The impact of the digitisation of the financial industry on the modelling and pricing of financial assets

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Abstract: Digital financial services continue to expand and replace the delivery of traditional financial services to the customers. The purpose of the study is twofold. First, to consider the growing interest in price modelling for financial assets. The second goal is to trace the role of digitisation in finance on changes in the methodology of both modelling and pricing of financial assets. Digitisation automates financial products and services, as a result of which the quality of financial services is increasing, the set of offers is expanding, and the financial markets are growing numerically. The transformation of finance to 'digit' allows us to provide a real basis for the widespread introduction of Bayesian methods of modelling and valuation of financial assets. The article introduces preliminary premises for the demarcation of classical and digital finance, as well as traditional and new methods of pricing and predictive modelling in connection with the wide implementation of 'big data' and 'digit'.

Keywords: digital finance; financial modelling; methodology; Bayesian method in finance; pricing.

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1 Introduction

The concept of 'digitisation finance' can be considered and defined in different ways. However, all can be combined around digital processing and digital organisation of money flow and related changes in the economy and the whole society. Often the digitisation of the industry is associated with the FinTech revolution (Arner et al., 2016) or penetration of information technology in finance (Sigova and Klyuchnikov, 2016). Undoubtedly, rapid changes in financial technologies have largely become possible due to the digitisation. In turn, the latter plays an important role in the further transformation of finance.

According to McKenzie, in developing markets, about 2 billion people are served by digital banking, over $ 2 trillion in loans, more than $ 4 trillion in deposits, and helped governments save up to $ 110 billion a year. By 2025, in the developing world, digital finance will be responsible for creating $ 3.7 trillion in GDP (McKinsey Global Institute, 2016). In many cases, access to financial services is seen as an important mechanism for overcoming backwardness and poverty. In this regard, the digitisation of finance is largely responsible for solving this problem.

The key moment of 'digitisation of finance' and its further penetration into society is the transition to new methods of pricing financial assets and on this basis of predictive modelling. Due to the rapid spread of modern technologies for the transfer and processing of money and other liquid assets (mainly securities), there is a desire to divide finance into primary and secondary or digital. The traditional (primary) theory of finance is based on the frequency statistical principle for determining the price of financial assets, while digital finance is more consistent with the Bayesian methods of determining the price. Probabilistic price estimates are not only the result of analysis of historical data, but also take into account current trends and possible directions of development, which implies scenario variants of future prices.

Modern finance, built on telecommunication technologies, on the one hand, formally has a great coherence of actions between communication participants and structural interactions between different parts and forms of financial assets; on the other hand, absolutely opposite processes are observed – disagreement appears and coordination becomes more complicated. In such conditions, the complexity of calculating the prices of financial assets and assessing the possible options for their future development sharply increases.

The purpose of the study is twofold. First, to consider the growing interest in price modelling for financial assets. The second goal is to trace the role of digitisation of information in the industry in the framework of modelling and methodological changes in pricing research.

2 Related work, framework and approaches

The literature on the issue of financial digitisation is extremely young. Unfortunately, it is still limited to the 'technical' and highly specialised aspects of the problem. At the same time, a solution of a number of conceptual issues has already matured, in particular, a participation of the digit in changing the methodology of the analysis, modelling and forecasting of finance.

The digital movement of finance in many respects predetermines a broader phenomenon – the 'financialisation' of the economy, as it creates a kind of 'material' conditions for the penetration of money, credit, and finance into all spheres of society (Sigova et al., 2016). The other side of the problem is the establishment of an information-financial society, which can be defined as DataFin (by analogy with FinTech), in which the merger of finance with information occurs (Wray, 2015). Naturally, all this is imposed on social communications and merges with the latter. The fact is that the digitisation of finance acts as a kind of catalyst for both financialisation and the information-financial development. In a number of cases, the problem of forming an information and financial society is reduced to the issue of the digital revolution with financial inclusions (Gabor and Brooks, 2016). Then the very meaning of the merger of information with finances is narrowed down. There are still no studies that have evaluated this triad of relationships and developed the conceptual framework for social, information and financial interactions. The article poses a more modest task – an analysis of the central aspects of the problem of financial digitisation associated with a change in the pricing methodology, which allows us to draw some broader conclusions and assumptions about the impact of the transition of finance to the figure.

Many studies analyse the effect of digitisation of finance on the firm performance. In such cases, both quantitative and qualitative methodologies are used. Despite considerable research into the impact of financial figures on firm productivity, the first literature review on this area appeared in 2017 (Abbasi and Weigand, 2017). The review can play an important role in the further development of research by identifying their 'white spots'. The survey on the impact of digitisation on the banking and related industries was also conducted last year (Sigova and Klyuchnikov, 2017).

The digital finance has many options and opportunities: new business models that emphasise the direct monetary result of any actions and not only the company, but also the community and state regulation is built on the achievement of the final result. Meanwhile, in the economy, not all are quantifiable and digitised. In finance, measurements are always combined with word descriptions. Words and numbers are twins, which create the value for financial ideas and decisions. They can also reflect subjective process, the psychological characteristics of the decision-making. Words expand the ability to explain and understand the behaviour of the economy, including evaluating it using metaphors. In this sense, verbal financial constructions are comparable with mathematical ones, which study the non-metrical properties of figures or spaces (shape, structure and location) that represent a topology. Financial categories and models are capable of capturing and mirroring and processing the economy from qualitative positions, as well as geometry, which views the phenomenon from a spatial perspective, rather than from measurements and quantitative determinateness. Topology assumes a variety of forms, which can be used differently. Each of them does not lose touch with its original forms. Similarly, the word descriptions of financial interactions in the form of categorical apparatus and semantic connected constructions, terms, concepts and definitions serve for qualitative characteristics. Complementing their respective model range, which can combine quantitative measurements with qualitative non-metric properties and orders. The industry's digitisation puts a new distinction between digital and verbal descriptions of finance. New methods of pricing and financial modelling try to take into account digital and word descriptions of finance.

At the heart of the transition to the virtual market and the digital economy is largely the digitisation of finance. This transition raises new questions. The main ones are: to what extent does the 'invisible hand' still dominate? Is the illusion of a competitive price in markets controlled by robots and algorithms? Can existing laws protect consumers in conditions of digitising all transactions? The changing market reality already transfers power to the hands of a few, equipped with new knowledge and having access to 'great data' and 'digit'. In this regard, new approaches to the pricing of financial assets, the calculation of market prices and financial forecasting arise.

On the last economic form in Davos, it was assumed that many transformations that will occur in the next thirty years, inevitably, are due to technological trends that are already in motion. Often an optimistic 'road map' of transformations is proposed – from virtual reality in the house to the digital economy and artificial intelligence. And at the heart of all interactions and transitions will be new payment, settlement and investment processes, the basis of which will be the universal pricing of financial assets and the digital financial platform. Their appearance will be the result of the digitisation not only of the financial industry, but also of the basic economic processes. The quantification of finance is connected in many respects with new price determination mechanics that will allow changing the forecasting mechanism and in many respects assessing the whole future. By incorporating new approaches to price determination and forecasting into a universal financial platform, it is easier to stay on the wave of change and build everyday relationships with financial technologies. In such circumstances, the basis for all the transformations is the financial digitisation.

Within the framework of our civilisation, we can single out three major revolutionary changes in finance, which in many ways served as the basis for socialisation and the formation of modern society, and also became the original infrastructural vehicles for progress. The first, undoubtedly, is associated with the emergence of money and the conquest of their dominant positions in society. The second is the formation of derivatives from assets of instruments – first bills of exchange, then bonds and shares, as well as the distribution of double bookkeeping and the decimal system of accounting and calculation (the Middle Ages). At the heart of the third was an information breakthrough in financial communications. Initially, it was based on the electric transmission of investment and monetary information (second half of the 19th and early 20th centuries) (Klyuchnikov and Zatevakhina, 2017), and now on the digitisation of finance (Klyuchnikov et al., 2017).

3 The transition of pricing under the influence financial digitisation

Forecast analysis of prices for financial assets is extremely important for traders, it is necessary for asset management and budgeting at various levels and forms of ownership, and is also useful for politicians and the general public. In addition, it is essential for any forward-looking assessments of the state of finance. The digitisation of the financial industry has made significant adjustments to the mechanisms of both pricing and predictive assessment of finance.

Risk analysis is part of every decision taken. The market is constantly faced with uncertainty, ambiguity and volatility. The quantification of finance allows for a new approach not only to pricing, but also risk assessment in price.

Despite the emergence of opportunities for unprecedented access to information, the prediction of future prices becomes even more difficult than before. However, new methods are emerging that will allow us to consider possible options and assess the impact of risk on their performance.

Modelling through the Monte Carlo method opens up new possibilities and presents options, consideration of which allows making decisions more effectively (Klyuchnikov and Molchanova, 2015). In order to calculate the value of the portfolio risk (VaR), it is advisable to launch a Monte Carlo simulation, through which you can predict the worst-case scenario - a possible loss for a portfolio with a specific time horizon. For this, two conditions for VaR are usually indicated: trust and time's horizon.

3.1 From the frequency statistics to the Bayesian pricing

In the past two decades, the option-pricing hypothesis has become one of the main directions for the forecast pricing of financial assets. And it became a key notion not only of theory, but also of exchange practice. It was widely used to calculate stock prices. The formula compiled on hypothesis basis introduced the conditions that allowed us to deal with basic market processes and, on the whole, it allowed us to characterise the state of finances. Due to its compact form and relative computational simplicity, the formula built on the basis of the pricing hypothesis is very popular in the financial industry. Using this formula, traders began to better understand and evaluate financial assets in accordance with two components of value: intrinsic value and time value. The application of the model allowed considering possible price variants, which increased the level of predictive behaviour. Over time, traders switched to using some modified versions of the model, which allowed them to make their own decisions about what to buy and sell. So there was a peculiar personification of predictive modelling – the model began to meet the individual characteristics of traders and meet their personal needs and requirements.

When looking for possible options for future prices, the most important questions are: what kind of pricing model is most acceptable and which variant of probabilistic evaluation is preferable? Moreover, this problem is important not from the position of solving the mathematical problem of determining the future price, but for a more accurate description of the real market pricing process, estimating the possible dispersion of prices and approach to the 'best' price. So the mathematical justification for considering all the unknowns in the process of pricing can be fulfilled quite accurately. In particular, under certain assumptions, market makers set prices fairly accurately in accordance with their real market value (accuracy is determined in the first minutes of trading – as the dispersion of supply and demand is insignificant). In doing so, they are based on existing mathematical models, since the distribution of price probabilities on the market allows you to select the necessary actions based on the maximisation of the expected value of the utility function. However, regardless of the market maker's setting of the price (bid price), the demand introduces significant adjustments (asked price) and changes the efficiency of the mathematical model. Thus, there is a discrepancy between mathematical evidence and market testing, which is reflected in the spread between the prices of supply and demand. The discrepancy is based on differences in the nature of the randomness itself – in the first case, it can be attributed primarily to frequency statistical (within the historical series describing the preceding events), and in the second – completely to Bayes probabilistic (including ones that do not have analogues in the previous event series). Thus, in the first case, the process of assessing the probabilities of establishing certain prices in the market is relatively free of assumptions and relies on previous events as determining for the future; in the second, the calculations are based on various assumptions that are ranked by significance and the events that they assume affect the following. Differences lie in the empirical and a posteriori probabilistic solutions to the pricing problem. The a posteriori probability follows from the interaction of the probability of occurrence of the event, which follows from the a priori probability. Thus, the a posteriori probability of the parameters (the price of the derivative financial asset, for example, the stock option) θ is dependent on the event χ (the price of the original financial asset, for example, the stock), taking into account the indications X: $p(\theta|X)$, which contrasts with the likelihood function, which is the probability of the given parameters – $\rho(X|\theta)$. The likelihood function is related to the probability distribution function – $\rho(\theta)$. In general, the a posteriori probability can be represented as follows: $\rho(\theta|\chi) \propto \rho(X \mid \theta)\times \rho(\theta)$.

In order to preserve mathematical correctness, one cannot reject any interpretation of probability. Therefore, all variants of price calculations should be considered in the appropriate coordinate system and each option should be considered as possible under certain circumstances. As a result, a rather large dispersion of possible variants is formed. As a practical consequence, there are large spreads between the prices of supply and demand. Different hedging methods are used to level the risk. This compensates for the risk that may be underestimated in the Black-Scholes pricing model.

There is also a multiplicity of 'uncorrelated' rates, in the hope that the exposure risk will compensate each other and, as a result, neutralise the possible losses associated with unforeseen risks and not considered auction trading. Thus, a kind of hedging is being built, which includes premiums that can cover losses. The collection of such premiums is associated with the creation of a unique portfolio of reliability. Thus, in the end, profit compensates for any unknown events (including those related to unpredictable uncertainty – such as the 'black swan'). On the basis of all new trends, the international market of derivative options is thriving. Its quantitative growth exceeds all other changes in the financial market. If in the calculation of the probabilities of certain prices to exclude the philosophy of the model and work exclusively within the Kolmogorov axiom, then it is necessary to classify the methods of forecasting and probabilistic estimates. Moreover, if each method is mathematically correct, then it should be used. However, practice shows that forecasts based on one method and within one time interval may not be realised within the other.

3.2 Modifications of pricing modelling

To assess the price prospects of financial markets, binomial variants of price movement modelling are recognised. The first versions of this approach appeared in 1979. They were proposed by three researchers (Cox et al., 1979). The model was originally applied for a simplified evaluation of options. Later, variants of pricing models for various financial assets appeared. This transition was mainly due to the expansion of the application of the Brownian motion and the construction of a tree of targets in the Markov regime (chains and Markov processes). As a result of introducing new approaches into the model, it became possible to reflect information about the situation on the market that could not be modeled only by a linear Gaussian process. Thus, it became possible to change the parameters de-pending on the situation on the market and at the same time preserves the simplicity of the model. This approach was consistent with the hypothesis of market efficiency, in particular with the provision that all information about the price of shares is reflected in their value. This combination and complementation of the two hypotheses and their practical application strengthened the evidence base of classical financial theory.

As a result, there has been a transition from static to dynamic perception as a pricing hypothesis, as well as an effective market hypothesis. Using the so-called multi-fractal switching of Markov chain in finance ensured such a transition. Thus, a kind of revolution in the approaches to forecasting was made. So, if the future was evaluated from the perspective of extrapolation of past events and based on long time series, the new approach opened new prospects for forecasts – the future state depends only on the current state, and not on the events that took place before them.

The introduction of the preference assessment formula into options, which included the investor risk and his subjective opinions, became a significant contribution to the hypothesis and greatly expanded its application. A practical consequence of the new approaches was the transition to the current management of portfolio investments – investment funds began to continuously regulate portfolios in accordance with the principle of non-arbitrage. One consequence of this transition was the increased liquidity of the markets, as investment funds began to regularly review their portfolios and continuously sell and buy shares, which affected the increase in market activity (before this, long-term storage of shares in portfolios was practiced). At this time, the so-called high-frequency trade on the basis of robots programmed to optimise the breakdown of portfolios of investment funds and sell at the best price of their parts, as well as the purchase of not all new volumes at once, but various parts at favourable prices, intervened. As a result, price optimisation was outlined and the search for maximum price hikes for individual brokers and investors became more complicated.

When looking for possible options for future prices, the most important questions are: what kind of pricing model is most acceptable and which variant of probabilistic evaluation is preferable? There are two main methods of pricing and on their basis predictive modelling:

1 Interpretation of frequency probability

  Classical interpretation of frequency probability: a pragmatic definition of probability is sufficient: $p(E) = \lim_{N \to \infty} n/N$, where N – number of financial cycles (tests, experiments) for a certain period of time, n(E) is the number of recessions E (events) for a certain period of time.

Each cycle (experiment) should be repeatable (in principle identical). In this respect, each repeated financial event couldn't be regarded as an identity; while the time of the onset of oscillations, their amplitude, duration, causes and consequences are in principle unique, but the ups and downs are repeatable. The disadvantage of this method: one cannot make categorical statements about the probability of any true value. At a certain level of reliability, only the upper and lower limits that boundary repeatability.

2 Bayesian statistics, subjective probability

Preliminary subjective assumptions are included in the calculation of the probabilities of hypotheses H (instead of the designation E – the event used in the previous equation, in order to distinguish two methods of determining the probability, we use the other designation of the event – H).

p(H) – the degree of conviction that H is true.

Metaphorically: probability is the ratio of a specific rate to the expected result, for example, of additional investment or their decline and recession.

Two types of events are given: A and B. The probability of A is p(A), and of B is p(B). Then the probability A or B is p(A or B) = p(A) + p(B) – p(A and B).

If A and B are mutually exclusive, then p(A and B) = 0.

A special case: B = $(\bar{A})$ (A does not happen), p(A и $(\bar{A})$) – p(A) + $p(\bar{A})$ = 1.

The joint probability of events A and B occurs simultaneously:

p(A and B) = p(A) • p(B | A), where p(B | A) is a conditional probability.

If A and B are independent, then we obtain ρ(B|A)=p(B), respectively:

p(A and B) = p(A) • p(B).

Thus, the transition to Bayesian mathematics in finance fundamentally changes the very approach to the accuracy of results and their interpretation. If earlier the accuracy ensued from the theory of measurements was clearly enough fixed and did not cause doubts, and then under new conditions the accuracy is rather conditional and subjective. It is based on the correlation and limit in certain boundaries, which is due to the conventionality of measurements within the established parameters. The new measurement rules are based on game theory. In general, the modern approach to the probability of financial events is based on the synthesis of objective and subjective in measurements, frequency and Bayesian statistics. Its use became possible only due to the financial digitisation, which made it possible not only to significantly expand the data to be taken into account, but also to change the approach to their processing. So, in many respects the transition to new methods of pricing and predictive modelling was prepared by revolutionary changes in finances caused by the arrival of 'big data' and 'digitisation'.

4 Digital reorientation of the finance theory

Many models that are traditionally used by one approach can be applied to another approach. In general, the Bayesian approach is a maximum abstraction with almost always solved problems of determining the probabilities of market accidents, and if solutions are not available, then this situation is also fully mathematically described. Statistics in the consideration of the financial market makes extensive use of mathematics, but in the variants of mathematical guesses – the average statistical movement of the market, the average spread of price options, etc. In statistics idealised abstractions are not considered (although they are used as tools), it involves real-world phenomena. That is why it is statistically possible to confirm the hypothesis of the efficiency of the stock market (Fama, 1965). If you include all the circumstances, then the hypothesis of financial instability (Minsky, 2008) more fully meets the Bayesian philosophy. In our opinion, the discrepancy between the two approaches that determine the financial market, on the one hand, is both effective and, on the other hand, not effective - unstable and uncertain, rather laid in the differences in frequency-statistical and Bayesian approaches to the assessment of events. Therefore, in our opinion, considering interpretations of probabilities, taking into account the application of the two options considered to the financial market, allows us to move from an idealised to a real financial market with all its uncertainties and variously directed accidents. According to many economists, the Minsk moment based on the irrationality of the market, has become the defining vector of financial development. To open the veil from financial bubbles, which are the result of systematically irrational behaviour, can be made with the help of Bayesian probabilities. As explained by the American economist Randall Wrey, the most important idea of Minsky is that ‘stability destabilises’ to the extent that the economy formally achieves reliability and stability, but in fact prepares the conditions under which the collapse becomes more and more likely (Sigova and Klyuchnikov, 2016). An evaluation of this crash with a higher level of probability is achieved by means of the Bayesian approach to the definition of probabilities.

Thus, rather simple statistical tools provide an opportunity to simplify the system and on this basis to order it towards the average values. This approach allows you to fit the problem area into a rather abstract market model. Solving the problem in this way makes it possible to find a purely mathematical solution for the market system and make reasonable guesses of the directions of development. But they are just well informed guesses that are made on the basis of frequency samples and average abstractions.

Bayesian methods allow us not to expand so much as to reorient the usual methods of assessing financial prospects by including not only past trends and repeatable results, but also current and often differently directed phenomena and processes. At the same time, the main emphasis is on current situations, not on past repeatability and habitual cyclicality. By means of such methods, the search for and evaluation of the probabilities of the development of existing situations, which can both maintain their importance in the future, and with different rates decrease or increase. In addition, with its help, it is possible to search for dependent results and construct entire chains of probabilistic events, as well as to make estimates of possible variants of development to evaluate variants for certain outcomes, with a particular sequence of development. Thus, thanks to the Bayesian method, a new perspective appears for predictive modelling of markets. The transformation of finance to ‘digit’ allows us to provide a real basis for the widespread introduction of Bayesian methods of modelling and valuation of financial assets.

The theory of probability helps provide the grounds for a realist solution to the measurement problem within traditional finance in conditions of relative stability of markets and sustainable growth. In the face of limited data and computational capabilities, it was limited to a small number of data. The digitisation of finance has allowed extending both the scope of the theory of probability and the range of data included in the calculations.

5 Digitisation and verification of financial actions

There are differences between the statistical and Bayesian methodologies of studying financial events. Meanwhile verifiability is rather difficult. Difficulties begin with the search for criteria for verifiability for several reasons. First, it counts existential statements (for example, 'the price reflects the intrinsic value of the asset') as scientific, although there is no way to finally show that they are false or truthful. In the end, the fact that financial products are sold in accordance with the demand and supply, does not deny that they are based on intrinsic value, rather than purely market competitive relationships. Secondly, universal statements (for example, 'all swans are white' or 'oil prices will go up') are meaningless simply because they can never be finally verified (at least then the price go down at crisis). However, these varieties of universal statements are common in science, and some observations (e.g., observation of the black swan or bear markets) can clearly show that they are false. Finally, the criterion of verification of probabilities in its own light does not make sense, because it cannot be verified at least till the event coming.

Partially in response to such concerns, the digitisation closely leads to the reliability criteria of credibility and, instead, emphasise the importance of transition to a new round of trust based in particular, on block technology. The authors, however, support the thesis that digital finance has not played any role in formulating a satisfactory criterion for demarcating the information sphere to traditional and 'big data' (Sigova and Klyuchnikov, 2016).

Digital finance is characterised by being bold in two related ways. First, digital finance, unlike traditional financial theories, is often not consistent with generally accepted views of the world, based on common sense or previous experience. Digital finance has additional information content as well storage and calculation capabilities, which allows them to significantly expand the observed markets, time horizons and possible options. With this in mind, the digit opened up additional opportunities for researchers in theorising and gave them extra boldness. This boldness has allowed departing from the ideal market designs, which offered the classic finance and proceeds to analyse the imperfections of the financial markets, a variety of noise effects, friction and behavioural features. The general trend of development is the approximation of financial models to market realities, and not to imaginary ideal constructions.

It can be argued that digital finance can play an important role both in the scientific and philosophical context, as they open up scope for rethinking many traditional views. Secondly, digital finance is very real. Their reality is aimed at further knowledge of the truth – the realities of financial interactions. In this sense, digital finance is a kind of pacificator that believes that although a specific theory accepted in traditional financial science may be true, we will never know about it. For the same reasons, it can be argued that it is impossible to justify your conviction that a certain financial theory is completely correct. Finally, when, under the influence of big data and the digits, financial science progresses, confirming or rejecting the truth of various specific concepts, hypotheses, theories, definitions, it continues to rely purely on intuition on the evolutionary model. True, with a possible caveat – the prospects and possibilities for the digitisation of finance and new technologies, in particular, the issue of money and financial assets do not fully disclose yet. We have just started discussing the possibilities and prospects of the transition from centralised to decentralised finance, changing the approach to trust – the central property of monetary communications.

In particular, the digit had an impact on behavioural finance. First of all, it allowed to include in the set of indicators with which the researchers operate and which include in the model many motives and psychological characteristics of market participants. The theory of psychoanalysis grips that human behaviour is driven at least partly by unconscious desires and motives. The big data and digit allowed taking into account data on the behaviour of market participants from social networks. As a result, the market analysis shifts into new directions that were not taken into account before and were not taken into account in modelling and pricing.

6 Conclusions

Financial content is part of the historical progress and is a singular process that occurs only once; it is impossible to test any market up and down. This stands in stark contrast to disciplines such as physics, where the testing plays a central role in making progress. A law that purports to describe the future progress of financial market in its entirety cannot be easily tested in this way. Even in cases where a particular prediction about the price or crisis is wrong, there is no way to change the theory for retesting. There is also no possibility of formulating and testing laws of a more limited scope, such as those designed to describe the process that occurs on a particular exchange, or the trends that are trying to become determinants in a given market. In this respect, the digitisation does not remove the restrictions from the limited testing of financial laws and verification of the effect of hypotheses in the real market conditions. Nevertheless, it expands the possibilities of researchers.

The authors put to the forefront the prospects of methodological financial digitisation, which will allow to change the theoretical and practical ideas about finance and, accordingly, to change the management mechanism of the industry. As soon as we start trying to explain or predict the behaviour of the market as a whole and its individual players in terms of the psychological motivations of the individual, we quickly note that these motives themselves can not be understood, on the one hand, without reference to the wider social environment in which markets find themselves, on the other hand, without a contest of objective economic reality. However, objective economic reality is the product of specific social actions and institutions that, in a long evolution, have led to their emergence. There is a hope that the digitisation will allow us to combine the analysis of subjective current modifications and interests with the past interests and motives crystallised in the corresponding financial institutions.

When looking for possible options for future prices, the most important questions are: what kind of pricing model is most acceptable and which variant of probabilistic evaluation is preferable. And, not from the position of solving the mathematical problem of determining the future price, but for a more accurate description of the real market pricing process, estimating the possible dispersion of prices and the approach to the 'best' price. In the face of increasing uncertainty in markets, the best option is to estimate not only the history of price movements but also the current market conditions.

From a purely mathematical standpoint, the differences between frequency and Bayesian methods are very simple: in statistics, the frequency response is an average fixed value; in Bayesian statistics, an unknown parameter is considered as a random variable. If the first method was widely used in finance, then the second method is just beginning to break through, not only for estimating probabilities, but also as a forecasting tool and a mechanism necessary for making decisions, which makes it possible to include it in the arsenal of financial markets management. Bayesian methods allow not only to expand, but to reorient the usual method of assessing financial prospects by including not only past trends and repeatable results, but also current various-order phenomena and processes. The advantage of estimating probabilities using empirical probabilities is that this procedure is relatively free of assumptions and therefore, from the formal side, it is more attractive not only for markets players, but also for decision-making at the state level and in various areas of the economy.

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References

Abbasi, T. and Weigand, H. (2017) *The Impact of Digital Financial Services on Firm's Performance: A Literature Review*, 30 May [online] https://arxiv.org/pdf/1705.10294.pdf (accessed 14 February 2017).

Arner, D.W., Barbarist, J. and Buckley, R.P. (2016) 'The evolution of Fintach: a new post-crisis paradigm?', *Georgetown Journal of International Law*, Vol. 47, No. 4, pp.1272–1318.

Cox, J.C., Ross, S.A. and Rubinstein, M. (1979) 'Optional pricing: a simplified approach', *Journal of Financial Economics*, Vol. 7, No. 3, pp.229–263.

Fama, E. (1965) 'Random walks in stock market prices', *Financial Analyst Journal*, September to October, Vol. 21, No. 5, pp.55–59.

Gabor, D. and Brooks, S. (2016) 'The digital revolution in financial inclusion: international development in Fintech era', *New Political Economy*, Vol. 22, No. 4, pp.1–14.

Klyuchnikov, I. and Molchanova, O. (2015) 'Monetary and financial economy: from stability to instability', *Scientific Notes of the St. Petersburg Academic University*, Vol. 4, No. 52, pp.7–13.

Klyuchnikov, I. and Zatevakhina, A. (2017) 'Financial stability in the era of digital technologies: conceptual approaches and directions of regulation', *Scientific Notes of the International Bank Institute*, Vol. 2, No. 20, pp.3–19.

Klyuchnikov, I., Molchanova, O. and Kliuchnikov, O. (2017) 'Probability of financial stability and security: concepts and models', *Finance and Business*, Vol. 13, No. 1, pp.70–81.

McKinsey Global Institute (2016) *Digital Finance for All: Powering Inclusive Growth in Emerging Economy*, September, No. 124, p.8, NewYork.

Mihsky, H. (2008) *Stabilizing and Unstable Economy*, 5 May, McGraw-Hill, New York.

Sigova, M. and Klyuchnikov, I. (2016) 'The theory of financial innovation. A critical review of the main approaches', *Bulletin of the Financial University*, Vol. 6, No. 96, pp.85–96.

Sigova, M. and Klyuchnikov, I. (2017) 'Large data and the transition to a new financial order', *Scientific Notes of the International Banking Institute*, Vol. 3, No. 21, pp.5–22.

Sigova, M., Kruglova, I. and Klyuchnikov, I. (2016) 'Approaches to the classification and assessment of the prospects for financial security', *Banking Law*, No. 6, pp.29–35.

Wray, L.R. (2015) *Why Minsky Matters. An Introduction to the Work of a Maverick Economist*, 3 November, Princeton Univ. Press, Princeton (N.J.).