variable, taken on the interval from 0 to 1. Suppose the obtained value of the variable is in the interval from 0 to 0.5. In that case, it is assumed that an event has occurred, which corresponds to a zero value. In our case - this signals a low level of financial inclusion of the population. Suppose the calculated value is equal to or greater than 0.5. In that case, an event with a value of 1 has occurred. It identifies a high level of financial inclusion of the population.

The second block includes the main indicators of formal education in the country, which are the model's independent variables.

In the geographical dimension, 93 countries with different levels of socio-economic development were covered. The time period of the study was chosen in 2017. A research period is determined by the availability of all statistical data involved in the analysis. In particular, the source of educational determinants was World Bank Databases, World Development Indicators, indicators of financial inclusion of the population from World Bank Databases, G20 Financial Inclusion Indicators, and the Global Findex Database in 2017. Also, the population's financial literacy level was modeled for 2017 on the base of the annual reports of the OECD because there is an open date only for 2014.

All calculations in the work were performed in the STATA/SE software complex. The integrated level of financial inclusion is determined by the method of the principal-component factors (PCF). Factor loads are used to calculate the weight of every variable. For this purpose, the following formula (1) is used:

$$w_i = \frac{f_i * d_k}{\sum_k f_i * d_k}, \quad (1)$$

Source: OECD, 2008

where

w_k – weight of i -indicator;

f_k – factor load of i -indicator;

d_k – share of general dispersion of k -factor.

The integrated indicator, which describes financial inclusion is calculated by the following formula (2)

$$I_{lm} = \sum \bar{y}_{ij} * w_i, \quad (2)$$

where I_{lm} – integral indicator, which describes financial inclusion during j -year.
Source: OECD, 2008

To formalize the impact of educational determinants on the level of financial inclusion, the logit (3, 4) and the probit models (3, 5) are using.

$$\text{Logit/Probit} = b_0 + b_1X_1 + \dots + b_nX_n + \varepsilon, \quad (3)$$

$$Y(\text{Logit}) = \frac{\exp(b_0 + b_1X_1 + \dots + b_nX_n)}{1 + \exp(b_0 + b_1X_1 + \dots + b_nX_n)}, \quad (4)$$

$$Y(\text{Probit}) = \frac{1}{\sqrt{2\pi}} \exp^{-\frac{1}{2}} (b_0 + b_1X_1 + \dots + b_nX_n), \quad (5)$$

Source: Demirgüç-Kunt and Detragiache, 2005

The model is then estimated using the maximum likelihood method. To analyze the relationship between financial inclusion and educational determinants, the empirical model estimated is (6):

$$\begin{aligned} \text{Logit/Probit} = & b_0 + \text{comped}X_1 + \text{govexp}X_2 + \text{ptrpr}X_3 + \\ & + \text{ptrsec}X_4 + \text{ptrter}X_5 + \text{sepr}X_6 + \text{sesec}X_7 + \text{seter}X_8 + \text{FLX}_9 + \varepsilon, \end{aligned} \quad (6)$$

Source: Demirgüç-Kunt and Detragiache, 2005

Research Results

In the first step of the research, we will analyze the input array of data for the block of financial inclusion using descriptive statistics (Table 2).

Table 2. Descriptive statistics for financial inclusion parameters

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>f1</i>	93	66.78	25.91	0.15	99.92
<i>f2</i>	93	59.61	42.44	1.27	227.82
<i>f3</i>	93	16.68	11.65	0.45	58.59
<i>f4</i>	93	1459.10	1031.93	28.00	7263.99
<i>f5</i>	93	1514.10	1015.77	2.20	4422.10
<i>f6</i>	93	2162.10	9584.96	2.12	85982.65
<i>f7</i>	93	0.32	0.28	0.00	0.90
<i>f8</i>	93	0.25	0.23	0.00	0.87
<i>f9</i>	93	0.62	0.27	0.05	1.00

Source: Own calculations

The value of the determinants of financial inclusion for the studied sample of countries shows a wide range between the minimum and maximum values. This is primarily determined by the economic level of development in these countries. The higher the level of economic development, the higher the value of the financial inclusion of the population.

The intermediate results of the factor analysis used to calculate the weights when forming the integral indicator are shown in Table 3.

Table 3. Factor analysis results after rotation for calculating financial inclusion parameters weight

Factor	Variance	Difference	Proportion	Cumulative	Variable weight
Factor1	4.316	2.697	0.480	0.480	
Factor2	1.619		0.180	0.659	
Rotated factor loadings (pattern matrix) and unique variances					
Variable	Factor1	Factor2	Uniqueness		
<i>f1</i>	0.888	0.211	0.167		0.164
<i>f2</i>	0.540	0.602	0.347		0.042
<i>f3</i>	0.186	0.798	0.328		0.055
<i>f4</i>	0.340	0.585	0.542		0.041
<i>f5</i>	0.701	0.208	0.466		0.129
<i>f6</i>	0.370	-0.279	0.785		0.068
<i>f7</i>	0.911	0.083	0.164		0.168
<i>f8</i>	0.866	0.243	0.191		0.160
<i>f9</i>	0.937	0.216	0.075		0.173

Source: Own calculations

As a result, an integrated indicator of financial inclusion (FI) is formed. If the actual value $FI \geq 0.5$, then the binary variable Logit / Probit corresponds to 1; if $FI \leq 0.5$ - 0. According to this condition, the countries are grouping in table 4.

Table 4. Integrated level of financial inclusion distribution

0 level (less than 0.5)	1 level (more than 0.5)
Afghanistan, Albania, Algeria, Argentina, Australia, Bosnia and Herzegovina, Cambodia, Canada, Estonia, Hungary, Indonesia, Ireland, Latvia, Lesotho, Malaysia, Moldova, Nigeria, Norway, Panama, Philippines, Poland, Singapore, Sweden, Thailand, Vietnam, Zambia	Armenia, Austria, Belarus, Belgium, Bolivia, Brazil, Bulgaria, Burundi, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, France, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Honduras, India, Israel, Italy, Japan, Kazakhstan, Kenya, Korea, Kyrgyz Republic, Lebanon, Lithuania, Madagascar, Mauritius, Mexico, Namibia, Netherlands, Nicaragua, Pakistan, Papua New Guinea, Paraguay, Peru, Portugal, Romania, Russia, Rwanda, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Switzerland, Tajikistan, Tanzania, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan

Source: Own calculations

The result of the impact of educational determinants on the level of financial inclusion is presenting in table. 5.

Table 5. Logit/ Probit regression results

Educational determinants	Coef.	z	P> z	Coef.	z	P> z
	Logit model			Probit model		
comped	0.74	0.87	0.03	0.48	0.90	0.03
govexp	1.92	3.01	0.00*	1.15	3.15	0.00*
ptrpr	2.57	2.49	0.01*	1.46	2.58	0.01*
ptrsec	1.20	1.67	0.10	0.74	1.71	0.09
ptrter	1.18	1.29	0.20	0.73	1.32	0.19
sepr	-0.18	-0.55	0.04	-0.11	-0.55	0.04
sesec	1.60	2.26	0.02*	0.92	2.31	0.02*
seter	2.32	2.54	0.01*	1.39	2.60	0.01*
FL	10.19	4.76	0.00	5.61	5.39	0.00

Source: Own calculations

Increase of financial literacy, duration of compulsory education, government expenditure on education, pupil-teacher ratio, school enrolment in secondary and tertiary levels positively influence on the level of financial inclusion. The strongest statistically significant impact on financial inclusion is exerting by financial literacy. As the level of financial literacy increases by one unit, the value of financial inclusion will increase by 10.19 units. Next in strength is the relationship between the pupil-teacher ratio and financial inclusion. Increasing the ratio of pupils to teachers per unit increases financial inclusion by 2.57. The number of students enrolled in secondary and high school also has a positive and statistically significant effect on financial inclusion. The increase of school enrolment in tertiary level leads to a rise of financial inclusion by 2.32 units and in secondary level - by 1.6 units.

The increase of government expenditure on education leads to a rise of financial inclusion by 1.92 units and the increase of duration of compulsory education, leads to a rise of financial inclusion by 0.74. Finally, school enrollment in the primary level has a negative influence on financial inclusion. With an increase of this indicator per unit, the level of financial inclusion will fall by 0.18 units.

Conclusion

Thus, the study made it possible to confirm that managing the determinants of financial inclusion should begin with the definition of educational determinants. It was formalized the functional relationship between the population's financial inclusion and nine educational determinants by building logit and probit models.

The level of financial inclusion was estimated as integrated index, based on nine key indicators of financial inclusion of the population, which varies from 0 to 1. The value of the integral index is obtaining by the method of the principal-component factors. As a results of logit and probit models, the critical hypothesis about the importance of the impact of the educational component on financial inclusion is confirming.

The most substantial impact of financial literacy on the level of financial inclusion is quite clear. Financial literacy is an indicator of the readiness to be active consumers in the financial services market. The impact of financial literacy is the strongest of the selected set of educational determinants. State regulators of the financial sector need to pay maximum attention to improving the level of financial literacy. There is the positive effect of pupil-teacher ratio on the level of financial inclusion. This dependence is extremely paradoxical, as, in three of the five scientific developments, the increase in the number of students per teacher hurts the quality of knowledge. This result is causing by the limited conditions of modeling and may be the basis for further research. The negative impact of school enrollment in the primary level on the level of financial inclusion indicates that primary school pupils should not be involved in the financial services market at all or to a limited extent. This effect is due to the age restrictions of students on making the correct optimal decisions in the financial services market. The number of high school pupils and students has a strong positive effect on financial inclusion.

The results indicate that the dimensions of education significantly impact the formation of the population's financial inclusion, which is why it is necessary to pay considerable attention to the management of such determinants. As mentioned earlier, formal education has limited participation in the formation of financial literacy of the population. Therefore, from the side of the state, this component can be strengthened and considered in reforming the educational system. This is possible thanks to appropriate financial and personnel support.

Despite the obtained results, this article has certain limitations. First of all, they relate to the time period of the study. A thorough analysis can be carried out with big comparable data, but within the framework of this study, the financial inclusion and dimensions of education for such countries are available only for 2017. Another

limitation of this work is the absence of informal education indicators because these data are quite individual and are analyzed within the framework of separate individual projects at the country level. This problem does not make it possible to form a sufficient array of data for a large sample of countries. Despite the mentioned limitations, this study has scientific value because it made it possible to confirm the positive influence of educational determinants on financial inclusion in the country. This statement applies to the analyzed European countries and can be used in the process of reforming educational systems in order to ensure the financial inclusion of the population. Further research by the authors aims to trace the dynamics of such influence or its transformation in the conditions of geopolitical instability and the COVID-19 pandemic, which will be possible if more up-to-date statistical data are available.

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ZARZĄDZANIE EDUKACYJNYMI DETERMINANTAMI INTEGRACJI FINANSOWEJ JAKO KLUCZOWEGO CZYNNIKA ZRÓWNOWAŻONEGO ROZWOJU: MODELOWANIE LOGIT- PROBIT

Streszczenie: Niniejszy artykuł poświęcony jest zagadnieniu identyfikacji zależności pomiędzy wymiarami edukacji formalnej w danym kraju a poziomem jego integracji finansowej. W tym celu, zastosowano modelowanie logitowo-probitowe pomiędzy całkowitym wskaźnikiem integracji finansowej, opartym na kalkulacji czynników głównych, a różnymi wymiarami edukacji. Jako przedmiot badania wybrano dziewięćdziesiąt trzy kraje o różnym poziomie rozwoju społeczno-gospodarczego. W rezultacie potwierdzono pozytywny, statystycznie istotny wpływ takich determinant jak: świadomość finansowa, czas trwania edukacji obowiązkowej, wydatki rządowe na edukację, stosunek liczby uczniów do liczby nauczycieli, zapisy do szkół na poziomie średnim. Zapisanie do szkoły na poziomie podstawowym miało negatywny wpływ na integrację finansową. Ten wektor badań pozwoli na ukształtowanie głównych kierunków zarządzania edukacyjnymi determinantami integracji finansowej, które są ważnymi wektorami reformowania systemu edukacji i zapewnienia integracji finansowej na poziomie krajowym.

Słowa kluczowe: zarządzanie, edukacja, integracja finansowa, cele zrównoważonego rozwoju, modelowanie logit-probit

管理作为可持续发展关键因素的金融包容性的教育决定因素。logit-probit模型

摘要：本文致力于确定国家正规教育程度与金融包容性水平之间的关系问题。为了实现这一目标，在基于主成分因素计算的金融包容性综合指标和教育的各个维度之间采用了Logit-probit模型。选择了93个具有不同社会经济发展水平的国家作为研究对象。结果证实了金融知识、义务教育期限、政府教育支出、师生比例、中学入学率等决定因素在统计上的积极影响。小学阶段的入学率对金融包容性有负面的影响。这一研究方向将允许形成对金融包容性的教育决定因素进行管理的主要方向，这是改革教育系统和确保国家层面金融包容性的重要载体

关键词：管理、教育、金融包容性、可持续发展目标、logit-probit模型