

Modelling the Global Stock Market: Methodology and Tools

MYKOLA BURMAKA¹,
BORYS PRYKHODKO²

ANNOTATION. The article is devoted to substantiation of new scientific approaches to the study and analysis of relevant processes of modelling global stock markets using interdisciplinary tools within the framework of existing patterns and taking into account the peculiarities of evolution of socio-economic systems and globally significant market factors. The article considers the fundamental principles of stock market modelling, which, in addition to the structural component, are determined by the typology of the investment process in the economy and are determined by post-industrial development factors, in particular, the processes of digitalisation, networking, platformisation, technologicalisation and intellectualisation. This leads to the formation of qualitatively new states of the stock market, which are characterised by internal similarity of functioning processes, logical and schematic description, and a certain sequence and continuity of development. To this end, the article formulates a hierarchical species range of stock market models, provides their essential characteristics and builds a “spiral” of evolution of stock market models. On this basis the article offers a mechanism of forecasting the stock market with the use of resources of different models and successive change of types of models within the system hierarchy of stages of development of the market. As a result of the study, it is concluded that with the gradual complication of the type of model, the relationship between the model components and the parameters of these components, a general paradigm of global stock market development is formed, which allows analysing trends, patterns, features, factors, market processes, and also provides opportunities for their forecasting. This methodological approach can be used for modelling and forecasting the development of other socio-economic systems that operate on the basis of the market and marketability.

KEY WORDS: global stock market, financial globalisation, stock market models, evolution of stock market models, stock market structure, systematic approach, stock market forecasting.

Introduction

The study of the impact of financial globalisation on the processes of transformation of stock market systems and models is currently gaining important theoretical and methodological significance. This is due to both the formation of a new paradigm of the global financial market³, which we have been witnessing over the past decade, and institutional and structural changes in the global investment process⁴, which the stock market actually functions to serve.

Along with significant scientific achievements in the field of stock market modelling, the problem of forming a modern adequate scientific and

¹ **Mykola Burmaka** – PhD in Economics, Associate Professor, Head of the Department of International Management at Kyiv National Economic University named after Vadym Hetman, Honoured Economist of Ukraine. Sphere of scientific interests: global economy, international financial markets, digital economy. E-mail: nburmaka@ukr.net.

² **Borys Prykhodko** – PhD student at Kyiv National Economic University named after Vadym Hetman. Sphere of scientific interests: global management, digital economy, network economy. E-mail: prykhodko.bv@ukr.net.

³ *Global financial development: trends, technologies, regulation*: monograph / O. M. Mozgovyi, T. O. Frolova, L. V. Rudenko-Sudarieva and others; under the scientific editorship of Doctor of Economics, Professor O. M. Mozgovyi – Kyiv: KNEU, 2017.

⁴ See: 1) Burmaka M. O., Zinchenko F. A. Global format of financial and institutional transformation of stock exchanges. *International Economic Policy*. – 2017. – No.2 (27); 2) Burmaka M. O. Creativity of the global investment process. *International Economic Policy*. – 2018. – No.2 (29).

methodological apparatus that would allow to study the latest trends in the transformation of financial and stock market models, analyse the modification of structural relationships between model elements, and predict the dynamics of these transformations to develop strategies for achieving macroeconomic equilibrium and balance in the face of permanent global turbulence and c Under the influence of modern processes of networking, digitalisation and technologisation of the global investment industry⁵, an obvious trend is the diffusion of established market models with the formation of qualitatively new characteristics and features on this basis, which also necessitates the study of the phenomenon of permanent transformation of stock market models.

Thus, the purpose of the article is to substantiate new scientific approaches to the study and analysis of modern stock market modelling processes using interdisciplinary tools within the framework of existing patterns and taking into account the peculiarities of the evolution of socio-economic systems and globally significant market factors.

The modern concept of stock market models

The stock market (or securities market) as a set of specific market institutions, stock intermediaries and other stock market infrastructure entities, investors and capital borrowers, as well as relevant⁶ relationships between all of them regarding the circulation of various types of securities (or assets reflected in securities) to transform savings and savings into investments⁷ is central to the financial system.

At the same time, the stock market as an economic subcategory is traditionally viewed as a component of the financial market, which in turn consists of credit, currency, money, insurance segments, and also includes public and corporate finance.

The general typology of financial market models is determined by the established interrelationships of their essential features, such as, for example, mechanisms for financing long-term economic growth, the ratio of the main classes of financial assets, and the market structure (subject, instrumental,

⁵ Burmaka M. O., Zinchenko F. A. Global format of financial and institutional transformation of stock exchanges // *International Economic Policy*. – 2017. – No.2 (27).

⁶ In this context, the term relevance is used to define the degree of usefulness of certain economic actions, for which usefulness is assessed on the basis of subjective judgement. In the economic sphere (which includes the stock market industry), the concept of relevance usually describes information related to making the most effective [investment] decisions. For more details, see Ludwig von Mises. Human Action: The Scholar's Edition // Mises Institution. 1998. – P. 55, 57, 120. – [Electronic resource]. – Access mode; <https://mises.org/library/human-action> (author's remark).

⁷ The terminology presented here is based on a generalisation of the conceptual apparatus of the stock market and certainly does not exhaust all the definitions currently available in the scientific, methodological and dictionary literature. One of such dictionary sources is: Collins Dictionary of Economics / C. Pass, B. Lowes, L. Davies. 1998. (author's remark).

regulatory and legal). The structure of the financial market provides a simplified view of its model, which, in turn, is an equivalent reflection of the complex phenomenon of real life⁸ – the financial market itself.

The theoretical justification of the financial market model involves the identification, analysis and generalisation of its objective and subjective components, which include, on the one hand, various financial instruments and products, such as securities, loans and other securitised assets, and, on the other hand, relevant financial institutions, such as banks and non-bank financial and stock intermediaries. On this basis, the financial market model is determined, in addition to the structure, by the prevailing mechanisms of financing the economy, which are provided either by banking or stock market institutions. In some cases, such financing is mixed, when banking and stock market institutions operate in the economy on a parity basis. In other words, the model appears as a derivative of the accepted concept of long-term financing of the processes of functioning and development of the national economy.

Since the stock market is isomorphic⁹ to the financial market in terms of the principles of financing (investment), and is a bioactive¹⁰ reflection of the financial market in terms of the main instrumental, infrastructural and regulatory features, it is assumed that the textbook models of the financial market apply to the stock market and vice versa.

According to the currently accepted theoretical and methodological approach, there are two main models of the stock market. Interpreting the main characteristics, essential features, mechanisms of functioning and peculiarities of organisation, international practice has defined them as the Anglo-Saxon¹¹ and continental¹² models. At the same time, each model is determined by a specific set of macro factors and prerequisites for the formation and development inherent only to a particular model, which

⁸ Philosophical Encyclopaedic Dictionary. *Model* // V.I. Shynkaruk (chairman of the editorial board) and others – Kyiv: Abris, 2002. – P. 391.

⁹ The general definition of isomorphism is the presence of similarities (equivalence) in different objects (*author's remark*).

¹⁰ In this case, the apparatus of mathematical logic is used. In a bijective mapping, each object of one set corresponds to exactly one element of the second set. The inverse mapping is also defined, which has the same property. A bijective mapping is also called a mutually exclusive mapping. In the case of financial and stock markets, the bijective mapping mechanism works as follows; for example, a loan is a debt security (bond, treasury bill), a mortgage loan is a mortgage security, currency derivatives are stock derivatives, payment is a bill, a bank is an investment bank (stock dealer), a currency exchange is a stock exchange, etc. (*author's remark*).

¹¹ or the stock (public, open, market) type model, which provides for the dominance of stock market financial instruments (securities, primarily shares) and stock intermediaries in the form of investment banks in investment processes; that is, it is a model of stock, "securities" financing of the economy; due to the fact that this model is focused on retail investors and forms a dispersed structure of investment capital, the institution of property rights and methods of its protection are becoming important (USA) (*author's remark*).

¹² or the European (German, banking) model, which envisages the dominance of long-term bank lending in investment processes and the strengthening of the role of universal banks; this model forms a concentrated structure of investment capital and, as a result, the debt (credit) nature of economic financing (Germany, France, Switzerland, Austria) (*author's remark*).

include historical, political, social, cultural, mental, economic, political, legal and a number of others.

If such a set of features does not allow to unambiguously qualify a national market model as one of the above or if the national model contains features of both models on a parity basis, such a model is called a mixed model¹³. The processes of financial globalisation are now adding to this set of fundamental factors the level of correlation between real and financial (virtual) capital and the parameters of investment potential for each model.

The modern economic bibliography contains a fairly wide range of scientific works devoted to the study of financial and stock market models both in the institutional context and in the context of the functioning of investment capital and capital formation.

Thus, the theoretical analysis of stock market models is devoted to the works of V. D. Bazylevych and V. M. Sheludko¹⁴, W. Buffett¹⁵, A. T. Holovko¹⁶, A. Greenspan¹⁷, R. Lee¹⁸, J. Murphy¹⁹, O. Mozgovyi²⁰, in which, using a number of aggregate indicators, the stock market is considered as an integral economic phenomenon with an emphasis on quantitative and qualitative prospects of development of this financial segment. Such a somewhat trivial approach to models was especially relevant in the 1990s in the context of the rapid formation of a number of new national economies in transition to the market and was fully justified for a particular country (new independent country) to make a reasonable choice of the stock market model that would best fit the model of the reformed national economy.

A number of scientific papers also study the peculiarities of the two main stock market models that are most prominently represented in the developed economies of the world – the USA²¹ and the EU²². At the same time, the

¹³ implies the presence of both banks and non-bank investment institutions in the stock market, which operate on the basis of banking and stock market legislation with equal rights and opportunities in stock market operations (including Ukraine). (*author's remark*).

¹⁴ *Stock market: Textbook*; in 2 books – Book 1 / V. D. Bazylevych, V. M. Sheludko and others; edited by V. D. Bazylevych – K.: Znannya, 2015. – 621 p.

¹⁵ Warren E. Buffett. *The Essays of Warren Buffett: Lessons for Corporate America*. – The Cunningham Group & Carolina Academic Press, 2015. – 358 p.

¹⁶ Golovko A. T. *Markets of financial instruments and their financial infrastructure: Monograph* / A.T. Golovko, S. M. Laptev, V. G. Kabanov – K.: Krok University of Economics and Law, 2009. 560 p.

¹⁷ Greenspan A. *The Age of Turbulence: The Adventures in a New World*. – New York: The Penguin Press, 2007. – 531 p.

¹⁸ Lee R. *Running the World's Markets: The Governance of Financial Infrastructure*. – Princeton University Press, 2011. – 472 p.

¹⁹ Murphy J. *Technical Analysis of the Financial Markets*. – New York Institute of Finance/prentice Hall, 1999. URL: <https://books.google.com.ua/books/about/...>

²⁰ *Global financial development: trends, technologies, regulation: Monograph* / O. M. Mozgovyi, T. O. Frolova, L. V. Rudenko-Sudarieva and others; under the scientific editorship of O. M. Mozgovyi – Kyiv: KNEU, 2017. 782 p.

²¹ These include, in particular, the classic fundamental work – Teweles R. J., Bradley E. S., Teweles T. M., *The Stock Market* – John Wiley & Sons, Inc. 1992. – 650 p., which reveals the nature and principles of the American stock market in retrospective and modern contexts.

²² See, for example, Leonov D. A., Levochkin S. V., Khoruzhiy S. G. *Financial services market as a paradigm of European integration: Monograph* / Under the scientific editorship of V. M. Fedosov.

market model appears as a complex multi-parameter substance with a combination of a number of external and internal socio-economic “reagents”, mostly specific to each national economy.

Along with the traditional algorithms for the functioning of a particular stock market model in a particular country, which are currently being analysed by scholars and practitioners, recent decades have seen an active transformation of established models, diffusion of various infrastructure components, catalysed by global investment competition, global technological and market, primarily digital, network and intellectual changes, as well as the formation of a new paradigm of global economic cycles against the backdrop of “shifting” prospects²³.

The applied nature of such an approach should primarily provide for the possibility of scientific forecasting of evolutionary processes of transformation of stock market models. Considering the transformation of these models as a separate process that can also be modelled, the research should result in algorithms for forming the most adequate models that will allow for long-term forecasts of the development of a wide range of socio-economic processes.

Fundamental principles of stock market modelling

One of the classical functions of the stock market is the investment function, which is realised by accumulating and directing temporarily free funds from their owners (accumulation and saving of the population and households, passive capital of enterprises, other monetary and non-monetary assets) into the production sphere with the subsequent rational redistribution of these investments on a competitive basis between industries and areas of activity, regions and countries, the state and enterprises in search of the industry (area, region and country) that will promise the maximum (or acceptable) profit.

The existing correlation between the stock prices of companies' shares and the cost of investment capital within a particular industry as a whole, as well as the rather small lag²⁴ between stock price fluctuations and subsequent fluctuations in companies' costs, proves that new investments follow the estimate [growth] of future revenues almost without delay.

In the theoretical and applied aspects, the stock market model, in addition to the structural component, is determined by the typology of the investment process. The structure of the market covers the totality of all its actors by type and characteristic functional features – investors (creditors), investment

²³ Weild, D. Making Stock Markets Work to Support Economic Growth: Implications for Governments, Regulators, Stock Exchanges, Corporate Issuers and their Investors / D. Weild, E. Kim, L. Newport // OECD Corporate Governance Working Paper, No. 10, 2013. OECD Publishing. URL: <http://dx.doi.org/10.1787/5k43m4p6ccs3-en>.

²⁴ lag is an economic indicator that characterises the time interval between two interrelated economic phenomena, one of which is the cause and the other is the effect. (*author's remark*).

beneficiaries, investment intermediaries, as well as a set of infrastructure and regulatory²⁵ components – various trading, depository and clearing, information systems, self-regulatory and regulatory institutions.

Scientific developments in the field of stock and financial market modelling, as well as the extensive practical experience of their operation accumulated to date, allow us to classify existing market models into the following three groups:

1) models used to study and analyse the general patterns and characteristics of the functioning and development of markets, their impact on economic growth and ensuring the balance of the economic system; this group includes macroeconomic, economic-mathematical and economic-statistical models, which determines the ability of these models to identify specific mechanisms of interaction between financial and stock markets and markets for goods, services, various resources, labour, innovations, etc;

2) models that implement alternative approaches to the analysis and research of financial and stock markets and are based on the concept that these markets are considered as complex systems with high degrees of freedom, to which methods of studying dynamic systems are applied, and therefore they are also called econometric models; There are many such models²⁶, but it is worth highlighting fractal²⁷, factor²⁸, regression²⁹ and agent-based³⁰ models that use appropriate scientific methods of market analysis;

3) models used to analyse certain market segments and processes and representing the latest achievements of financial theory based on a sophisticated mathematical apparatus; models of this group include, in particular, the Black-Scholes Option Pricing Model (OPM), the Arbitrage Pricing Model (APM), and the Capital Asset Pricing Model (CAPM).

The stock market as a complex integral system consists of a set of interconnected elements that constantly interact with each other, has

²⁵ The stock market model has a decisive influence on the formation of the regulatory system, dictating the choice of the type of stock (and financial) market regulator: 1) a specialised stock market regulator, 2) a unified regulator (of the stock market and non-banking financial services market), 3) a mega-regulator (of the stock market, non-banking financial services market, and banking services market). At the same time, a specialised regulator is usually formed under the “stock” model of the stock market (for example, the Securities and Exchange Commission, SEC, in the United States), and a mega-regulator is formed under the banking or mixed model (a striking example is the Federal Financial Supervisory Authority, BaFin, in Germany). (*author's remark*).

²⁶ An overview of a large number of specific models is presented, in particular, in R. N. Mantegna and H. E. Stanley. *An Introduction to Econophysics: Correlations and Complexity in Finance*, Cambridge University Press, Cambridge, 1999. (*author's remark*).

²⁷ See, in particular, Peters E. E. *Fractal Market Analysis: Applying Chaos Theory to Investment and Economics*. – Jhon Wiley & Sons, Inc. 2003. – 298 p. (*author's remark*).

²⁸ See, in particular, Factor, discriminant and cluster analysis / Collection of works edited by I.S. Enyukov – Moscow: Finance and Statistics, 1989. – 215 c. (*author's remark*).

²⁹ See, in particular, Draper N. R., Smith H. *Applied Regression Analysis*. – Jhon Wiley & Sons, Inc., 1998. – 736 p. (*author's remark*).

³⁰ Agent-based models (ABMs) are implemented by methods of imitation (simulation) modelling, are reflected in the scientific bibliography in sufficient detail and are widely used in the analysis of a wide range of socio-economic systems, including financial and stock markets, where a large number of agents and relationships between them are represented and interact. (*author's remark*).

essential characteristics, structure, performs purposeful functions and is in a constant process of dynamic change. These features define the methodology of scientific research and analysis of the stock market and its models, which is based on a systematic approach³¹ using the methods of system analysis³².

The processes of the stock market functioning, as well as the formation and development of its models, are significantly influenced by the adopted model of state regulation of the economy, the level of state intervention in socio-economic processes and economic growth. The Keynesian and neoclassical economic models, as well as their synthesis, theories of monetarism and supply-side economics, and liberalisation of state economic policy define the concept of forming a stock market model as an additional model to the budgetary, monetary, tax, currency, and social models of the national economy. It is undeniable that globalisation processes and the increasing level of economic openness introduce a significant variable component in the modification of existing stock systems, adapting them to the modern needs of the efficient functioning of financial markets.

This is due to powerful post-industrial factors of development, in particular, the latest manifestations of economic and financial globalisation, the main drivers of which are the comprehensive processes of digitalisation, networking, platformisation, technologicalisation and intellectualisation, which are currently taking place against the backdrop of an unprecedented and ongoing global economic crisis. This is fundamentally transforming the mechanisms and models of global markets, including stock markets. Within the framework of modern economic science, new research areas are emerging that study the impact of relevant changes in market institutions and various types of socio-economic interaction on global economic processes and vice versa.

The dissemination of market information and knowledge through social communications, digital technologies and social networks, and the use of huge amounts of economic data and statistical indicators are forcing scientists to improve qualitative and quantitative methods for studying modern complex economic and financial processes.

The scientific discourse is currently focusing on the impact of the narrative phenomenon on both individual and social (collective, group, professional) market behaviour³³. At the same time, the concept of economic narrative, as well as the concept of economic fluctuations, manifests itself without regard

³¹ See O'Connor J., McDermott I. *The Art of Systems Thinking: Essential Skills for Creativity and Problem Solving*. – Thorsons Pub, 1997. – 288 p. (*author's remark*).

³² See Blauberg I. V., Sadovsky V. N., Yudin E. G. *Systemic Approach in Systemic Science, Problems of Systemic Research Methodology* – Moscow, Mysl. – 1970. (*author's remark*).

³³ A wide range of issues related to the new scientific field of narrative economics is currently being explored in the latest work of the 2013 Nobel Prize winner in Economics, R. Schiller, "Narrative Economics: How Stories Go Viral & Drive Major Economic Events". – Princeton University Press. – 2019, as well as in the works of G. Akerlof and D. Snower (See Akerlof, G. A. and Snower, D. J. (2016). *Bread and Bullets* // *Journal of Economic Behaviour & Organisation*, 126, 58-71; and Akerlof, D. and Kranton, R. (2010). *Identity Economics: How Identities Shape Our Work, Wages, and Well-Being*. Princeton, NJ: Princeton University Press). (*author's remark*).

to the model on the basis of which the economic system or financial (stock) market is formed and functions. In the context of understanding the essence of this phenomenon, which is becoming “viral” and may, without exaggeration, turn into a pandemic³⁴, the economy as a whole and markets in particular may be able to predict financial crises, economic recessions and depressions, and, most importantly, prepare for them by responding in advance to possible negative consequences.

Most of the global economic crises of our time, especially the crisis of 2007–2009, their emergence and further course are primarily due to narrative factors: in the absence of objective grounds for economic growth, especially economic boom, it was a certain economic narrative that led to the formation of speculative models in the real estate, stock and currency markets.

The behaviour of stock and financial markets in early 2021, when the COVID-19 pandemic was estimated to have reached its midpoint and the real economy was just beginning to recover from the coronavirus crisis, is a clear indication of the presence of narrative effects in the global economy. Despite rather restrained forecasts for the global economic recovery after the pandemic, the frenzied demand in global markets exceeded all expectations. The rapid growth of global stock indices, gold and oil prices, a real boom in the crypto market amid record corporate profits, the emergence of a large mass of “excess” printed money with a simultaneous increase in savings and savings in developed economies, the depreciation of major currencies and almost zero (even negative) interest rates have created extremely alarming expectations in the global economy³⁵. The financial bubbles that are being inflated in several critical segments of the global economy, primarily on stock exchanges³⁶, could accelerate global inflation and trigger a new global economic crisis. The boom in consumer demand and post-pandemic uncertainty are undoubtedly driven by current economic narratives.

As the stock market is undoubtedly a complex system, the scientific approach to the formation of a methodological apparatus for research and analysis of stock market models is based on a number of system-wide

³⁴ We can see a complete analogy of this phenomenon in today’s historical realities, with the CoViD-19 pandemic in mind: an economic virus, as it turns out, is no different from a biological virus – they can have an equally significant impact on the course of geo-economic processes, and the dynamics of the spread of economic narratives is similar to the dynamics of the spread of epidemics. Bitcoin is an example of this. (*author’s remark*).

³⁵ Expert and analytical opinion in this area is based on a large array of data, reviews, estimates and statements that are currently widely covered in leading scientific and numerous economic periodicals. Surprisingly, however, the only thing that currently unites all experts is the lack of unanimity in forecasts for the future course of global economic processes due to large-scale uncertainty and multifactorial development. (*author’s remark*).

³⁶ The stock market “coronavirus” excitement of investors can be illustrated by the so-called Buffett indicator, an indicator that characterises how overvalued the shares of companies on the stock exchange are. It is calculated as the ratio of stock market capitalisation to US GDP. At the end of 2020, when the US GDP declined by 3.5 % and all stock indices rose, this ratio reached 200 %, which is even higher than in the early 2000s before the collapse of Internet companies (dot-coms), when the Buffett index was 160 %. The dot-com boom ended, as we know, with the collapse of the NASDAQ index in March 2000 and the bankruptcy of hundreds of Internet companies created by the “information economy” in Silicon Valley, as well as a temporary loss of investor confidence in this sector of the economy and an outflow of investments. (*author’s remark*).

regularities and principles of functioning and development of complex systems³⁷. At the same time, transformational processes in the global stock market cause the evolution of existing market models and the underlying paradigms. A more difficult task is to model the development of stock market models themselves under the influence of various endogenous and exogenous factors. The applied nature of such modelling is determined by the ability to predict critical events in the stock markets, taking into account the constant need for an adequate response to them, primarily through regulation, which, in fact, corresponds to the feedback principle by which complex systems operate: stability in dynamic systems is achieved through the circular nature of feedback loops. A concrete manifestation of this principle is the fact that regulation is based on continuous feedback information about the achieved result³⁸.

Formation of a methodological apparatus for modelling stock markets

It is logical to conclude that models of various objects, both natural, scientific and technological, as well as political, economic, social, industrial, and financial, are constantly transforming both in the process of evolution of our knowledge about the object of modelling and changes in the environment of this object. It is clear that in the current environment, under the influence of rapid digitalisation, networking and technologisation of the financial and economic sphere, stock market models are beginning to demonstrate fundamentally new features and properties. This leads to the formation of qualitatively new market states, which are nevertheless characterised by internal similarity of functioning processes, logical and schematic description, a certain sequence and continuity of development (from simple to complex).

In order to build the most adequate models of the stock market, which will allow us to predict further trends in its development and forecast the occurrence of a wide range of situations in it, it is necessary, first of all, to typify our knowledge about the object (the stock market).

In our case, important factors for such typification and further generalisations in the modelling process may include: a) the vector of market development; b) the pace of complexity of its infrastructure; c) the emergence of new participants and financial engineering of instruments;

³⁷ They are described in detail in the classical scientific works of the founders of the systemic approach: Bertalanffy L. von. History and Status of the General Systems Theory. In the book: System studies. Methodological problems. Yearbook. – Moscow: Nauka, 1973, pp. 20–37; Blauberger I. V., Yudin E. G. Establishment and essence of the systematic approach. Moscow, 1973; Prigozhin I. From the Existing to the Emerging: Time and Complexity in the Physical Sciences. Moscow: Nauka, 1985; as well as scientific works by the founder of cybernetics, W. R. Ashby. (*author's remark*).

³⁸ This is in line with the approaches set out in the theory of functional systems. (*author's remark*).

d) the dynamics of environmental transformation, etc. This approach involves taking into account the level of complexity of the object, understanding the trends and the degree of interconnection between these trends and the facts of their manifestation.

On this basis, we will formulate the following types of stock (financial) market models, which are described in the order of their complexity:

1. A descriptive model: on the one hand, it is based on the assumption that the stock market is analogous to other socio-economic objects (e.g., credit market, investment market, money market, foreign exchange market), which have similar features of functioning and development, and on the other hand, it allows identifying and analysing the identified trends, giving them a certain type of systematisation³⁹.

2. Correlation model is based on the interrelationships in the stock market system and assessed by certain quantitative indicators, among which the correlation coefficient is most often used, as well as other quantitative ratios that are revealed in the analysis of interrelated events and phenomena in the stock market;

Since this model already has essential features and stable relationships between the elements of the system, it allows us to formulate a general typification of the stock market with certain parameters for each type, and, for example, to quantify the change in one market indicator when another changes.

3. Quantitative model is a certain improvement of the previous correlation model and already provides an opportunity to quantify the relationships between various market parameters, which allows to model specific market indicators with great accuracy, knowing one or more others.

4. The process model is characterised by the concept of a process within which there is an objective change in market parameters over time, i.e. these parameters are described as a function of time, usually in the form of a system of equations.

The above list of models indicates that each of them is essentially a successive complication of the next model in relation to the previous one. At the same time, the previous model is presented as a component of the next one, or the next model is supplemented with new elements compared to the previous one. In other words, the next stage of modelling actually uses the information about stock market processes obtained at the previous stage. This allows us to form a single hierarchical system of market models with different levels of complexity, mechanisms of functioning and understanding of the processes on the market.

³⁹ Approaches to the formation of descriptive models are contained in 1) A. H. Maslow. *The Farther Reaches of Human Nature*. Harmondsworth: Penguin, 1971; 2) Altshuller G. S. *Laws of System Development // Creativity as an Exact Science* – Moscow: Soviet Radio, 1979.

As a result, we can introduce another model – the *aggregate model*, which, unlike the previous ones, includes two or more lower-level models, which allows us to significantly expand the scope of this model and, in our opinion, the quality of forecasting market processes.

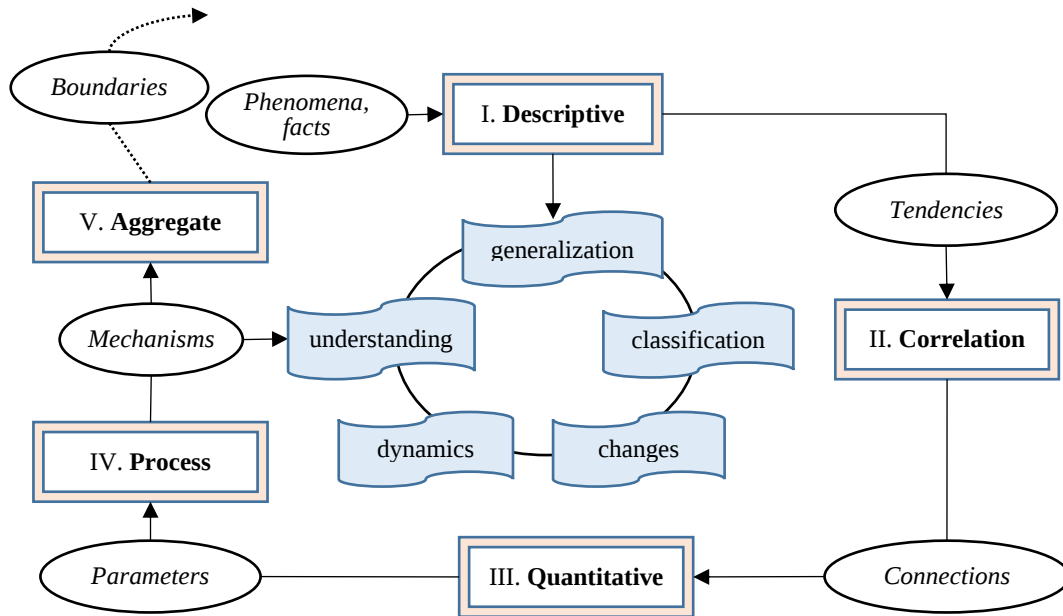


Figure 1. Spiral of evolution of stock market models

As can be seen from Figure 1, each subsequent type of model uses the resource obtained at the previous stage of model development as a new element. This resource is actually the object of modelling, for which the next model of the corresponding type is used (the sequence of these objects in Figure 1 is placed counterclockwise).

In this case, such a resource, for example, for a descriptive model, will be generalised facts and phenomena in the market, and the object of modelling will be the identification of trends; for a correlation model, the resource will be systematised and classified trends, and the object of modelling will be interrelationships; for a quantitative model, the resource will be changes in interrelationships, and the object will be the interdependence of parameters, etc. As a result of consistent changes to the models, we are able to consider a greater number of alternatives for market development and take into account the specifics of market situations more accurately. As a result, we

can predict more complex scenarios of the modelled object's behaviour and optimise this behaviour according to certain criteria (see Table 1).

Table 1

PECULIARITIES OF STOCK MARKET FORECASTING BY DIFFERENT TYPES OF MODELS

Type of model	The stage of evolution	Functionality of the model	Optimisation criteria	Forecast.
Descriptive ●	Objectification (FR as an object)	Responsibility, plural	Identification of phenomena, patterns and features	Typical development scenarios ↑
Correlation ●	Actualisation	Value	Direction and speed of change	Concentration of change ↑
Quantitative ●	Details	Periodic fluctuations	Limit states	Disparities, anomalies ↑
Process ●	Functionality	Singularity (crisis, collapse)	Influence	Long-term changes, forecasting cycles ↑
Aggregated ●	Systematisation	Interdependence	Performance.	General interconnection of different components of the economic system ↑

Table 1 shows that to develop a forecast based on a particular stock market model, a model of a higher level than the forecast itself is always used, i.e. for a specific situation, specific external conditions and specific market characteristics, it is impossible to develop a forecast based on the same quantitative model within, for example, a quantitative model, and for this purpose it is necessary to use a model of the next level – a process model.

Mechanisms for applying models in stock market forecasting

As mentioned above, a new type of model is created by using the resources accumulated in the process of developing models of previous types, which is why this accumulation occurs gradually. Thus, stock market modelling includes the following stages:

A) **for a descriptive model:**

- 1) collecting, accumulating and analysing facts about the market;
- 2) searching for analogies to facts and phenomena in the market among other socio-economic models;
- 3) drawing up a description (“image”) of the market model with the establishment of similarity (commonality) of trends that unite these facts and phenomena;
- 4) checking whether the trends are consistent with the facts and phenomena we observe in reality and forming an initial classification of facts and phenomena in the market;

B) for the correlation model:

- 5) formulating hypotheses about the main correlations, as well as testing these correlations using established analogies and new facts in the market;
- 6) identification of factors influencing the formation of the model with the study of the effect of each factor separately and independently of others based on the additivity effect⁴⁰;
- 7) search and study of “anomalous” factors that may contradict the model’s forecast, with possible “completion” of the primary (basic) classification of facts and phenomena in the market;

C) for a quantitative model:

- 8) measurement of one or more (including “abnormal”) market indicators;
- 9) identification of the “driving” forces that lead to changes in the state of the market model and its structure;
- 10) formulation of quantitative regularities, the totality of which makes it possible to describe market behaviour in certain conditions.

Thus, each of the considered stages of evolution of market models is a successive change in the type of model and represents a systemic hierarchy of stages of market development, forming, in fact, a fractal structure of its transformations. In fact, the study of any type of model begins with the use of descriptive mechanisms, and at the next stages we identify those components that form the basis of the forecast of the corresponding type. In addition, we can assume that there can be several descriptive (classification) models of the stock market, but to form a correlation model, it is important to find qualitative indicators of the relationship, i.e. the analogy should be based not only on trends, but also on the content of changes.

Other types of models, as noted above, in addition to revealing market trends and the relationships between phenomena and facts in the market, should allow for quantitative forecasting of market development, i.e., provide for the compilation of probable quantitative indicators of its structural components. Thus, the process model should offer mechanisms for qualitative (functionally dependent) and quantitative research of market processes.

⁴⁰ An additive effect is a situation where the result of the action of several factors in a system corresponds to the sum of the effects of each of these factors if each of them acts separately.

Conclusions

The evolutionary nature of the development of financial and stock markets, the processes of forming its models, tools and infrastructure institutions certainly has a logical (sometimes eclectic) direction and sequence. Improvements in the conceptual and computational apparatus of the stock market contribute to a deeper understanding of the essence and interconnectedness of the phenomena that occur in it, taking into account their chaotic and unpredictable nature. This process will continue to cover the markets for other financial, quasi-financial, and virtual financial assets: synthetic, composite, digital, cryptoassets, etc. Descriptive and correlation models can be perceived as a methodological basis for stock market research and analysis.

Going through the stages of gradual complication of the model, highlighting the relationships between the model components and the parameters of these components, a general paradigm of global stock market development is formed, which reveals trends, patterns, features, factors, processes, and also provides opportunities for their forecasting.

Obviously, this methodological approach, with certain variations, can be used to model and forecast other socio-economic systems that operate on the basis of the market and marketability, using the techniques of generalisation, abstraction, systematisation, classification and ordering. The emergence of new resources (functionality) in the transition from one model to another stimulates the transformational nature of market development, which necessarily uses elements of the previous types of models.

** This article was translated from its original in Ukrainian.*

References

1. Burmaka, M. O. "Creativisation of the Global Investment Process." *International Economic Policy* 2018, no. 2 (29). [In Ukrainian]
2. Blauberg, I. V., V. N. Sadovsky, and E. G. Yudin. *Systematic Approach in System Science, Problems of System Research Methodology*. Moscow: Mysl, 1970. [In Russian]
3. Buffett, Warren E. *The Essays of Warren Buffett: Lessons for Corporate America*. The Cunningham Group & Carolina Academic Press, 2015.
4. Burmaka, M. O., and F. A. Zinchenko. "Global Format of Financial and Institutional Transformation of Stock Exchanges." *International Economic Policy* 2017, no. 2 (27). [In Ukrainian]
5. Draper, N.R., and H. Smith. *Applied Regression Analysis*. Jhon Wiley & Sons, Inc., 1998.
6. *Factor, Discriminant and Cluster Analysis*. Edited by I.S. Enyukov. Moscow: Finance and Statistics, 1989. [In Russian]

7. Golovko, A. T., S. M. Laptev, and V. G. Kabanov. *Markets of Financial Instruments and Their Financial Infrastructure*. K.: Krok University of Economics and Law, 2009. [In Ukrainian]
8. Greenspan, A. *The Age of Turbulence: The Adventures in a New World*. New York: The Penguin Press, 2007.
9. Lee, R. *Running the World's Markets: The Governance of Financial Infrastructure*. Princeton University Press, 2011.
10. Leonov, D. A., S. V. Levochkin, and S. G. Khoruzhiy. *The Market of Financial Services as a Paradigm of European Integration*. Edited by V. M. Fedosov. K.: WIRFR, 2008. [In Ukrainian]
11. Mantegna, R. N., and H. E. Stanley. *An Introduction to Econophysics: Correlations and Complexity in Finance*. Cambridge: Cambridge University Press, 1999.
12. Maslow, A. H. *The Farther Reaches of Human Nature*. Harmondsworth: Penguin, 1971.
13. Mozgovyi, O. M., T. O. Frolova, L. V. Rudenko-Sudarieva, et al. *Global Financial Development: Trends, Technologies, Regulation*. Edited by O. M. Mozgovyi. Kyiv: KNEU, 2017. [In Ukrainian]
14. Murphy, J. *Technical Analysis of the Financial Markets*. New York Institute of Finance/Prentice Hall, 1999. <https://books.google.com.ua/books/about/...>
15. O'Connor, J., and I. McDermott. *The Art of Systems Thinking: Essential Skills for Creativity and Problem Solving*. Thorsons Pub, 1997.
16. Pass, C., B. Lowes, and L. Davies, eds. *Collins Dictionary of Economics*. 1998.
17. Peters, E. E. *Fractal Market Analysis: Applying Chaos Theory to Investment and Economics*. Jhon Wiley & Sons, Inc., 2003.
18. *Philosophical Encyclopaedic Dictionary*. Model. Edited by V. I. Shynkaruk and others. K.: Abris, 2002. [In Ukrainian]
19. *Stock Market: Textbook; in 2 Books – Book 1*. Edited by V. D. Bazylevych. K.: Znannya, 2015. [In Ukrainian]
20. Teweles, R. J., E. S. Bradley, and T. M. Teweles. *The Stock Market*. John Wiley & Sons, Inc., 1992.
21. Weild, D., E. Kim, and L. Newport. "Making Stock Markets Work to Support Economic Growth: Implications for Governments, Regulators, Stock Exchanges, Corporate Issuers and Their Investors." *OECD Corporate Governance Working Paper*, no. 10, 2013. OECD Publishing. <http://dx.doi.org/10.1787/5k43m4p6ccs3-en>.

Received on: September 28, 2023.

Accepted on: November 13, 2023.

Released on: December 15, 2023.