

SCENARIO MODELING OF FRONTIER FINANCIAL MARKET DEVELOPMENT

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Abstract. *Purpose* – Hypothesis verification and quantification of the relationship between drivers and the resulting factors for a lasting impact on the long-term ICT development, globalization, structural changes in the geo-economy and changes in socio-ethical standards in society in the frontier financial markets.

Research methodology – Based on open source information, a database of almost 19,000 data was formed - 748 observations by country on 25 indicators. The simulation was performed on the basis of a mixed-model, which is a statistical model that is an extended version of the General Linear Model (GLM), using SAS / STAT® 13.1 software.

Findings – Based on the Solution for Fixed Effects and Solution for Random Effects and the test of fixed effects, globalization, economic dominance, economic growth and human development were identified as statistically significant patterns of transformation of frontier financial markets.

Research limitations – The paper does not attempt a comprehensive coverage of the topic. However, it identifies main drivers of the development of frontier financial markets and makes calls for further research.

Practical implications – The findings are likely to be useful for practitioners and researchers to gain knowledge about the main drivers of the frontier financial markets development.

Originality/Value – The application of the technique of multidimensional ranking of drivers has identified globalization, geoeconomic changes and human development as the most influential drivers for the development of frontier financial markets.

Keywords: mixed-model, financial assets market, financial market, frontier markets, ecosystem.

JEL Classification: G17, G23.

Conference topic: Contemporary Financial Management.

Introduction

The new millennium has been proved to be a period of development of revolutionary innovations and qualitative changes in the information, technological, institutional areas, and at the same time has become tangible for all world society. During this period changes in the financial markets took place in almost all its subsystems, which is characterized both of quantitative and qualitative nature. The financial markets entered a period of systemic transformation where the drivers and trends of this process are formed in and by the society.

Currently, scientists are actively studying the vector of transformation of financial markets and its impact on the economy and social sphere. In this context, the issues of modernization of approaches to the formation of the institutional dynamics of the financial assets market, the impact on the interaction of its actors are relevant. Accordingly, studies of the form of adaptive development of financial institutions and individuals to the conditions of systemic transformation of the financial assets market have become remarkable.

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The purpose of this article is to test the following hypothesis:

- the main factors influencing the ecosystem of the financial assets market in frontier markets are: the development of information and communication technologies (ICT development); globalization; shifts in the structure of geoeconomics and demography and social standards. The objectives of this article are to verify this hypothesis using mathematical and statistical modeling and quantification of the impact of these drivers on the transformation of financial asset markets in frontier markets, or in other words, quantification of the relationship between control (drivers) and the resulting model parameters.

The article is structured in the following way. Firstly, the background is presented that focuses on the processes of systemic transformations and drivers of changes in the ecosystem of financial markets. Secondly, the methodology of the study is described. Thirdly, the results of the simulation based on the mixed-model is summarized and visualized in the results and discussion parts. These are followed by the conclusion part.

1. Background

The existence of a correlation between economic growth and financial conditions was studied in the beginning of the 20th century (Mitchell, 1913; Clark, 1937). In fact, the idea of influencing real economic indicators through the channels of financial and monetary markets has become especially popular in the context of the Keynesian direction (Davidson, 1965; Mosler & Silipo, 2017; Wray & Forstater, 2006). It was broadly interpreted by neoclassicists (Fisher, 1932; Romer, 1986; Blanchard, 2006). Among the modern authors which study the issues of maintaining economic growth through the tools of financial regulation are Krugman (2009), Bernanke (2015), Stiglitz (2019).

Based on the laws of the process of systemic transformations, the precondition for changes in the ecosystem of the financial markets are drivers that cause a certain reaction of the system.

In the context of the study of the transformation of the financial assets market, the key parameter that determines the ability to change system parameters is the general stability of the ecosystem (global stability). It is provided through a feedback mechanism: negative and positive. In the first case it is a question of blocking of certain external influences for preservation of efficiency of system, in the second – about transformation of qualities of an ecosystem and transition to a state of equilibrium with new parameters.

In our opinion, one of the most successful methods for assessing the emerging properties of the financial markets of a particular country, group of countries or region or to form their ranking on a certain basis is developed and implemented by the World Bank in a series of reports on global financial development (Global Financial Development Report) and its “4×2” evaluation system (4×2 measurement framework).

This technique is quite broad in scope and detailed in terms of components and levels of analysis. It involves assessing the components of the country’s financial system in two aspects:

- financial institutions (banks, insurance companies and other non-bank financial institutions);
- financial markets (such as stocks, bonds and financial derivatives).

The meaning of the concept of “financial markets” in this case is interpreted as close as possible to the meaning that we mean in the contest of the “financial assets market” term.

Each of these objects is assessed, in turn, by four characteristics – the size or “depth” of financial markets and institutions in comparison with the size of the national economy (financial depth); opportunities and degree of use of financial markets and institutions by economic entities of a certain country (access); efficiency of financial markets and institutions in performing their functions in the economy (efficiency); stability of financial markets and institutions (stability). Each of these characteristics receives a rank value based on a weighted assessment of the set of quantitative indicators that measure it.

Turning to the system of characteristics by which the market is evaluated, it should be borne in mind that “market efficiency” is interpreted differently from what is embedded in the content of the concept in theory. According to the methodology of the World Bank, it is not so much about the ability of the market to effectively reflect information in the prices of financial assets, but about its ability to perform the functions of financial intermediation. The key indicator for assessing the effectiveness of the World Bank’s interpretation is the turnover ratio (the ratio of transactions with assets to capitalization of assets). A certain relationship between efficiency – as it is understood in the theory of financial assets market – can be justified: the higher the turnover, the higher the liquidity of the market, considering the price synchronicity, it can characterize the market’s ability to detect price given the maximum amount of information.

Financial asset markets are a complex object to quantify and compare due to their heterogeneity. According to the World Bank, the key differences between financial asset markets in developing countries are their insignificant depth, relatively small amount of financial assets in free float, and low market concentration by issuers. Indicators of the relative size of the capitalization of financial asset markets in different countries show that there is uneven development of financial asset markets in countries with different levels of economic development and a significant dominance of the US financial assets market (market capitalization is 19.7% of world capitalization) (Kawa, 2015).

This leads to the next step in forming a methodological approach to this research of systemic transformations of financial asset markets – for correct conclusions it is necessary to pre-cluster financial markets, forming relatively homogeneous groups in terms of depth, access, efficiency and stability.

Currently, there are several classifications based on differences in the levels of economic development of countries. The World Bank classifies countries on the basis of nominal gross national income (GNI) per capita, formerly called gross national product (GNP) (World Bank, 2012). In 2017, low-income countries included those with an annual per capita income of less than 995 US dollars, to countries with below average income – 996 – 3 895 US dollars, to countries with above-average income – 3,896 – 12,055 US dollars, and with a high – more than 12 055 US dollars (World Bank, 2021). Low- and middle-income countries are sometimes referred to as developing economies (or countries). Such mixing of concepts is common in both academic and professional literature, but this approach is too general and does not reflect the investment characteristics of the economy. According to various sources, the countries whose markets are developing include from 6 to 44 countries around the world. This discrepancy is explained by different selection criteria.

The sign “developing” in the context of the investment characteristics of certain countries indicates that these countries are in a state of transition from their previous level of development to a higher level.

The term “emerging markets” (EM) was first used in 1981 during a conference on the development of the Thai economy. International Finance Corporation economist Antoine van Agtmael was looking for a term that would differentiate countries (such as Thailand) with high economic growth potential from the pool of other underdeveloped countries (Agtmael, 2007). Its main motive was to create a more attractive image of markets with high growth potential and at the same time remove the prejudices associated with the expression “third world” or “low-income country”. Agtmael determined that stock markets in countries with a per capita income of at least 10,000 US dollars should be classified as emerging. Today, the World Bank uses the level 11,906 US dollars GNI per capita to differentiate between developed and developing countries.

In 1999, Daniel Quint made a statement that a developing economy is a society that transitions from a dictatorship to a free market economy, with increasing economic freedom, gradual integration into the world economy and with other members of the developing world market (Global Emerging Market), expanding the middle class, improving living standards, social stability and tolerance, as well as expanding cooperation with multilateral organizations (Quint, 2007).

International institutions, academia, and business agencies have different definitions of a country’s belonging to a developing country and are arguing over clear options for doing so. Heterogeneous and geographically separated countries, such as Chile, Poland, Indonesia, Kenya and Pakistan, are clearly defined as “developing countries”.

Many scientists are trying to identify emerging markets based on qualitative rather than quantitative parameters. In contrast, D. Moritz argues that the criterion of rapid growth as an indicator of emerging markets is incorrect, as no region outside East Asia and the Pacific has grown consistently, faster than in developed countries in the last two decades (Moritz, 2010). Instead, he proposes to identify developing countries by two characteristics: a high degree of instability and a transition situation in the economic, political, social and demographic dimensions. The main characteristics in this context are the rule of law, the presence of regulation and control, ensuring the implementation of contracts. These conditions signal the transition of the economy from an informal to a formal system, where the rules are transparent and apply equally to all market participants.

Another starting point for determining the list of developing countries is provided by investment information providers, although their classification methodology is not transparent.

The MSCI Emerging Markets Index, launched in 1988 as the first benchmark index for this sector of the global capital market, has had a significant impact on the interpretation and implementation of the term “emerging markets”. Inclusion in this index of the country attracted the attention of international investors and increased the inflow of funds, which in turn contributed to the growth of the domestic economy. The index includes Brazil, Chile, China, Colombia, the Czech Republic, Hungary, Egypt, India, Indonesia, Korea, Malaysia, Morocco, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey.

The history of this index began in late 1986, when the company Capital International Perspective introduced the Emerging Markets (EM) index, which made it possible to monitor financial asset markets in countries that were not part of the developed group. Capital International Perspective was later acquired by Morgan Stanley. In May 2009, MSCI Inc. (before that, in 2004, merging with Barra) became a public independent company specializing in research and analysis in the field of capital markets for institutional investors.

In addition to MSCI Inc. also FTSE – a British provider of capital market indices, publishes an index of emerging markets (FTSE, 2021). FTSE distinguishes between highly and moderately developed emerging markets according to the level of GNI and the development of capital market infrastructure. High-level markets: Brazil, the Czech Republic, Hungary, Malaysia, Mexico, Poland, South Africa, Thailand, Taiwan, Turkey. Mid-level: Chile, China, Colombia, Egypt, India, Indonesia, Morocco, Pakistan, Peru, Philippines, Russia, UAE. Interestingly, the FTSE list of China and India, which dominate among developing countries due to the size of the economy and population are in the group

of middle-income countries, which means that the capital market infrastructure is underdeveloped in these countries.

It should also be noted that the two indices – MSCI and FTSE include almost the same group of countries, which makes their lists a reliable source of information about countries that can be considered as developing.

In addition to the above institutions, the International Monetary Fund, Columbia University, and the rating agency Standard & Poor's are also involved in the identification and analysis of emerging market countries.

The separation of subgroups of countries within developing countries, such as Asian tigers (Hong Kong, Singapore, South Korea and Taiwan) or BRIC countries (Brazil, Russia, India and China), indicates the need for clearer parameters for defining and assigning a country to this group, because the definition of "developing" has become too vague. Nevertheless, most researchers tend to believe that the economies of these countries are in the process of transition to a free market economy that is integrated into the world economic space.

Since 1996, the term "Frontier Market (FM)" has been coined to describe the small capital markets of 21 countries monitored by the International Finance Corporation. It is important not to confuse it with the term "transition economies", introduced by the UN after the collapse of the socialist bloc. When translating this term, it is often identified with transition markets, however, it should be noted that it, in particular, was to emphasize the process of transition from a socialist system to a market economy. Currently, transition economies include 17 countries of the former socialist bloc.

For a long time, the attention of foreign investors has been focused on emerging markets and BRICS countries. But gradually the border markets were able to make progress in the formation of market mechanisms, accumulated sufficient resources and experience of cooperation in world markets. About 1.5 billion people living in countries with border capital markets have become a new driver of development for the global economy. These countries saw a significant increase in per capita income: its average annual rate, according to the World Bank, was the same as in the Emerging Markets, and twice the level of developed countries.

Methodological and statistical support for this "marginal group" indicator was later transferred to Standard & Poor's, and the S&P/IFC Composite Frontier Markets indicator was introduced. In July 2007, Standard & Poor's introduced the S&P / IFC Extended Frontier 150, consisting of the 150 most capitalized and liquid companies in the "frontier markets", followed by the S&P Select Frontier Index (a subset of Frontier 150 that included 30 companies out of 11). border "countries).

In early 2009, S&P revised the composition of "border markets", including the addition of several rich Middle Eastern oil-producing countries from the Gulf Cooperation Council (GCC), so that 35 countries are now included in Frontier Markets, according to S&P. The index was renamed the S&P Frontier Broad Market Index (VMI). The index primarily includes companies with a market capitalization of more than 100 million US dollars. However, if the total capitalization of such companies does not reach 80% of the total market capitalization of countries, then the index may include smaller companies (at least in such quantities as to reach 80% of the threshold). The maximum volume of companies included in the index as of 2018 is 17, 070 million dollars, and the index includes 589 companies (S&P, 2021).

Shortly after S&P Dow Jones Indices LLC, in December 2007, Morgan Stanley Capital International, in turn, introduced the MSCI Frontier Markets Index, which initially covered 19 countries and was expanded to 33, of which 22 are indexed (Morgan Stanley Capital Inc [MSCI], 2017). The formation of the index considers the stability of economic development of the market, the volume and liquidity of shares of companies included in the index, as well as market availability for institutional investors (market openness to nonresidents, barriers to capital movement, financial sector stability and regulatory environment, etc.).

Currently, several consulting firms are actively exploring frontier markets, including AON Hewitt, Arnerich Messina, Callan Associates, Russell Investments and Meketa Investment Group. Goldman Sachs constantly monitors the "N-II countries", which are a number of countries with large populations that have the potential for sustainable economic development (Goldman Sachs, 2021). The criteria for inclusion in the list are a high assessment of the elements of the growth environment: macroeconomic stability (inflation, budget deficit and external debt); macroeconomic conditions (investment and trade openness); human capital (schooling and life expectancy); political conditions (political stability, rule of law, fight against corruption); technology (number of personal computers, telephones and Internet users).

At the same time, despite the high activity of analytical agencies in the field of border market monitoring, there are, depending on the methodology, about 20 countries with active stock markets, which are ignored by the existing Frontier Indexes. According to the MSCI Frontier Markets Index, IMI is 12 countries, including recently Ukraine (MSCI, 2021). These countries number more than 280 million people and have, according to the World Bank, more than 20% of the market capitalization of border markets. For example, Saudi Arabia, which remains a closed market for foreign investors, except for certain types of notes (P-notes).

Today, countries with frontier markets account for 21.6% of the world's population, 6% of its nominal GDP and only 3.1% of world market capitalization. At the same time, an investor who wants to have a portfolio perfectly balanced in the structure of the global market, has an interest in keeping 3.1% in the assets of frontier markets. At

the same time, it is important to remember that frontier markets are inefficient, so capitalization ratios may contain significant errors associated with inadequate valuation of financial assets.

Concluding the consideration of the methodological aspects of this study, it is necessary to dwell on another important aspect – which should be an evaluation criterion for the effectiveness of the transformation processes of the financial assets market. In itself, the change of certain market parameters indicates the stability of this ecosystem, the direction of its transformation.

Given that the financial assets market is not a self-sufficient system, but one of the service subsystems of society, it is correct to rely not only on the criteria that characterize the state of the financial assets market, but on its contribution to the development of society.

In 2015, the UN formulated 17 goals in the field of sustainable development as a guideline for policy-making and strategic objectives of social development until 2030 (United Nations, 2015). These goals are not declarative – the achievement of each is concretized through a set of relevant tasks and a system of adequate indicators to assess progress. Sustainable Development Goals (SDGs) are widely recognized by the world community, well-defined priorities of social development, which allow to assess the social efficiency of the financial assets market.

The most obvious role of the financial assets market is to ensure:

- “gradual and sustainable economic growth, full and productive employment” (SDG8) by facilitating access to finance and expanding the range of financing instruments, including innovative enterprises, small and medium-sized businesses;
- “creating a sustainable infrastructure that promotes industrialization and innovation” (SDG9) by reducing the cost of financing for business and expanding innovation;
- “reducing inequalities within and between countries” (SDG10) through the promotion of financial inclusion and through the portfolio investment mechanism within the global financial assets market.

These strategic priorities of social development are not direct results of the financial assets market, as well as key performance indicators (Key Performance Indicators, KPI) for its participants. Some professional participants in the financial assets market are focused primarily on increasing the market value of property rights, rather than increasing the property itself or increasing public welfare, and some organized marketplaces have too high barriers to entry for innovative and small businesses. The result of their functioning as a system is such emergent properties as the reduction of costs for the allocation of financial resources and the “disclosure of the fair value” of financial assets. Thus, the financial assets market contributes to the creation of social welfare and sustainable development.

Within this research and in the context of the above methodological approaches to the research of systemic transformations of the financial assets market, further consideration of this problem will quantify changes in systemic (emergent) qualities of financial asset markets of different levels of development and identify direction and strength of ecosystem feedback.

2. Methodology

To quantify the emergent properties of the financial assets market, we chose the World Bank approach to assess the financial development of countries as the most adequate methodological approach. Each system parameter of the financial assets market – availability, depth, functionality and stability – is assessed using a set of indicators.

As a result of aggregation of indicators, in the fixed parameters of the model there were 6 indicators that characterized the drivers of financial assets market development (Figure 1) and 5 indicators that determined the quality parameters of the market (Figure 2).

Therefore, at the stage of forming a database for the research, a database was formed from countries categorized as frontier markets for financial assets (Frontier Markets, FM) according to the methodology of classification of financial asset markets described above. These countries are Bangladesh, Egypt, Indonesia, Iran, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey and Vietnam.

Mixed Model Repeated Measures (MMRM) is a statistical model that is an extended version of the General Linear Model (GLM) that allows to analyze data with fixed and random effects.

This class of models offers some advantages over the standard linear model SLiM (standard regression) or ANOVA (Analysis of Variance) to describe economic processes. This makes them an effective tool for estimating the relationships in a set of data obtained from repeated measurements of a certain parameter of the same experimental object (for example, the value of an indicator over a number of years of the same group of countries). In such a data set, the source of variability can be both an external factor and internal factors associated with changes in the state of the object itself. When using the above-mentioned standard (actually – traditional for most studies) modeling tools, the difference between these fundamentally different types of data is not considered - the whole array is perceived as a set of independent random variables. That is, if we have the value of the same object for a number of years, then the reactions of a particular experimental unit can mean the reaction of the same unit when re-measured. In such data sets, it is necessary to consider the presence of correlation between variables obtained by repeatedly measuring the index of the same object and possible volatile variability.

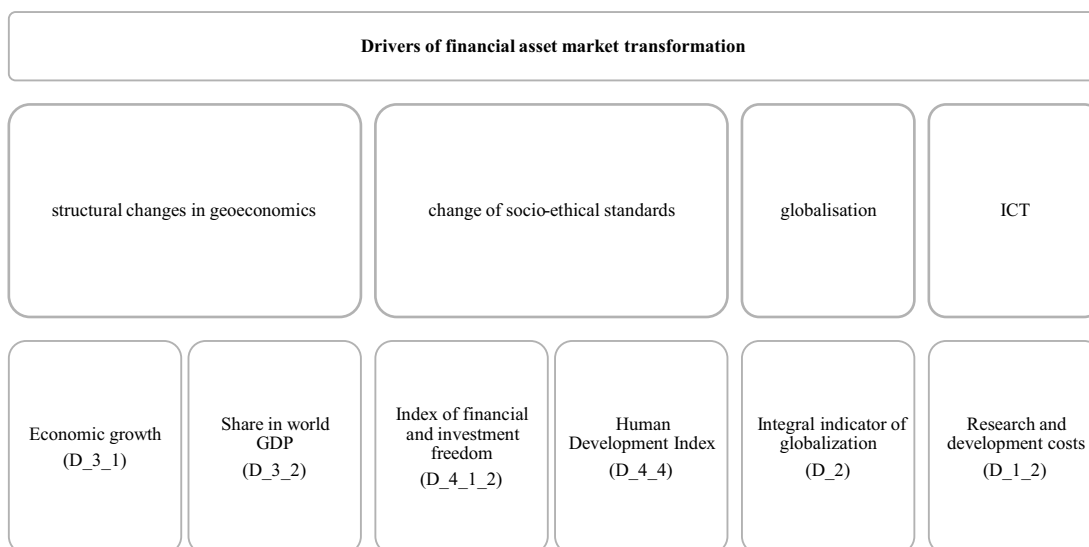


Figure 1. Indicators of mixed-model drivers (source: own calculations)

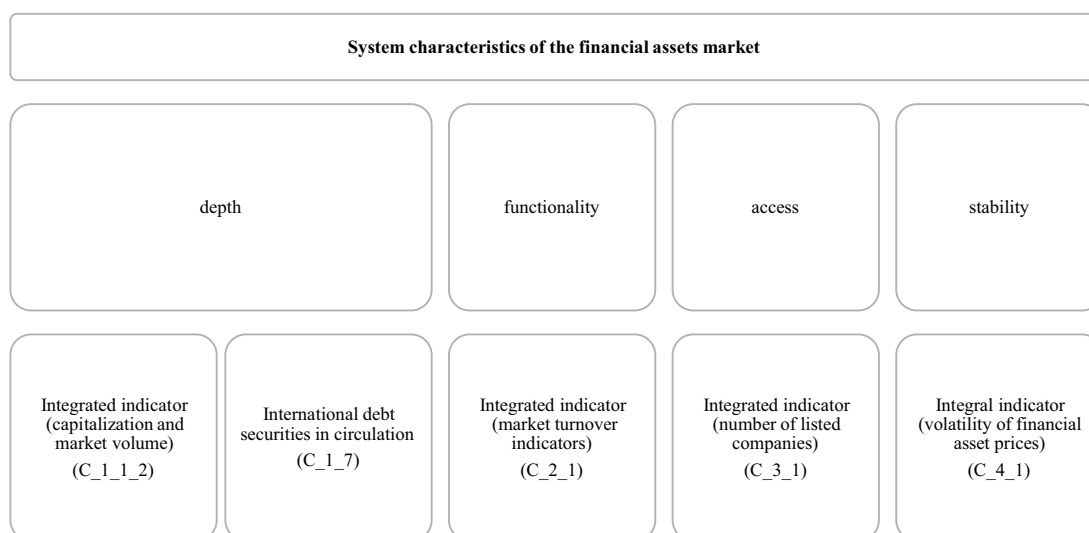


Figure 2. Indicators of system parameters of the financial assets market in the mixed-model (source: own calculations)

The mixed model allows to effectively overcome the above problem of data analysis, which are dependent, with a hierarchical structure, longitudinal or correlated. Their advantages are especially evident for data obtained by repeatedly measuring values on the same statistical units (longitudinal studies), or by measuring clustered statistical units. Another advantage of the mixed-model in relation to this research is the ability to work in the partial absence of data.

Thus, we believe that the use of SLiM or ANOVA to analyze the relationship between a group of drivers and the systemic qualities of the financial asset market within certain groups of countries is incorrect, because the data are not completely independent. The calculation of series of linear regressions for each individual indicator has its drawbacks: the number of observations is significantly reduced, and the results may be inaccurate. That is why, given the above, we use a mixed-model.

A fixed effect in a mixed model is a parameter that changes according to a certain pattern, and a random effect is a parameter that changes randomly. That is, in contrast to linear regression where the data are random variables and the parameters are fixed, in the mixed model the random variables are given and the parameters are random for some categories and fixed for others. Two sets of parameters in a mixed linear model actually specify the full probability distribution of the data: fixed effects parameters and covariance parameters. The unstructured covariance-dispersion structure of the mixed-model assumes that the interaction is detected at values of p less than 0.05 (or less than 5%).

Key features for determining the relationship between model parameters are Solution for Fixed Effects and Type 3. Tests of Fixed Effects. The tables contain a T-test and an F-test for significance for each fixed effect ($Pr > |t|$ and $Pr > F$). Small values – usually less than 0.05 or 0.01 indicate a significant effect of the indicator. Hereinafter, the tables are compiled using SAS / STAT® 13.1 software.

3. Findings and discussion

Frontier markets for financial assets are represented by ecosystems that are in the process of stabilization. The architecture of such markets has not yet been formed, the actors are institutionally and functionally blurred. These markets are characterized by strong competitive pressure from institutional intermediaries. The state, in most cases, dominates the debt asset market, causing a substitution effect.

Nevertheless, this group is more homogeneous in terms of assessing random effects. Only when assessing stability and functionality do individual markets show specificity in relation to identified relationships.

The integrated indicator of the depth of financial asset markets is strongly influenced by two indicators related to social development and financing conditions for individual investors (Figure 3). And their influence is opposite. The level of human development creates conditions for increasing the capacity of financial asset markets, and the liberalization of investment and financial operations limits the depth of the market.

The reason for this situation may be the “outflow of capital” to more stable markets, if investment conditions for residents are liberalized. Together with the indicators that characterize the social aspects of development, the depth of border markets is influenced by their importance in the world economy. This is confirmed by the results of the second model, which determines the impact on market depth, but through the inverse of debt, which is attracted to international markets for financial assets (Figure 4). In this case, there is a strong influence of economic development: the more significant the country’s role in the international arena, the less attractive are the markets of other countries – both for the borrower and for the investor, and thus increase the depth of the local market.

The efficiency of frontier markets in terms of trade conditions, reducing the cost of transactions and the formation of fair prices of financial assets (functionality) is significantly influenced by globalization and the role of the country in the geoeconomy (Figure 5).

The economic development indicator for frontier markets has a negative regression coefficient with functionality. The reason for this is the very nature of economic growth: frontier financial markets operate in unstable economies that depend not only on domestic growth parameters but also under strong pressure from geoeconomic trends, so changes in economic size are often interpreted as growing uncertainty and, consequently, and systemic risks.

The availability of frontier markets for financial assets is determined by factors of social development and the structure of the geoeconomy (Figure 6): the growth of economic potential and education, financial literacy of the population expands the range of its potential participants.

Dependent Variable C_1_1_2					
Solution for Fixed Effects					
Standard					
Effect	Estimate	Error	DF	t Value	Pr > t
Intercept	4312.85	873.15	14	4.94	0.0002
Year	-2.2331	0.4489	14	-4.97	0.0002
D_4_1_2	-0.8318	0.2512	128	-3.31	0.0012
D_4_4_	3.2356	0.6533	128	4.95	<0.0001

Figure 3. Estimation of fixed effects of the mixed-model for the integrated indicator of depth of marginal markets of financial assets (parameter C_1_1_2) (source: own calculations)

Dependent Variable C_1_7					
Solution for Fixed Effects					
Standard					
Effect	Estimate	Error	DF	t Value	Pr > t
Intercept	-2456.36	267.14	14	-9.19	<0.0001
Year	1.2328	0.1329	14	9.28	<0.0001
D_3_2	-54.8854	13.5978	134	-4.04	<0.0001

Figure 4. Estimation of fixed effects of the mixed-model for the indicator of volumes of international debt securities (in circulation) as a share of GDP (parameter C_1_7) (source: own calculations)

Dependent Variable C_2_1					
Solution for Fixed Effects					
Standard					
Effect	Estimate	Error	DF	t Value	Pr > t
Intercept	3484.87	783.78	10	4.45	0.0012
Year	-1.6825	0.3952	10	-4.26	0.0017
D_2	-1.1623	0.3995	97	-2.91	0.0045
D_3_2	-62.4658	28.0248	97	-2.23	0.0281

Figure 5. Estimation of fixed effects of the mixed-model for the integrated indicator of functionality of frontier markets of financial assets (parameter C_2_1) (source: own calculations)

Dependent Variable C_3_1					
Solution for Fixed Effects					
		Standard			
Effect	Estimate	Error	DF	t Value	Pr > t
Intercept	2406.37	377.57	14	6.37	<0.0001
Year	-1.2179	0.1928	14	-6.32	<0.0001
D_2	0.4063	0.2405	130	1.69	0.0936
D_3_1	-0.2629	0.1604	130	-1.64	0.1035
D_3_2	26.1226	11.8189	130	2.21	0.0288
D_4_1_2	-0.2147	0.1060	130	-2.03	0.0449
D_4_4	0.9750	0.3391	130	2.87	0.0047

Figure 6. Estimation of fixed effects of the mixed-model for the integrated indicator of availability of frontier markets of financial assets (parameter C_3_1) (source: own calculations)

Dependent Variable C_4_1					
Solution for Fixed Effects					
		Standard			
Effect	Estimate	Error	DF	t Value	Pr > t
Intercept	3105.88	255.70	15	12.15	<0.0001
Year	-1.4919	0.1272	15	-11.73	<0.0001
D_2	-0.2809	0.09255	132	-3.03	0.0029
D_3_1	-0.6802	0.1125	132	-6.05	<.0001

Figure 7. Estimation of fixed effects of mixed-model for integrated indicator of stability of frontier markets of financial assets (parameter C_4_1) (source: own calculations)

The list of drivers of stability for frontier markets of financial assets – economic development and globalization (Figure 7). The direction of the relationship is equally negative, which indicates a violation of the local stability of the ecosystems of these markets in the context of growing open economies and unstable growth.

A generalized representation of the directions of influence of drivers of systemic transformation of the financial assets market on the systemic characteristics of frontier markets are presented in Table 1.

Table 1. Directions of influence of socio-economic drivers on the system characteristics of frontier financial markets (Frontier Markets, FM)

	Depth	Functionality	Access	Stability
ICT				+
Globalization		+		+
Geo-economics	+	+	+	+
Ethical living	+		+	

From the point of view of interconnectedness on the example of frontier markets we can observe a rather diversified impact of drivers: the ecosystem of frontier markets is more sensitive to changes in external conditions, has a low degree of resistance, which in the absence of mechanisms to prevent or dampen imbalances can lead to the incapacity of financial markets.

Conclusions

As a result of the application of general scientific methodology, the methodological tools of the research were established, which correspond to its purpose and tasks: the World Bank’s method “4×2” (4×2 Measurement Framework) was adapted to assess the emerging properties of the financial assets market; the approach to clustering of financial asset markets based on the methodology of the international analytical company MSCI Inc. is substantiated. (MSCI Global Investable Market Indexes Methodology), according to which capital markets are divided into frontier markets (Frontier Markets), emerging markets (Emerging Markets) and developed markets (Developed Markets).

A formal description of the model was made, the parameters of the mixed-model were defined: a list of control indicators, a system of result parameters and approaches to categorization of the database for frontier markets of financial assets (Frontier Markets, FM). Based on the formed database and its processing, mixed-models were built for each group of countries with frontier markets of financial assets, which analyzed the impact of drivers on the system characteristics of the market using the software SAS / STAT® 13.1.

Based on the evaluation indicators for fixed and random effects (Solution for Fixed Effects, Solution for Random Effects) and the test of hypotheses on the significance of each of the fixed effects (Tests of Fixed Effects), were identified as statistically significant individual patterns of frontier financial markets:

- ecosystems of frontier markets are sensitive to changes in external operating conditions, have a low degree of resistant stability, as evidenced by the large number of identified direct and indirect impacts by drivers (10 vs. 9);
- systemic transformations of frontier markets for financial assets are determined by the processes of social and economic development, as well as globalization processes.

Disclosure statement

The authors declare no conflict of interest.

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