Conceptual model for managing sustainable development of the financial market based on fuzzy cognitive maps: case study of Kazakhstan

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Abstract: Kazakhstan's financial market, being relatively small in size, does not have the ability to compensate for the needs of economic entities for financing development through market mechanisms. Therefore, a decision support tool is needed to ensure continued growth. The solution was to use a fuzzy cognitive map and a method for constructing indicators of the system's sustainable development which included a set of three types of subsystem: economic, financial institutions, and financial markets. The sample, containing data from between 1993 and 2018, uses 31 indicators of the economic development of Kazakhstan to reflect the ability of the system to develop in terms of depth, accessibility, efficiency, stability, integration, innovation, and cognitive approach of the economic agents. The current state of the financial market for the period up to 2025 indicates initial shallow depth and slow progress requiring increased investment, GDP growth and reduced inflation to stimulate its development.

Keywords: economic system; financial market; financial institution; financial indicators; sustainable development; fuzzy cognitive map; FCM; conceptual model; decision support system; strategic decisions; Kazakhstan.

Reference to this paper should be made as follows: Nichkasova, Y., Sadvokassova, K. and Kayupov, N. (2021) 'Conceptual model for managing sustainable development of the financial market based on fuzzy cognitive maps: case study of Kazakhstan', *Int. J. Economic Policy in Emerging Economies*, Vol. 14, No. 1, pp.1–38.

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1 Introduction

One of the most commonly cited definitions stresses the economic aspects of sustainable development as "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). Creating a model of sustainable economic growth for the formation of Kazakhstan's global competitiveness is an urgent strategic task to ensure economic growth rates higher than the world average and promote Kazakhstan among the top-30 most economically developed countries. The essential conditions for the successful implementation of this task are to ensure macroeconomic stability, the effective performance of financial institutions to support economic development and the expansion of channels of access to monetary resources through financial markets.

Financial markets do not function indirectly from the economic system, which forms the basic conditions for their development. Analysis of the factors of the economic development of Kazakhstan was conducted by a number of researchers (Aizhan and Makaevna, 2011; Khoich, 2012; Akimov and Dollery, 2008; Facchini, 2013; Kalyuzhnova and Patterson, 2016; Kalyuzhnova, 2011; Mukhamedzhanova and Medebayeva, 2018; Mukhtarova et al., 2018; Oskonbaeva, 2018; Shahbaz et al., 2017). The period from 1991 to 2018 is characterised by the implementation of a number of institutional reforms aimed at shaping the market economy. The main results are the high dynamics of GDP, record-breaking levels of attracting FDI based on the extraction of natural resources, and the high need for diversification of economic development directions.

Unfortunately, despite significant progress, Kazakhstan's economy is excessively dependent on external investments, suffers from low diversification and lacks internal resources. Experts of the World Economic Forum and the Organisation for Economic Cooperation and Development argue that access to financial resources is the main constraint for sustainable economic growth in Kazakhstan (OECD, 2016; Schwab, 2017). The OECD report highlights seven key constraints for economic development, including the fragility and underdevelopment of the financial sector, which operates in a difficult economic environment associated with a lack of transparency in the state regulatory system. The financial system remains fragile and vulnerable to external shocks. The banking system is undergoing a period of adaptation to new prudential requirements, which negatively affect its ability to credit the economy (Kasman and Mekenbayeva, 2016; Ruziev and Majidov, 2013; Ziyadin, 2012). According to researchers, despite a high level of penetration of the banking system into the economy (more than 90% of enterprises have bank accounts), only 19% of them had access to lending (OECD, 2016). The financial market, being relatively small in size, does not have the ability to compensate for the needs of economic entities for financing development through market mechanisms. The volume and structure of trades indicate a discrepancy between the size of the stock market and the size of the economy, and the low activity of issuers indicates a lack of experience and knowledge in the use of financial instruments to attract long-term financing.

The government, in order to improve access to financial resources, is taking measures to develop the institutional structure of the financial system, including banking institutions and the functioning of the stock market. Serious efforts were made to consolidate and improve the banking sector, including through direct funding of systemically important banks to preserve the stability of the country's banking system, controlling the level of non-performing loans. Thus, in 2018, through the fund for problem assets, the state allocated $24 billion to rehabilitate the banking system. However, banks are still limited in their ability to increase capital, which negatively affects their performance as a channel for the transformation of savings into investments. Under these conditions, Kazakhstan's economic entities are forced to rely mainly on restricted domestic sources of financing, which is holding back the growth and development needed to accelerate the transformation of the economic structure.

In contrast to this current situation, the strategic objectives of the development of Kazakhstan's economy require an active transformation of the financial sector in order to fully implement its investment and sustainable development of financial functions. The diversity and complexity of the tasks facing the Government of Kazakhstan require a holistic view of the financial and economic system, as well as creating a decision support tool for preliminary assessment of the consequences of political and economic decisions taken to ensure its long-term growth. The solution can be realised using the methods of the system's formal description: strategic planning, implementation of a cognitive approach and interpretation of the results using simulation modelling at a high strategic level of abstraction.

In this regard, our research questions are: what indicators can be used to collate adequate information on financial and economic sub-systems in order to form an integrated figure of economic development? What are the projected dynamics of the development of the financial market of Kazakhstan in the period up to 2025 on the basis of actual data since independence? Do the predicted dynamics meet the requirements of the country's development? Is it possible to strengthen the dynamics of development and which instruments of economic and financial policy will be most effective?

To build the conceptual model (further – CM) for managing the sustainable development of the financial market of Kazakhstan, we used two main tools: a simulation method based on a fuzzy cognitive map (FCM) (Axelrod, 1976; Kosko, 1986) and a method for constructing indicators of the system's sustainable development by Bossel (1999). This made it possible to create a system framework included economic and financial indicators that form the viability and sustainability of the system, and further, through modelling tools, implement the learning and self-development processes of the system for strategic forecasting and planning. Thus, the advantages of both methods were effectively integrated into the development of the CM. This study, which used as a basis an integrated, systematic approach and mathematical simulation for the model of a highly structured, open and dynamically developing economic system, is an example of a socio-economic model with a high level of abstraction. We created a specific set of economic and financial indicators, including the latest on the factors of innovation, adaptability and behavioural finance that could reveal information about the past, current and future performance of the system. The database of 25 years of economic development in Kazakhstan is open for further research at Nichkasova (2019).

Based on our research, we concluded that without implementing special policies the financial market will develop at a slow pace and will not play a significant role in economic growth. This model is a practical tool to support decision-making in the formation of financial and economic policies for sustainable development of the financial market.

The remainder of the paper is structured as follows. The next section presents a brief review of the literature, giving the methodological background of cognitive mapping and a review of previous studies including system theory, decision theory and methods, management, strategic planning and system dynamic implemented in the socio-economic system. Section 2 presents the research problem and the steps followed during the construction of the CM. Section 3 presents the preliminary results and the CM application area and the conclusion discusses and describes the limitations of the CM.

2 Literature study: financial development and FCM

Historically, the financial system has responded to the needs of the time, being fundamental to facilitating the structural transformation of economies. As in previous transformations, the modern financial system needs to play a major role in the economy's transition towards sustainability. The multiplicity of market failures constituting barriers to sustainable finance require governments to kick-start, encourage, and accelerate its development using a systematic approach of public policy measures and interventions (UN, 2017). Financial stability can be defined as "a condition in which the financial system – comprising intermediaries, markets and market infrastructure – is capable of withstanding shocks and the unravelling of financial imbalances, thereby mitigating the likelihood of disruptions in the financial intermediation process which are severe enough to significantly impair the allocation of savings to profitable investment opportunities" (ECB, 2007).

However, the conclusions regarding the determinants of the structural shift in overall economic growth are rather inconclusive and widely discussed both in academic and policy circles. The aim of achieving 'inclusive sustainable growth' indicates that the divergence in tools is quite severe and specific for each country. Modern scholars (Bhanumurthy and Singh, 2013; Sohag et al., 2015; Wu and Broadstock, 2015; Wongpiyabovorn, 2016) are trying to find out a specific relationship between economic and financial sector development for their countries. One policy conclusion that arises here is that the reforms in the financial sector need to have the overall macroeconomic growth perspective and not just the growth of the sector alone. That is why public authorities including governments, central banks, regulators, and supervisors, are taking legislative, policy, regulatory, and supervisory steps to achieve a range of objectives linking sustainability and the financial system. This can be accomplished through the reinforcement of the national policy of financial sector sustainable development with broad support across all parts of government and the private sector.

The main requirements for a financial system are stability, development and efficiency. Financial stability refers to:

a an environment that prevents insolvency and bankruptcy of financial institutions,

b creates conditions that avoid significant disruptions in the provision of key financial services (WB and IMF, 2005).

Financial development is the process of strengthening and diversifying the provision of financial services in an efficient and effective manner in accordance with the requirements of economic agents in order to maintain and stimulate economic growth. The fundamental complementarity and balance between financial stability and development are manifested through the vision that stability supports sustainable financial growth. At the same time, a policy aimed at stimulating financial development is necessarily associated with an increase in macroeconomic and financial risks that must be managed. Growth is important and financial development has a crucial role in the process (King and Levine, 1993; Beck et al., 2000; Demirguc-Kunt and Levine, 1996; Levine, 2004; Demirguc-Kunt et al., 2017; Levine et al., 2000; Luintel et al., 2016; Schwab, 2016, 2018). Thus, the promotion of an orderly process of financial development while maintaining stability necessarily includes the correct consistency and coordination of a number of financial policies.

Due to the complexity of the systems, conditions for decision making are becoming more and more complex: the business environment is constantly changing and fraught with high levels of uncertainty and risk due to differences in economic, political, social, cultural and geographic conditions (Wu, 2012; Balarezo and Nielsen, 2017). There is a limitless amount of data available, but less time to process it. The importance of the manager's competency is still unexceptionable because of the fact that strategic decisions are distinguished by unique, case-specific conditions. Moreover, they are hard to describe in a formal way due to their individual and subjective characteristics, therefore some authors consider strategic decision-making more as an art than a science (Simon, 1957; Alter, 1975; Sprague and Carlson, 1982; David, 1989; Drucker et al., 2001; Power, 2002; Antuchevičiene et al., 2010; Merigó, 2014; Zavadskas et al., 2014; Muñoz, 2018).

In multi-criteria decision analysis as a discipline aimed at supporting decision-makers who are faced with making numerous and conflicting evaluations, three widely known methodologies are used for identifying, classifying and evaluating various alternatives:

analytic hierarchy process (AHP), structural equation modelling (SEM) and FCM. All these decision methodologies are differentiated by the way the objective and alternative weights are determined, as prescribed by axiomatic and/or rule-based structures. Each of them has its own strengths and weaknesses.

AHP, developed by Saaty (1977), is build on the 'theory of prioritised hierarchies' for dealing with problems involving the consideration of multiple criteria simultaneously by using principles of decomposition, pairwise comparison, and priority vector generation and synthesis. According to Liberatore and Nydick (2008), the main distinction of AHP is its inherent capability to weigh a large number of different factors, of different natures, including both qualitative and quantitative data, in order to make a decision based on a formal and numerical process. However, as it was argued by Mohamadali and Garibaldi (2009), despite the convenience of AHP the fuzziness and vagueness existing in many decision-making problems may contribute to the imprecise judgements of decision-makers in conventional AHP approaches. Thus, conventional AHP does not reflect natural human thinking. In order to avoid these risks on performance, a fuzzy extension of AHP was developed to address hierarchical fuzzy problems.

SEM is widely applied in social studies to predict endogenous latent variables and to validate research hypotheses underpinning latent constructs due to its capability to measure and specify simultaneously multiple causal relationships between a set of (latent) non-observed variables and specific observed indicators. SEM can be used to perform a holistic explanation for the causal relationship of latent variables in a specific domain problem. However, as it was pointed out by Tommasetti et al. (2015), SEM is quite complicated and does not support what-if analysis contrived to consider decision-making scenarios. Therefore, the results of SEM analysis are still vague for decision-making and do not enable the identification of specific solutions to the problem. Farahani et al. (2015) argued that in some methods based on theoretical basics such as SEM there is no chance to find an optimal solution, hidden patterns and determinants of a causal relationship between variables. Given the uncertainties, decision-makers tend to use the fuzzy approach, as taking fuzziness into account may be felt to provide less risky decisions. Therefore, to link quantitative and qualitative knowledge with uncertainty and hidden patterns it seems necessary to use FCM.

Cognitive maps are recognised in the decision-making arena as well-established and interactive visual tools, which allow for the structuring and clarification of complex decisions. The cognitive approach, proposed by Axelrod (1976) for representing social scientific knowledge developed in both theoretical and applied aspects, is used to model semi-structured systems. This approach is focused on activating the intellectual processes of the decision-maker as an auxiliary tool for solving problems in the form of a formal model. This model is a cognitive map of the situation as a set of describing factors, on which a set of cause and effect relationships is given. Cognitive mapping is a powerful experience-focused thinking instrument, which can be useful in the definition of strategic guidelines (Howick and Eden, 2011). It allows for the modelling of complex relationships between variables in manifold phenomena (Canas et al., 2015; Carlucci et al., 2013), facilitates the representation, identification, codification and interpretation of information, and stimulates communication and mental associations (Gavrilova et al., 2013). As decision-support tools, cognitive maps reduce cognitive load (Gavrilova and Leshcheva, 2015), help reveal frequently-omitted variables (Eden and Ackermann, 2001; Ferreira et al., 2015a), and improve understanding of decision situations (Durif et al., 2013; Ferreira et al., 2015b), making them extremely versatile and a useful way of representing strategists' understanding of industrial and environmental forces (Schwenk, 1984, 1989).

Kosko extended the idea of cognitive maps by adding fuzzy logic, hence the name FCM. FCM is a modelling methodology for complex decision systems, which originated from the combination of fuzzy logic (Zadeh, 1965) and neural networks to model nonlinear information observed in time, has a graphical and a mathematical representation in the form of a vector matrix calculation and describes the behaviour of a system. Each concept represents an entity, a state, a variable, or a characteristic of the system (Dickerson and Kosko, 1997; Kok, 2009). The detailed description of the structures and principles of organisation presented by Van Vliet et al. (2010) and Xirogiannis and Glykas (2004). The main goal of building an FCM around a problem is to be able to predict the outcome by letting the relevant concepts interact with one another. These predictions can be used to find out whether a decision made by someone is consistent with the entire collection of stated causal assertions (Jetter and Kok, 2014).

These types of cognitive maps, as neuro-fuzzy systems, are able to:

1. incorporate expert knowledge in the decision-making framework, thus revealing powerful and far-reaching consequences in the modelling of complex decision problems (Mazlack and IEEE, 2009)
2. incorporate 'vague and qualitative knowledge' providing a bridge between qualitative and quantitative approaches (Rotmans, 1998) and work with qualitative variables (Van Vliet et al., 2010)
3. add system understanding (Bayer, 2004)
4. do not need hard data and allow inclusion of social effects (Van Vliet et al., 2010)
5. "as more and more data is available to model the problem, the system becomes better at adapting itself and reaching a solution" (Salmeron, 2012)
6. represented as weighted directed graphs, can be easily interpreted (Jetter and Kok, 2014).

FCM modelling uses a mix of qualitative and quantitative approaches, it provides means to overcome the limitations of expert opinion-based methods by enabling the inclusion of multiple and diverse sources, it considers multivariate interactions that lead to nonlinearities, and it aims to make implicit assumptions (or mental models) explicit.

Over the last ten years, a variety of FCMs have been used for representing knowledge and artificial intelligence in the field of business: strategic planning (Diffenbach, 1982; Xirogiannis and Glykas, 2004), information retrieval (Johnson and Briggs, 1994), distributed decision modelling (Zhang et al., 2014), dynamic modelling (Koulouriotis et al., 2001b, 2001c), solving decision problems characterised by high levels of complexity (Lee et al., 1997). An extensive deliberation falls outside of the scope of this paper, but for further discussion, see also: Stylios and Groumpos (1999), Groumpos and Stylios (2000), Kok (2009), Salmeron (2009), Papageorgiou and Salmeron (2013), Yaman and Polat (2009) and Ferreira and Jalali, 2015). FCM has several properties that make them useful for future studies: they provide an efficient way to elicit, capture and communicate causal knowledge; ease integration and inputs from large and diverse groups; allow a quantitative analysis of the quasi-dynamic behaviour encoded to aid decision making; and can be linked to a future state that simultaneously considers all direct and indirect connections between all concepts (Jetter and Kok, 2014).

FCMs have been successfully applied to various social sciences as a new modelling technique aimed at simulating the operational efficiency of complex hierarchical process models with imprecise relationships while quantifying the impact of the reengineering activities to the overall system architecture (Carvalho, 2013; Mardani et al., 2015). They are also considered a suitable approach to describing a complex framework such as the socio-economic and environmental behaviour of a system in the rural sector (see, e.g., Sacchelli and Fabbrizzi, 2015; Carmona et al., 2013; Lopolito et al., 2011; Papageorgiou et al., 2011). By using FCM Pachura and Hajek (2013) presented how regional innovation strategies help decrease the technology gap in Central European countries. Economic and mathematical modelling of development in medium cities and monotowns, taking into account peculiarities at the modern stage of development including distribution of labour resources and investment flows, was made by Sadovnikova and Zhidkova (2012) and Rogachev (2017b, 2017a).

With regard to the subject of this study, of particular interest is the review of studies of financial and economic systems using a FCM. Economic and financial systems are examples of complex structures characterised by interactions among many socio-economic and institutional variables. These interactions can be represented by a high degree of nonlinearity due to the presence of feedback and loops expressed by reciprocal connections among components of systems and human behaviour issues. Another significant characteristic of financial and economic systems is uncertainty. In addition, there is the temporal and spatial dynamism of the parameters characterising these systems that make framework analysis and developing policies a difficult task. A detailed literature analysis on the identification and categorisation of uncertainty in models was developed by Refsgaard et al. (2007), Van der Sluijs (2012), Warmink et al. (2010) and Armacost et al. (1999), using the integrative approach in a holistic framework. The results from the above-mentioned studies suggest that extending knowledge and the sharing of information in complex systems could be interpreted as an integrated evaluation of the real world.

In general, we observe the processes of institutionalisation, deregulation and harmonisation of legislation with an increase in the trend of financialisation of the economy. Most large banks in industrialised countries are now complex financial institutions offering a wide range of services in international markets and strategically controlling billions of dollars in cash and assets. Stephens and Skinner (2013) and Ferreira et al. (2017) report on the increasing importance of banks in economic development to understand the effects of how they affect and are affected by these ongoing changes in the global economy. The 21st century saw the result of new global trends in the financial industry: new financial instruments, securitisation, consolidation of financial institutions in response to high competition with fintech companies. Banks operate in more complex and rapidly changing environments, competition is becoming fiercer (Wu, 2012; Carlucci et al., 2018). In turbulent contexts, the real source of competitive advantage is underlined by the organisation's ability to consistently meet environmental changes (Carmeli and Tishler, 2004). In such a climate, it becomes increasingly necessary for financial and banking institutions to have clearly understood visions and missions, on the basis of which they can determine the strategies and tactics that will be used to achieve their objectives. These changes highlight the need for banks to mobilise, explore, and evaluate tangible and intangible resources and capabilities (Ferreira et al., 2012).

Using the fuzzy cognitive mapping approach enhances the understanding of the key factors underlying banking. By depicting the cause and effect linkages among determinants of ethical banking, and analysing them holistically, such a map helps create a theory, based on experts' practice in this field (Ferreira et al., 2016a). Ferreira et al. (2016b) creates an integrated framework to identify and dynamically analyse the determinants of bank branch service quality and their cause and effect relationships. The results indicate the applicability and usefulness of the proposed approach. Carlucci et al. (2018) built a FCM to model, dynamically analyse and test the reciprocal influence of key factors underlying sustainable banking. Research has shown the potential of implications and practical applications for both bank managers and policymakers aiming to increase the efficiency of their decision making in the context of sustainable banking. Another application of FCM as a decision-making tool, in the banking industry, has been discussed in the paper of Nasserzadeh et al. (2008) with the aim of simulating and representing the factors affecting customer satisfaction which is considered both a tool and a need in today's competitive society and Brun et al. (2014) for e-relationship marketing.

FCMs were successfully applied by Lee and Kim (1997) to infer implications from stock market analysis results, and then, a new concept of fuzzy causal relations found in FCMs were applied to analyse and predict stock market trends. The model of the financial market was created by Koulouriotis et al. (2001a). Xirogiannis and Glykas (2004) reported on experiments conducted in two major financial sector enterprises. Gupta (2017) created the model of the economic system to decipher the development paradigm of the national economic system with respect to mutual influences. As a result, it was proven that FCMs may provide holistic strategic performance evaluation and management, significantly easing the complexity of deriving expert decisions concerning strategic planning and business analysis in economic and financial system modelling.

3 Methodology and data

3.1 A structure of the conceptual model

The conceptual model consists of three subsystems: the economic system, the system of financial institutions and the system of financial markets. Generally, these systems are measured by a wide variety of quantitative and qualitative indicators, the combination of which allows the implementation of a multifactorial, systemic and integrated approach in analysing the financial system. International financial institutions such as the IMF, World Bank and World Economic Forum use several methods to assess the level of development of economic and financial systems.

Analysis of methods for assessing the development of financial markets revealed the following main documents and databases used by international development institutions. The structure of indicators for assessing economies through indicators of the financial system is published by the World Economic Forum in the annual financial development report (WB, 2015, 2018) across 206 countries. The Aggregated Financial Development Index (AFDI), developed by the IMF (2016), is a methodological development of the previous methodology. The Global Findex Database, one of the latest assessments of financial penetration and the introduction of financial technologies, was developed by the World Bank and the International Bank for Reconstruction and Development (Demirguc-Kunt et al., 2018).

Methodologically financial system is structured into two large segments: financial institutions and financial markets and there are four groups of financial system indicators, which measure depth, efficiency, accessibility, and stability and form a matrix of 4×2. The methodology for this matrix formation is justified in the report of Cihak (2012), and presented in a World Bank (WB) (2013) report. At the same time, despite the diversity and wide range of possibilities to use these methods, databases and indicators give the state of the financial market at the current time, or, as a rule, one or two years later due to the conditions of collecting and processing statistical data. In addition, this system of indicators does not allow conscious management forecasting decisions and scenario analysis, which is especially important for national regulators when developing strategic financial policies or introducing local incentives and assessing the consequences of such decisions.

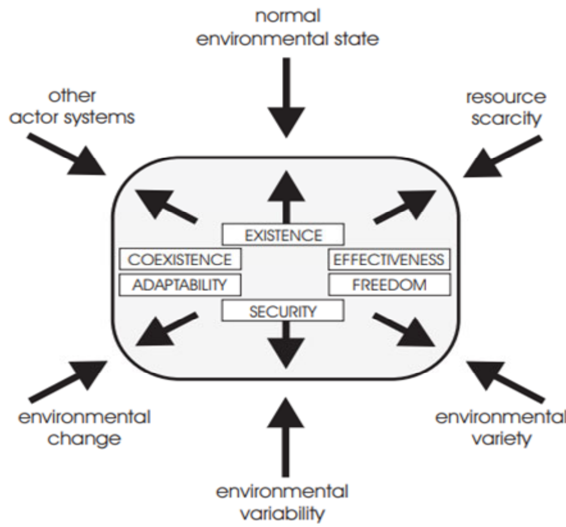
3.2 Modelling of sustainable system

The use of the theory of systems (Mesarovich and Takahara, 1975; Klir, 1973) provides a scientific approach to the analysis of the economic and financial system as a complex organised object. In accordance with this, each element is regarded as relatively heteronomous, but also a relatively autonomous system, to the structure, environment, composition, and state of which the principles of system decomposition are equally applied.

One of the classical methods for constructing a model of a system is the method proposed by Bossel: determining the viability of various systems based on selected indicators (Bossel, 1987; Bossel and Strobel, 1978; Bossel, 1999). The indicators reflect the functioning of the system and inform both about the current state of the viability of the system and about its contribution to the functioning of the systems dependent on it. This method is advisable for a system characterised by a variety of indicators that cannot be brought to a single integral indicator since most of them are often not additive and cannot be added.

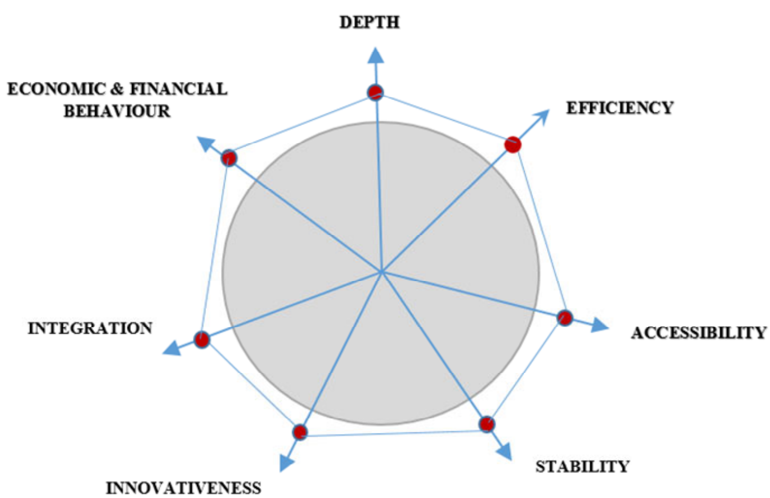
The basic orientors are the most fundamental aspects of systems orientation (Figure 1). Resulting from the basic properties of the higher-level system, these guidelines are the same in all self-organising systems, regardless of the functional and physical nature of the system. The basis orientor, having the minimum satisfaction, signals the limited development of the system. The stability and viability of the system require the uniform satisfaction of all its basic orientors. The development of the system will be constrained by the orientor, which currently has minimal satisfaction. Consequently, special attention should be paid to those basic orientors, which are currently limiting factors. According to the Bossel's approach, for any system six basic reference points can be distinguished due to the external environment of the system and one reference point due to the existence of the system: existence, effectiveness, freedom of action, security, adaptability, coexistence and psychological needs. In a particular application, this general checklist of basic orientors must be made system and context-specific and reflect its viability and sustainability (Bossel, 1999).

Figure 1 Fundamental properties of system environments and their basic orientor counterparts in systems



Source: Bossel (1999)

Figure 2 Orientors and visualisation of the state of viability of economic and financial systems (see online version for colours)



Source: Author's development

Orientors are labels for certain categories of concerns or interests. The names of Bossel's orientors were transformed in accordance with the four main indicators of the development of financial systems and markets used by international financial development institutions and three more were added as author's development (Table A1). Figure 2 provides the adaptation of Bossel's methodology to the economic and financial system application.

According to financial development and economic growth theory, formulated by Goldsmith (1969), the financial sector is the basis for the development of the entire economy, which means that increasing the financial depth of the economy and the scale of financial markets contribute to economic growth. Therefore, the orientor 'existence' in application to the financial market model was renamed as 'depth'. The efficiency of financial intermediaries is an important factor in the viability and sustainability of the financial system. The theory says that an effective financial market is characterised by prices that reflect all available public information, the absence of bubbles, the ability to manage risks through hedging, a tendency to redistribute savings in the most productive investments (Tobin, 1984). That absolutely corresponds with the idea that the system should have an impact on the external environment in the course of the struggle for limited resources but it should remain efficient. Based on this the orientor 'freedom of action' was renamed 'accessibility', which is defined as a characteristic of the ability of economic agents to freely use financial services in all available ways. The orientor 'security' is defined as the ability of the system to protect itself from the adverse effects of the external environment – changing, unstable, unforeseen conditions that go beyond the boundaries of the normal state. In terms of the financial system, security could be transformed into 'stability'.

The effects of the Fourth Industrial Revolution led to the need to reflect new factors that affect the productivity and competitiveness of countries. The success of the economy implies its flexibility, focus on the future, the ability to quickly adapt to changes, as well as respond to external impacts relatively smoothly and quickly. Innovation in a country means the ability to be an ecosystem that not only produces scientific knowledge but also allows all industries and services, as well as society as a whole, to be more flexible, interconnected and open to new ideas and business models. Information and communication technologies are an imperative of development, channels for the dissemination of knowledge and technology, a way to reduce their cost. These trends, in our opinion, should be reflected in indicators of the sustainable development of the financial system. Therefore, we introduce three new orientors as the author's methodology (innovativeness, integrity, behavioural finance), which reflect modern tasks for the functioning of economic and financial systems and meet the requirements of adaptability, coexistence and human behaviour in a process of making economic and financial decisions.

The 'adaptability' of a system as the ability to adapt, learn, and self-organise to develop the most appropriate response methods to changing environmental conditions has a significant connection with 'innovativeness' as the ability of the financial intermediaries to quickly perceive innovations and financial technologies, which increases the speed of transactions, reduces their cost and leads to increased efficiency. The orientor 'coexistence', which means the ability to take into account the interests and behaviour of other systems in the external environment and being able to change its behaviour while maintaining stability, we renamed 'integration'. This is the degree of integration into the global network of financial markets and the world economic system while maintaining autonomy, which implies the ability to provide the economy with financing through the accumulation of domestic sources. The orientor 'psychological needs' means the ability of the system to replicate themselves, satisfy psychological needs, be accountable and comply with legal requirements. To describe the importance of cognitive process, people's behaviour in economic life and their financial decisions which are taken with legal requirements and the aim of satisfying psychological needs we use the name 'economic and financial behaviour'.

3.3 Indicators

Indicators of sustainable development must inform us about the state of the system we are concerned about. Since that state is significantly determined by the system's environment, the indicators must reliably capture important aspects of the system's interaction with its environment. Hence their viability and ultimately the viability of the total system are also preconditions for sustainable development. This means that a holistic system view must be adopted in the search for indicators.

To build the frame of the model we fulfilled each orientor in each of the systems and identified their respective indicators, which provide information about the system sustainability. The main difficulties and limitations that we faced when choosing: a small amount of data on individual indicators or their complete absence, which may be due to the difficulty or impossibility of collecting them in the period of formation of the Kazakhstan economy or the appearance of the latest trends in the digitalisation of the financial system. A more detailed justification of the choice of indicators from the subsystems will be presented below. A total of 31 indicators were employed. The selected system indicators are unique, but not static, since knowledge and statistical data are accumulated, it can be supplemented and expanded. As a result, the framework of the conceptual model of the management sustainable development of the financial market has been formed.

3.3.1 Economic system indicators (X)

The baseline study for the selection of indicators characterising the sustainable development of the economic system was the annual report of the World Economic Forum on the index of global competitiveness of countries. This report allowed the resolution of several research problems:

1. to analyse the strengths and weaknesses of the global competitiveness of Kazakhstan and to obtain indicative evidence of the thesis that the weakness of the financial system adversely affects economic development
2. to select indicators of economic development and trace the dynamics of their change.

Experts of WEF highlight inflation, public debt, national savings and per capita GDP as the main indicators, forming the viability and sustainable development of the economic system. All of them were employed for the model. Taking into account the peculiarities of the economic development of Kazakhstan and based on Eltejaei's (2015) conclusion that in oil-exporting countries, oil revenue plays the significant role for that economy, alongside other economic growth determinants we have included the indicators of investments, brent oil prices and the National Fund of Kazakhstan, as the main and connected factors that have a significant impact on economic stability. The benchmark for innovation is formed from the indicators of R&D and the level of SME development, as part of the number of existing small and medium-sized businesses and their contribution to the economy of Kazakhstan: the most active economic agents. The inflationary expectations of the population, analysed by the National Bank of the

Republic of Kazakhstan, are a reflection of the monetary policy results of the monetary authorities and the overall economic situation in the country. In total 12 indicators have been chosen (Table 1).

Table 1 Economic system's indicators

Economic system			
Orientor	*Indicator*	*Codes*	*Source*
Depth	GDP, billion USD	X9	IMF (2018)
Efficiency	GDP per capita, current prices	X2	IMF (2018)
Accessibility	Total Investments, % of GDP	X3	IMF (2018)
Stability	Inflation, average consumer price	X4	IMF (2018)
	Total central government debt, % of GDP	X1	IMF (2018)
	National Fund of Kazakhstan, mln. USD	X10	NBRK (2019a)
Innovativeness	R&D, a total amount, mln. KZT	X5	MNE (2019)
	The number of SME, active units	X7	
	The share of SME in GDP, %	X8	
Integration	Gross national savings, % of GDP	X6	IMF (2018)
	Brent oil price, USD for 1 barrel	X11	Knoema (2019)
Behaviour	Inflationary expectation, index, %	X12	NBRK (2019b)

Source: Author's development

3.3.2 Financial institution indicators (Y)

At the heart of the annual report of the World Economic Forum on financial development is the use of one key indicator for each characteristic of the financial system, which allows a comparison of the economies of different countries. These indicators were used for the first four orientors of the subsystems of financial institutions and financial markets. However, due to the lack of data on the 'bank lending-deposit spread' indicator, it was replaced by another bank performance indicator: 'bank net interest margin', as accounting value of bank's net interest revenue as a share of its average interest-bearing (total earning) assets. Since the main problem of the current state of the banking system in Kazakhstan is the high size of non-performance loans, the NPL indicator was added to the stability orientor.

Of particular difficulty was the choice of indicators characterising the adaptability of the systems to which we attributed the indicators in the field of financial innovations. As noted above, banks operate in a highly competitive environment that has arisen under the influence of digitalisation. The emergence of new financial services such as Internet banking and mobile payments have been the result of this competition with fintech agents and at the same time is an indicator of financial inclusion for overcoming poverty and inequality. We used a global database measuring financial penetration and the introduction of financial technologies, which was developed by the World Bank and the IBRD (Demirguc-Kunt et al., 2018). The base includes 777 indicators, providing a rigorous, multidimensional Figure of access to basic financial services, but only for 2011, 2014 and 2017. There were two indicators have been chosen for innovation orientor. As the orientor 'coexistence' applied to the financial system, we used the integration orientor into the global financial market which was applied the indicator ‘external loans and deposits of reporting banks vis-à-vis all sectors’ that characterises the access of Kazakhstan’s banks to external liquidity replenishment resources.

To reflect the human factor in assessing the state of banking institutions, we used the indicator ‘soundness of bank’, which came from the WEF GCI survey and in particular from the executive opinion survey (Schwab, 2018). This paper provides a yearly evaluation of critical aspects of competitiveness to capture reality as best as possible and form it from the opinions of business leaders of companies of various sizes and from the various sectors of activity. In relation to the soundness of banks, respondents make an assessment where 1 means extremely low and banks may require recapitalisation; 7 means extremely high and banks are generally healthy with sound balance sheets. As can be seen from Table 2, we used two dimensions of this psychological factor: with a score from 1 to 7 and as the rank through the global scale among all financial institutions under survey.

Table 2 The financial institution’s indicators

Financial institutions			
Orientor	*Indicator*	*Code*	*Source*
Depth	Private credit by deposit money banks to GDP (%)	Y1	World Bank (2018)
Efficiency	Bank net interest margin (%)	Y2	World Bank (2018)
Accessibility	An account at a formal financial institution (% age 15+)	Y3	Demirguc-Kunt et al. (2018)
Stability	The probability of default of a country’s commercial banking system (z-score)	Y4	World Bank (2018)
	Non-performance loan, % of total loans	Y8	NBRK (2018)
Innovativeness	Account ownership at a financial institution or with a mobile-money-service provider (% of population ages 15+)	Y5	Demirguc-Kunt et al. (2018)
	Made or received digital payments in the past year (% age 15+)	Y7	Demirguc-Kunt et al. (2018)
Integration	External loans and deposits of reporting banks vis-à-vis all sectors (% of domestic bank deposits)	Y6	World Bank (2018)
Behaviour	Soundness of Kazakhstan’s banks, score	Y9	Schwab (2018)
	Global ranking of Kazakhstan’s banks	Y10	Schwab (2018)

Source: Author’s development

3.3.3 Financial market indicators (Z)

As well as for the financial institution subsystem, for the financial market subsystem, four basic indicators from the World Bank methodology were used (Table 3). Further, we have added the indicator ‘stock market total value traded to GDP’ since for emerging financial markets with a small capitalisation the volume of trading also has significant importance as the indicator of depth. To assess the innovativeness of the financial market, we used an indicator that measures the number of active accounts of individuals on the Kazakhstan Stock Exchange. Thanks to financial technologies and the development of financial intermediation, an increasing number of individuals have the opportunity to invest in the financial instruments of the stock market.

Two indicators have been assigned for the orientor ‘integration’ – the number of national companies (per 1 million people) listed on Kazakhstan’s Stock Exchange (KASE) and the number of foreign companies listed in the KASE, which can be a measure of the openness of the financial market for its participants. Volatility index (the fear index) was selected as an indicator reflecting the behaviour of investors in the financial market, which, due to globalisation, can also be used for Kazakhstan’s stock market.

Table 3 The financial market’s indicators

Financial markets			
Orientor	*Indicator*	*Code*	*Source*
Depth	Stock market total value traded to GDP, (%)	Z1	World Bank (2018)
	Market capitalisation, bln. USD	Z9	
Efficiency	Stock market turnover ratio, (%)	Z2	
Accessibility	Market capitalisation excluded the TOP-10 companies to total market cap, (%)	Z3	WFE (2019)
Stability	Stock price volatility,%	Z4	World Bank (2018)
Innovativeness	The number of active accounts of individuals in transactions on KASE, units	Z5	KASE (2018)
Integration cohesion	Number of listed companies per 1,000,000 people	Z6	World Bank (2018)
	The number of foreign companies listed on KASE, units	Z7	WFE (2019)
Behaviour	A measure of the stock market’s expectation of volatility implied by S&P 500 index options (VIX)	Z8	MarketWatch (2019)

Source: Author’s development

3.4 A statistical data frame

Time series data for each system indicator was collected for the period 1993–2018 where it was possible based on international and national statistical databases: IMF, The World Federation of Exchange, Global Economic Forum, World Bank, National Bank of the Republic of Kazakhstan, Kazakhstan’s Stock Exchange, Ministry of National Economy of Kazakhstan. Some indicators have a shorter statistical period due to lack of data. The most complete data period used for the study is from 2000 to 2017 (Nichkasova, 2019). Fluctuations of two or three-time series were smoothed, by taking three or five-year symmetric averages. Further, on the basis of correlation-regression analysis and forecasting models, a forecast was made for the indicators of the main orientors of the Conceptual Model for the period from 2000 to 2025.

3.5 A matrix and FCM

Overall, FCM model building is a multi-step process. While these basic steps are agreed upon in the literature (Özesmi and Özesmi, 2004; Kok, 2009; Jetter and Schweinfort, 2011), additional steps and detailed approaches to each of these stages differ from author to author. FCM consists of nodes which represent factors that are most suitable for the decision-making environment for each type of sub-system. Arrows represent various causal relationships between factors and can have different numerical values. In particular, FCM is a designed feedback-oriented graph consisting of nodes (i.e., concepts) that illustrate the behaviour of systems. Each concept is encoded (Ai) in the interval [0, 1], which represents a value system variable. The boundaries of the relationship between the concepts are weighted and indicate the direction and degree of cause-effect relationships. A weighted edge indicates information about the degree of influence of the relationship between related concepts. The effect can be positive (stimulating effect) or negative (inhibitory effect). FCM can show ideas in indirect effects and between nodes that can only be understood after the entire map is displayed. If certain nodes are stimulated, the resulting actions may resonate through other nodes on the map along positively or negatively weighted compounds.

Figure 3 Cognitive map of GDP per capita (see online version for colours)

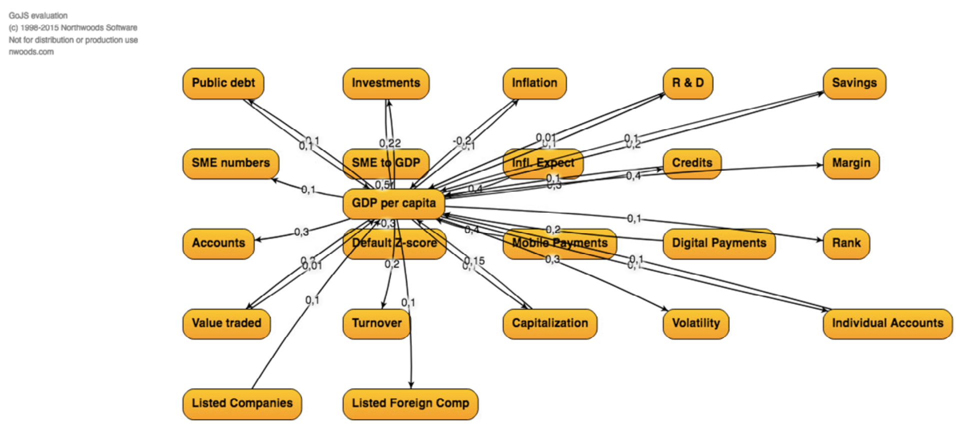
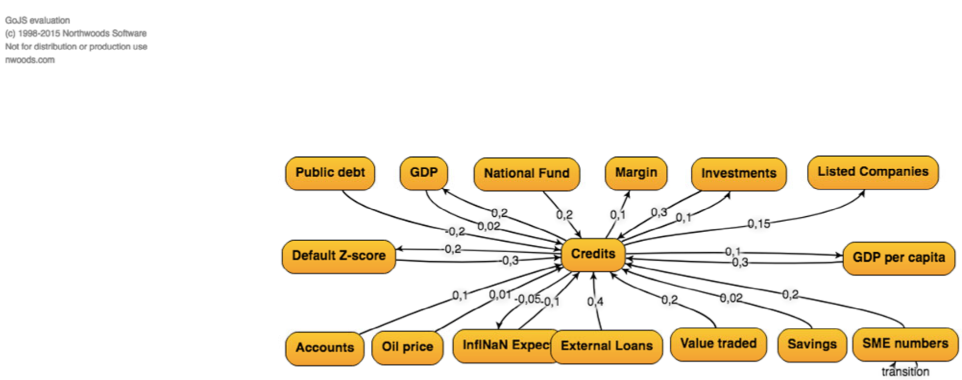
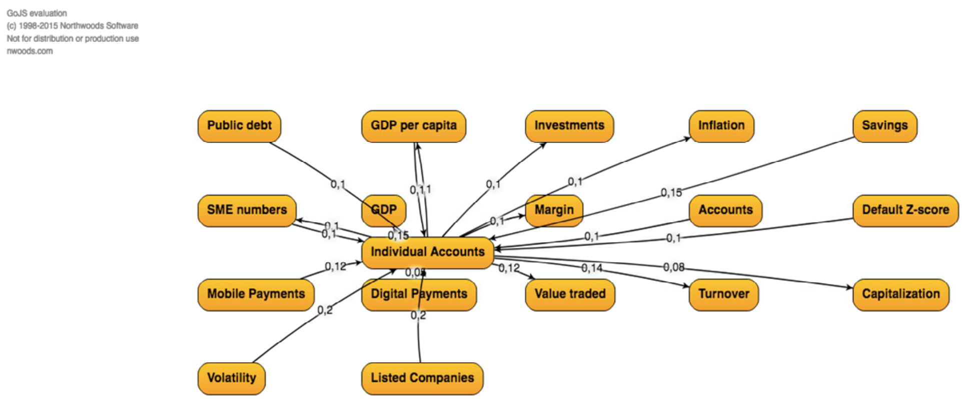


Figure 4 Private credit by deposit money banks to GDP (see online version for colours)



Given the weak structure of the economic and financial systems, the uncertainty of the factors and the connections between them, the possible variability of the structure in the conceptual model used methods based on ‘fuzzy cognitive modelling’. The FCM was developed on the basis of fuzzy rules by using accumulated experience and knowledge of the economic and financial system performance of Kazakhstan which was integrated into causal relationships between the factors of the simulated processor system. The expert opinion on the initial trend and the strength of the mutual influences of the indicators, positive or negative focus on the modelling situation, was used to obtain a matrix of mutual influence of factors (Table A1). Then, we constructed a structural diagram of cause-and-effect relations as a cognitive map, reflecting the interaction of factors, implemented in the system of cognitive modelling. Examples of a cognitive map created are presented in Figures 3–5.

Figure 5 The number of active accounts of individuals in transactions on KASE, units (see online version for colours)



Source: Authors development by using GoJS software

FCM fine adjustment is achieved by changing the learning order set. For instance, the initial tendency is the predictive state of the X1 concept for 2025 (0.074994) determined by dividing its potential by the mean value of its values over the years (equal to 49.97 in 2025). Initial concepts: the value of evaluating the concept X1 on the cognitive map for 2025 (–0.040724) is determined from the basic equation of situational modelling by the matrix multiplication of weights by the initial trends of all concepts. Further, the iterative method to achieve an accuracy of 0.00001 with a maximum of 30 iterations solves the problem of predicting situational modelling for determining the response to a different combination of pulses. During the training process, only the initial set FCM weight values (not equal to zero) are updated. Table A3 presents the fragment of learning output. As a result, we obtain an increment of concept values. The computed weight values kept their initial signs and directions as it was proposed by an expert. Finally, to create a conceptual model visual basic for applications project (VBA project) was used.

At the next stage, FCM's method allowed consolidation of all metrics (31) into orientors of economic and financial subsystems focused on studying the holistic structure and sustainability of the system as well as obtaining forecasts of its behaviour. Analytical processing methods and visualisation of the results by the spider chart and statistic outputs was applied. The dynamics of changes in the values of basic orientor in the absence of external control actions means its self-development. Each ray reflects the value of the change in the subsystem's indicators in the selected period, showing the vector values of the factors at the time. The measurement is calculated as the ratio of the indicator in the current period to the value for the previous period. Comparing the initial values of the factors and the changes, we can analyse the dynamic changes in the development of the system. The formal assessment was performed by the introduction of two coefficients – area (viability) and form (balance). The area factor (AF) indicates how the factual system is close to the system with maximum viability. The form factor (FF) indicates how balanced the development of the system is, i.e., how evenly the system develops according to the basic reference points. It is performed to quantify the constructed development scenarios. The closer the points on the 'star' rays to 1, the more stable the system.

This visualisation helps policy-makers to easily decode the meaning of the current performance of the sub-systems and see where management actions should be directed to maximise their viability and balance. In the further analysis of the constructed system, two closely related tasks are possible: the direct one – how the situation will develop under certain external influences and the reverse – which influences are needed to control the situation through target factors, leverage and their connections. But at this stage of the research, we are going to test only the self-development of the sub-systems, the relevance of the conceptual model to the current situation and make a long-term forecast of their sustainability and development in order to test the possibility of achieving the strategic goals.

4 Results and discussion

4.1 The forecast of individual metrics

The forecast for the economic system's development metrics is the stabilisation of inflation to a target level of 4% and a decrease in the inflation expectations of the population. The projected increase in oil prices, which is a positive factor for the economy of Kazakhstan, will stimulate the accumulation of the fund's resources and act as a counter-cyclical stabiliser of the economy. We expect a significant increase in the number of SME and R&D spending. However, the projected level of investment will be in the corridor of 25–35% of GDP, which may be holding back a significant qualitative transition to a new stage of economic development. A possible destabilisation factor will be the continuing growth of public debt associated with the need for economic transformation. According to the dynamics of the main indicative indicator of GDP, we expect average annual growth rates in the range of 3% and the achievement of 2019 billion USD by 2025 and, accordingly, GDP growth per capita to over 16,000 USD.

The completion of bank balance sheet clearing processes for non-performing assets will decline the probability of default (z-score), improve their global competitiveness rank and soundness, stimulate the growth of bank lending to the economy and expand access to foreign loans. However, due to increasing competition, opening up the market according to the requirements of the WTO, banks' profits will continue to decline. The process of digitisation of banking services and the expansion of types of remote payment services will be actively pursued.

Financial market indicators, which are very sensitive to macroeconomic performance, against the background of stabilising inflation and the positive dynamics of the main macroeconomic indicators, will witness a stable growth. However, this growth will be restrained at an average level of dynamics and will not significantly change the role of the financial sector in the economy of Kazakhstan in the period up to 2025. Among the positive signals of indicators is an active growth in the number of investors – individuals, as well as national and foreign companies listed on KASE.

4.2 Conceptual model's self-development results

The decision-making method based on a FCM made it possible to take a holistic view of the economic and financial sector by consolidating the dynamics of changes in the values of indicators into the conceptual model. During the CM's self-development process the indicator's values were transformed into several types of output data: statistical values of the AF and FF in dynamics; graphical visualisation on the state of viability and stability of subsystems; and identification of the orientors that require an influence action to improve the condition of the subsystems. Based on the values of the factors, we were able to validate the consistency of past and current characteristics of the sub-systems with their real state and to evaluate their development forecast. As follows from the presented summary graphs (Figure A1) the development of each system in the period 2010–2025 characterised by cyclicality and volatility and the period from 2010 to the current time reflect the past crises and growth periods. The vertical hierarchy of the subsystems reflects the strong position of the economic subsystem and the lowest level of the financial market's subsystems.

Overall, the viability of the subsystems (AF max = 0.53) is higher than its balance (FF max = 0.32) which is really true for Kazakhstan. Insofar as viability is an ability to adapt to changing internal environmental conditions, the economic and financial systems witnessed a deep structural change that increased the level of viability. Moreover, in the period up to 2020, we expect growth in the viability of financial markets and institutions, followed by entry into negative dynamics in the period up to 2025, which may be due to increased competition in financial markets after Kazakhstan's accession to the WTO, the appearance of international financial companies in the market and cyclical components. We predict the confident growth of the balance of the economic system as a result of the implementation of stable macroeconomic policies with a slight decrease in the dynamic after 2023 but a saved gap between subsystems. Stability due to the strong monetary policy and regulations against the backdrop of a moderate global external impact has good parameters. However, the chart presents generally the same picture of the development without structural shifts.

Selective analysis of the model's output graphics data ('stars') for 2010, 2018 and 2025 in the context of orientors of the subsystems visualises the current state of the systems at a given point in time (Figure A2). General characteristics: small size, bias relative to the centre, lack of balance. With such developmental characteristics, the system is sensitive to minor internal or external impulses. In particular, in 2010, in the aftermath of the global economic crisis, the economic system is characterised by a lack of stability, innovation, depth and high inflation expectations as a behavioural response of economic subjects. In 2018, we saw an improvement in all indicators of the economic system with the exception of the psychological factor (inflation expectations), which is subject to slower changes.

In 2010, banks were well-integrated and efficient, since the previous period was a time of high availability to foreign loans. However, later it caused significant damage to their stability and profitability through the growth of non-performing loans, which is shown by the 2018 schedule. An important element in the development of financial institutions at the present time is their innovativeness, the introduction of digital services, which is the key to a sustainable future. This trend continues in 2025, which means the transformation of the banking business model while maintaining the development of other orientors at a low level. We assume that financial institutions will be influenced by the processes of consolidation, the tightening of prudential requirements of the regulator, competition with financial companies and large international financial institutions. As a result, banks will not be able to qualitatively perform the functions of a financial intermediary to finance the development of the economy.

The size of the financial market system in 2010 is the smallest in comparison with the considered systems. However, the system has a relative uniformity in terms of depth, accessibility, stability and efficiency, characterised by a high level of innovation and high risks, like a developing market. By 2018, the system is developing in all directions, with the exception of innovation. However, a significant change by 2025 is not observed, since, as was shown in the graphs in Figure A2, after 2022, a cyclical decline in dynamics begins. Among the reasons for this, we can assume that the development of AIFC will have a negative impact on the indicators of the Kazakhstan Stock Exchange.

The multidimensional nature of financial systems reflects the fact that the depth of a financial system does not necessarily provide a high degree of financial availability; highly efficient financial systems are not necessarily more stable than less efficient ones, and so on (WB, 2018). The financial system is complex because it has an internal structure that includes a large number of different subsystems, processes, interactions and interconnections. All functions performed by the system are aimed at ensuring the achievement of a certain goal – the efficient allocation of capital. The boundaries of the system are permeable to the input and output resources that come from the environment and into it determining its individuality and autonomy. Since in the process of evolution the financial system adapts to its environment (economic system), it can be said that the properties of the environment of the system are reflected in the properties of the system. Functions are performed in the external environment and under the influence of external and internal factors, forming its characteristics, as a system of indicators characterising the state of the financial system. At the same time, the financial system is dynamic, i.e., has many states and has the ability to transition from one state to another continuously or discretely, and is able to generate complex dynamic and information processes, which is its ability to develop.

5 Discussion

The balance of theoretical reasoning and empirical evidence points towards a central role of finance in socio-economic development. According to the theory, financial markets are imperfect and the quality of financial intermediaries measured by their ability to smooth these imperfections during the capital allocation saving stability (Ramlall, 2018). Stability is a state in which the financial system is resistant to economic shocks and is fit to smoothly fulfil its basic functions. Nevertheless, it is not an area in isolation and constitutes a broad concept which involves both preventive and remedial actions, acting like an overlapping set between economics and finance.

Four characteristics of financial institutions and markets provide “empirical shape and substance to the complex, multifaceted and sometimes amorphous concept functioning of the financial systems” [Cihak et al., (2012), p.5]. We suggest a broadened view on the general theory of finance which has fewer restrictive assumptions and broader applicability to define 7 × 2 matrix of sustainability determinants as a potential component of “a new theory of sustainable finance that are building blocks for a more general theory of finance” [Fullwiler and Leach, (2015), p.3]. Each of these characteristics depends on socio-economic development, financial sector policies, and other parts of the enabling environment for financing. We consider the financial market as a system of economic interconnections, which are channels for the transformation of savings into investments through financial instruments used by professional participants and market institutions to dynamically influence the economic system in order to ensure its development and improve the welfare of all economic agents and the state as a whole.

Threats to financial stability are emerging from elevated political and policy uncertainty. The state has a crucial role in the financial sector: it needs to provide strong prudential supervision, ensure healthy competition, and enhance financial infrastructure. Varying economic and political circumstances across countries imply that financial sector policies require customisation: appropriate policies will differ across countries and over time.

6 Conclusions

Recently, significant progress has been made in the study of the stability of the financial system, which has been accompanied by increased interest in this topic. Despite this, the current approaches do not allow a clear definition of the determinants of the sustainability of the economic and financial systems. This research question is relevant for Kazakhstan which needs funding for accelerated economic development that entails risks and uncertainty. Therefore, management of the financial system, due to its multi-level complexity, and high development dynamics, requires, as a priority, research into the development of complex decision support systems at a high level of abstraction. This research proposes the use of FCMs to pursue a holistic view of the economic and financial market’s sustainability phenomenon.

a The paper made use of the World Bank’s and Bossel’s methodology to:

   1 Present a financial system in the form of a 4 × 2 matrix in terms of the characteristics of depth, efficiency, stability and accessibility for financial institutions and financial markets.

   2 Identify three new characteristics: innovativeness, integration, and the behaviour of economic agents.

   3 Transform seven key characteristics into orientors as the main determinants of the sustainability of the economic and financial subsystems.

   4 Define indicators and their interactions.

   5 Make a forecast for the development of the indicators until 2025. By using the FCM method.

6 Co-integrate all indicators into systems, create a visual map of the system as the conceptual model for managing sustainable development of Kazakhstan's financial market.

7 Analyse the CM's self-development dynamics.

8 Validate and verify the adequacy of the CM.

Although FCMs allow static, dynamic and loop analysis of the results to be produced, the main concern in the current study was to identify the cognitive structure of factors determining sustainable finance system. The results obtained show that the authors have compiled a qualitative composition of indicators that accurately describe the state of viability and balanced systems, as well as identifying areas that require managerial influences. The model allows visualisation of the state (stability and viability) of systems throughout quantitative and graphical output, as well as predicting a change in their state. We argue that predicted dynamics do not meet the requirements of Kazakhstan's development and policy-makers should strengthen the dynamics of development by using the most effective instruments of economic and financial policy. As it was proven in the process of research, in order to achieve this goal, effective interaction of the economic system, the system of financial institutions and financial markets, as well as the support tool for administrative decision-making is necessary.

b The major determinants of sustainability resulting from the FCM can represent important inputs in planning policies and managerial initiatives regarding the practical application of sustainable strategies. Getting these tools, the decision-makers and policymakers could monitor and analyse the current state of the system and regulate them using pre-tested measures. Based on the output of the simulation, we are confident that for Kazakhstan the development of financial institutions and financial markets requires the implementation of incentive government policies. Thus, we answered the research questions and proved that government policy should be aimed at stimulating the development of the country's financial sector in order to expand its role in the economy as an intermediary ensuring the effective transformation of capital into investments.

The results of this study can be expected to contribute to the literature at a methodological level of the functioning of the financial market through the development of a set of determinants of the sustainable development; identifying directions and channels of interaction between financial markets, financial institutions and the economic system; formation of a set of indicators and analytical databases; creating a practical tool for managing this process in the development and implementation of state financial policy.

The model can be:

1 integrated into the management system of Astana International Financial Centre, implementing the function of a new financial market institution in order to attract investment resources to the economy of Kazakhstan

2 used by governments of monetary and financial policy and experts in the field of economics and finance in developing scenarios for the economic development of Kazakhstan

3 applied for the development of the concept of a total financial market of the Eurasian Economic Union for testing forecasts and development risks

4 used in the educational process to train specialists in economic, managerial and mathematical specialities of universities.

c We see further development of the conceptual model in applying the scenario approach through simulation, based on neural network computation. For instance, for selecting scenarios that will ensure achievement of the goals set by the strategic economic development plan of Kazakhstan with an assessment of the impact of the functioning of Astana International Financial Centre on the financial market of Kazakhstan. Further researchers might want to:

1 conduct a panel study with a group of experts to determine the robustness of the results

2 replicate the study in different countries EAEU

3 compare the results obtained from the application of different methods in this context. Improvements and updates will strengthen our knowledge of the interaction between economic and financial systems, which can be incorporated within different strategies and policy interventions.

The conceptual model for managing the sustainable development of the financial market of Kazakhstan based on a FCM is a demonstrative version of an innovative management tool for the strategic development of Kazakhstan's financial system with the ability to analyse scenarios and select the most effective ways to achieve goals, optimise resources and reduce the risks of making wrong management decisions. The conceptual model is a work in progress. Constructive criticism, suggestions for improvement and feedback about applications and experience are welcome.

Acknowledgements

We express our gratitude to D. Seilkhanova and T. Kayupov thanks to whom this work took place and has the potential for further research. The conceptual model was presented at the Innovation Projects Competition, organised by the Eurasian National University in February 2019 (Astana, Kazakhstan) and the authors were awarded a diploma. All errors and inaccuracies of this work are the author's own.

References

AIFC Development (2019) *Investment Residency Program to Attract a New Wave of Foreign Capital* [online] http://government.kz/en/news/razvitie-mfca-programma-investicionnogo-rezidentstva-pozvolit-privlech-novuyu-volnu-inostrannogo-kapitala (accessed 20 August 2019).

Aizhan, K. and Makaevna, M.D. (2011) 'Impact of foreign direct investment on economic growth in Kazakhstan', in Tao, F. (ed.): *Sociality and Economics Development, International Conference on Sociality and Economics Development (ICSEP 2011)*, Vol. 10, pp.414–419.

Akimov, A. and Dollery, B. (2008) 'Financial system reform in Kazakhstan from 1993 to 2006 and its socioeconomic effects', *Emerging Markets Finance and Trade*, Vol. 44, No. 3, pp.81–97.

Alter, S.L. (1975) *A Study of Computer Aided Decision Making in Organizations*, PhD dissertation, MIT.

Antuchevičiene, J., Zavadskas, E.K. and Zakarevičius, A. (2010) 'Multiple criteria construction management decisions considering relations between criteria', *Technological and Economic Development of Economy*, Vol. 16, No. 1, pp.109–125, DOI: 10.3846/tede.2010.07.

Armacost, R.L., Hosseini, J.C. and Pet-Edwards, J. (1999) 'Using the analytic hierarchy process as a two-phase integrated decision approach for large nominal groups', *Group Decision and Negotiation*, Vol. 8, No. 6, pp.535–555.

Axelrod, R. (1976) *Structure of Decision: the Cognitive Maps of Political Elites*, Princeton University Press, Princeton, NJ.

Balarezo, J. and Nielsen, B.B. (2017) 'Scenario planning as organizational intervention', *Review of International Business and Strategy*, Vol. 27, No. 1, pp.2–52, DOI: 10.1108/ribs-09-2016-0049.

Bayer, S. (2004) 'Business dynamics: systems thinking and modeling for a complex world', *Interfaces*, Vol. 34, No. 4, pp.324–326.

Beck, T., Levine, R. and Loayza, N. (2000) 'Finance and the sources of growth', *Journal of Financial Economics*, Vol. 58, Nos. 1–2, pp.261–300.

Bhanumurthy, N.R. and Singh, P. (2013) 'Financial sector development and economic growth in Indian states', *International Journal of Economic Policy in Emerging Economies*, Vol. 6, No. 1, pp.47–63.

Bossel, H. (1987). 'Viability and sustainability – matching development goals to resource constraints', *Futures*, Vol. 19, No. 2, pp.114–128.

Bossel, H. (1999) *Indicators for Sustainable Development: Theory, Methods and Applications. A Report to the Balaton Group*, International Institute for Sustainable Development, Canada.

Bossel, H. and Strobel, M. (1978) 'Experiments with an intelligent world model', *Futures*, Vol. 10, No. 3, pp.191–212.

Brent Oil Futures (2019) [online] https://www.investing.com/commodities/brent-oil-contracts (accessed 2 February 2019).

Brun, I., Durif, F. and Ricard, L. (2014), 'E-relationship marketing: a cognitive mapping introspection in the banking sector', *European Journal of Marketing*, Vol. 48, Nos. 3–4, pp.572–594 [online] https://doi.org/10.1108/EJM-04-2012-0207.

Canas, S., Ferreira, F. and Meidutė-Kavaliauskienė, I. (2015) 'Setting rents in residential real estate: a methodological proposal using multiple criteria decision analysis', *International Journal of Strategic Property Management*, Vol. 19, No. 4, pp.368–380.

Carlucci, D., Ferreira, F.A.F., Schiuma, G., Jalali, M.S. and Antonio, N.J.S. (2018) 'A holistic conception of sustainable banking: adding value with fuzzy cognitive mapping', *Technological and Economic Development of Economy*, Vol. 24, No. 4, pp.1303–1322.

Carlucci, D., Schiuma, G., Gavrilova, T. and Linzalone, R. (2013) 'A fuzzy cognitive map based approach to disclose value creation dynamics of ABIs', *IFKAD 2013: 8th International Forum on Knowledge Asset Dynamics: Smart Growth: Organizations, Cities and Communities*, pp.207–219.

Carmeli, A. and Tishler, A. (2004) 'The elationships between intangible organizational elements and organizational performance', *Strategic Management Journal*, Vol. 25, No. 13, pp.1257–1278.

Carmona, G., Varela-Ortega, C. and Bromley, J. (2013) 'Supporting decision making under uncertainty: development of a participatory integrated model for water management in the middle Guadiana river basin', *Environmental Modelling and Software*, Vol. 49, pp.144–157.

Carvalho, J.P. (2013) 'On the semantics and the use of fuzzy cognitive maps and dynamic cognitive maps in social sciences', *Fuzzy Sets and Systems*, Vol. 214, pp.6–19, DOI: 10.1016/j.fss.2011.12.009.

Cihak, M., Demirguc-Kunt, A. and Feyen, E. (2012) *Benchmarking Financial Systems around the World*, World Bank Report, World Bank Group, Washington, DC.

David, F. (1989) *Strategic Management*, Merrill Publishing Company, Columbus.

Demirguc-Kunt, A. and Levine, R. (1996) 'Stock markets, corporate finance, and economic growth: an overview', *World Bank Economic Review*, Vol. 10, No. 2, pp.223–239.

Demirguc-Kunt, A., Horvath, B.L. and Huizinga, H. (2017) 'How does long-term finance affect economic volatility?', *Journal of Financial Stability*, Vol. 33, pp.41–59.

Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S. and Hess, J.R. (2018) *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution (English)*, World Bank Group, Washington, DC.

Dickerson, J.A. and Kosko, B. (1997) *Virtual Worlds as Fuzzy Cognitive Maps*, Prentice-Hall, Upper Saddle River, NJ.

Diffenbach, J. (1982) 'Influence diagrams for complex strategic issues', *Strategic Management Journal*, Vol. 3, No. 2, pp.133–146.

Drucker, P.F., Hammond, J., Keeney, R., Raiffa, H. and Hayashi, A.M. (2001) *Harvard Business Review on Decision Making*, Harvard Business School Press, Princeton, NJ.

Durif, F., Geay, B. and Graf, R. (2013) 'Do key account managers focus too much on commercial performance? A cognitive mapping application', *Journal of Business Research*, Vol. 66, No. 9, pp.1559–1567.

Eden, C. and Ackermann, F. (2001) 'Group decision and negotiation in strategy making', *Group Decision and Negotiation*, Vol. 10, No. 2, pp.119–140.

Eltejaei, E. (2015) 'Oil, government's budget and economic growth in Iran', *International Journal of Economic Policy in Emerging Economies*, Vol. 8, No. 3, pp.213–228 DOI: 10.1504/ijepee.2015.072337.

European Central Bank (ECB) (2007) 'Progress towards a framework for financial stability assessment', *OECD World Forum on 'Statistics, Knowledge and Policy'*, Speech by José-Manuel González-Páramo, Member of the Executive Board of the ECB, Istanbul, 28 June.

Facchini, F. (2013) 'Economic freedom in Muslim countries: an explanation using the theory of institutional path dependency', *European Journal of Law and Economics*, Vol. 36, No. 1, pp.139–167.

Farahani, H., Smarandache, F. and Wang, L.L. (2015) 'A comparison of combined overlap block fizzy cognitive maps (COBFCM) and combined overlap block neutrosophic cognitive map (COBNCM) in finding the hidden patterns and indeterminacies in psychological causal models: a case study of ADHD', *Critical Review*, Vol. 10, pp.70–84.

Ferreira, F.A.F. and Jalali, M.S. (2015) 'Identifying key determinants of housing sales and time-on-the-market (tom) using fuzzy cognitive mapping', *International Journal of Strategic Property Management*, Vol. 19, No. 3, pp.235–244.

Ferreira, F.A.F., Ferreira, J.J.M., Fernandes, C., Meidute-Kavaliauskiene, I. and Jalali, M.S. (2017) 'Enhancing knowledge and strategic planning of bank customer loyalty using fuzzy cognitive maps', *Technological and Economic Development of Economy*, Vol. 23, No. 6, pp.860–876, DOI: 10.3846/20294913.2016.1213200.

Ferreira, F.A.F., Jalali, M.S. and Ferreira, J.J.M. (2016a) 'Experience-focused thinking and cognitive mapping in ethical banking practices: from practical intuition to theory', *Journal of Business Research*, Vol. 69, No. 11, pp.4953–4958.

Ferreira, F.A.F., Jalali, M.S., Ferreira, J.J.M., Stankeviciene, J. and Marques, C.S.E. (2016b) 'Understanding the dynamics behind bank branch service quality in Portugal: pursuing a holistic view using fuzzy cognitive mapping', *Service Business*, Vol. 10, No. 3, pp.469–487.

Ferreira, F.A.F., Jalali, M.S., Meidute-Kavaliauskiene, I. and Viana, B. (2015a) 'A Metacognitive decision making based-framework for bank customer loyalty measurement and management', *Technological and Economic Development of Economy*, Vol. 21, No. 2, pp.280–300, DOI: 10.3846/20294913.2016.1213200.

Ferreira, F.A.F., Marques, C.S.E., Bento, P., Ferreira, J.J.M. and Jalali, M.S. (2015b) 'Operationalizing and measuring individual entrepreneurial orientation using cognitive mapping and MCDA techniques', *Journal of Business Research*, Vol. 68, No. 12, pp.2691–2702.

Ferreira, F.A.F., Spahr, R.W., Santos, S.P. and Rodrigues, P.M.M. (2012) 'A multiple criteria framework to evaluate bank branch potential attractiveness', *International Journal of Strategic Property Management*, Vol. 16, No. 3, pp.254–276.

Fullwiler, S.T. and Leach, J.A. (2015) *Sustainable Finance: Building a More General Theory of Finance*, Working Paper No. 106, Binzagr Institute for Sustainable Prosperity [online] http://www.binzagr-institute.org/wp-content/uploads/2015/04/WP-106.pdf (accessed 19 August 2019).

Gavrilova, T. and Leshcheva, I. (2015) 'The interplay of knowledge engineering and cognitive psychology: learning ontologies creating', *International Journal of Knowledge and Learning*, Vol. 10, No. 2, pp.182–197.

Gavrilova, T., Carlucci, D. and Schiuma, G. (2013) 'Art of visual thinking for smart business education'. *IFKAD 2013: 8th International Forum on Knowledge Asset Dynamics: Smart Growth: Organizations, Cities and Communities*, pp.1754–1761.

Goldsmith, R.W. (1969) *Financial Structure and Development*, Yale University Press, New Haven, CT.

Groumpos, P.P. and Stylios, C.D. (2000) 'Modelling supervisory control systems using fuzzy cognitive maps', *Chaos Solitons and Fractals*, Vol. 11, Nos. 1–3, pp.329–336.

Gupta, S. (2017) 'Modeling economic system using fuzzy cognitive maps', *International Journal of System Assurance Engineering and Management*, Vol. 8, No. 2, pp.1472–1486.

Howick, S. and Eden, C. (2011) 'Supporting strategic conversations: the significance of a quantitative model building process', *Journal of the Operational Research Society*, Vol. 62, No. 5, pp.868–878.

IMF (2016) *Introducing a New Broad-Based Index of Financial Development*, Working Paper,: IMF, Washington, DC.

IMF (2018) *World Economic Outlook Database* [online] https://www.imf.org/external/pubs/ft/weo/2018/02/weodata/index.aspx (accessed 25 February 2019).

Jetter, A. and Schweinfort, W. (2011) 'Building scenarios with fuzzy cognitive maps: an exploratory study of solar energy', *Futures*, Vol. 43, No. 1, pp.52–66.

Jetter, A.J. and Kok, K. (2014) 'Fuzzy cognitive maps for futures studies – a methodological assessment of concepts and methods', *Futures*, Vol. 61, pp.45–57, DOI: 10.1016/j.futures.2014.05.002 [online] http://edepot.wur.nl/327892.

Johnson, R.J. and Briggs, R.O. (1994) 'A model of cognitive information retrieval for ill-structured managerial problems and its benefits for knowledge acquisition', *International Conference System Sciences*, Hawai, Wailea, Vol. 27, pp.191–200.

Kalyuzhnova, Y. (2011) 'The national fund of the Republic of Kazakhstan (NFRK): from accumulation to stress-test to global future', *Energy Policy*, Vol. 39, No. 10, pp.6650–6657.

Kalyuzhnova, Y. and Patterson, K. (2016) 'Kazakhstan: long-term economic growth and the role of the oil sector', *Comparative Economic Studies*, Vol. 58, No. 1, pp.93–118.

KASE (2018) *News*, Kazakhstan Stock Exchange [online] [online] http://kase.kz/en/news/search/everywhere/strict/number of accounts/ (accessed 25 January 2019).

Kasman, A. and Mekenbayeva, K. (2016) 'Technical efficiency and total factor productivity in the Kazakh banking industry', *Acta Oeconomica*, Vol. 66, No. 4, pp.685–709.

Khoich, A. (2012) 'Role of foreign direct investment in Kazakhstan economy during independence years', *Actual Problems of Economics*, Vol. 138, No. 12, pp.517–526.

King, R.G. and Levine, R. (1993) 'Finance and growth – Schumpeter might be right', *Quarterly Journal of Economics*, Vol. 108, No. 3, pp.717–737.

Klir, D. (1973) *Systemology*, Radio and Svyaz, Moscow.

Knoema (2019) *Crude Oil Forecast: 2018, 2019 and Long-term to 2030* [online] https://knoema.com/yxptpab/crude-oil-price-forecast-2019-2020-and-long-term-to-2030 (accessed 2 February 2019).

Kok, K. (2009) 'The potential of fuzzy cognitive maps for semi-quantitative scenario development, with an example from Brazil', *Global Environmental Change-Human and Policy Dimensions*, Vol. 19, No. 1, pp.122–133.

Kosko, B. (1986) 'Fuzzy cognitive maps', *International Journal of Man-Machine Studies*, Vol. 24, No. 1, pp.65–75.

Koulouriotis, D.E., Diakoulakis, I.E., Emiris, D.M. and IEEE (2001a) 'A fuzzy cognitive map-based stock market model: synthesis, analysis and experimental results'. *10th IEEE International Conference on Fuzzy Systems, Meeting the Grand Challenge: Machines That Serve People*, Vols. 1–3, pp.465–468.

Koulouriotis, D.E., Diakoulakis, I.E., Emiris, D.M. and IEEE (2001b) 'Learning fuzzy cognitive maps using evolution strategies: a novel schema for modeling and simulating high-level behavior', *Proceedings of the 2001 Congress on Evolutionary Computation*, Vols. 1–2, pp.364–371.

Koulouriotis, D.E., Diakoulakis, I.E., Emiris, D.M. and IEEE (2001c) 'Realism in fuzzy cognitive maps: incorporating synergies and conditional effects', *10th IEEE International Conference on Fuzzy Systems, Meeting the Grand Challenge: Machines That Serve People*, Vols. 1–3, pp.1179–1182.

Lee, K.C. and Kim, H.S. (1997) 'A fuzzy cognitive map-based bi-directional inference mechanism: an application to stock investment analysis', *Journal Intellectual System of Accounting Finance Management*. Vol. 6, No. 1, pp.41–57.

Lee, S., Kardaras, G. and IEEE (1997) 'Elastic string based global path planning using neural networks', *International Symposium on Computational Intelligence in Robotics and Automation – Cira '97, Proceedings: Towards New Computational Principles for Robotics and Automation*, pp.108–114, DOI: 10.1109/cira.1997.613846.

Levine, R. (2004) *Finance and Growth: Theory and Evidence*, National Bureau of Economic Research, Cambridge, Mass.

Levine, R., Loayza, N. and Beck, T. (2000) 'Financial intermediation and growth: causality and causes', *Journal of Monetary Economics*, Vol. 46, No. 1, pp.31–77.

Liberatore, M.J. and Nydick, R.L. (2008) 'The analytic hierarchy process in medical and health care decision making: a literature review', *European Journal of Operational Research*, Vol. 189, No. 1, pp.194–207, DOI: 10.1016/j.ejor.2007.05.001.

Lopolito, A., Nardone, G., Prosperi, M., Sisto, R. and Stasi, A. (2011) 'Modeling the bio-refinery industry in rural areas: a participatory approach for policy options comparison', *Ecological Economics*, Vol. 72, pp.18–27.

Luintel, K.B., Khan, M., Leon-Gonzalez, R. and Li, G.J. (2016) 'Financial development, structure and growth: new data, method and results', *Journal of International Financial Markets Institutions and Money*, Vol. 43, pp.95–112, DOI: 10.1016/j.intfin.2016.04.002.

Mardani, A., Jusoh, A. and Zavadskas, E.K. (2015) Fuzzy multiple criteria decision-making techniques and applications – two decades review from 1994 to 2014', *Expert Systems with Applications*, Vol. 42, No. 8, pp.4126–4148, DOI: 10.1016/j.eswa.2015.01.003.

MarketWatch (2019) *CBOE Volatility Index* [online] https://www.marketwatch.com/investing/index/vix (accessed 1 March 2019).

Mazlack, L.J. and IEEE (2009) 'Representing causality using fuzzy cognitive maps', *2009 Annual Meeting of the North American Fuzzy Information Processing Society*, pp.283–288.

Merigó, J.M. (2014) 'Decision-making under risk and uncertainty and its application in strategic management', *Journal of Business Economics and Management*, Vol. 16, No. 1, pp.93–116, DOI: 10.3846/16111699.2012.661758.

Mesarovich, V.D. and Takahara, Y. (1975) *General System Theory: Mathematical Foundations. Case Western Reserve University Cleveland,* Academic Press, Ohio.

Ministry of National Economy of the Republic of Kazakhstan (MNE) (2019) *Statistics Committee* [online] http://stat.gov.kz/official/industry/13/statistic/6 (accessed 1 March 2019).

Mohamadali, N.A. and Garibaldi, J.M. (2009) *A Review of Selected Multi-Criteria Decision Analysis Techniques and Applications* [online] https://pdfs.semanticscholar.org/fa89/df18d75250f47f9001c5970634b42c4ee5a7.pdf (accessed 13 August 2019).

Mukhamedzhanova, A.G. and Medebayeva, A.B. (2018) 'Raw-material orientation of Kazakhstan: economic growth through improvement of institutional quality', *International Journal of Ecological Economics and Statistics*, Vol. 39, No. 1, pp.143–154.

Mukhtarova, K., Ziyadin, S., Kupeshova, S. and Doszhan, R. (2018) 'Problems of developing the foundations of sustainable competitiveness of industrial and innovative economy in Kazakhstan', *Economic Annals-XXI*, Vol. 168, pp.38–43.

Muñoz, P. (2018) 'A cognitive map of sustainable decision-making in entrepreneurship', *International Journal of Entrepreneurial Behavior and Research*, Vol. 24, No. 3, pp.787–813, DOI: 10.1108/ijebr-03-2017-0110.

Nasserzadeh, S.M.R., Jafarzadeh, M.H., Mansouri, T. and Sohrabi, B. (2008) 'Customer satisfaction fuzzy cognitive map in banking industry', *Innovation and Knowledge Management in Business Globalization: Theory and Practice*, Vols. 1–2, pp.444–450.

NBRK (2018) *Financial Sector Indicators: Banking Sector*, National Bank of the Republic of Kazakhstan [online] https://nationalbank.kz/?docid=1065andswitch=russian (accessed 15 December 2018).

NBRK (2019a) *International Reserves and Assets of the National Fund of the Republic of Kazakhstan*, National Bank of the Republic of Kazakhstan, Almaty [online] https://nationalbank.kz/?docid=285andswitch=russian (accessed 12 October 2018).

NBRK (2019b) *Monetary Policy*, National Bank of Republic of Kazakhstan [online] https://nationalbank.kz/?docid=3326&switch=english (accessed 17 January 2019).

Nichkasova, Y. (2019) 'Conceptual model for managing sustainable development of the financial market based on fuzzy cognitive maps: case study of Kazakhstan', *Mendeley Data*, v.1 [online] http://dx.doi.org/10.17632/4kngjy9ggt.1.

Nichkasova, Y. (2019) 'Conceptual model for managing sustainable development of the financial market based on fuzzy cognitive maps: case study of Kazakhstan', *Mendeley Data*, Vol. 2, DOI: 10.17632/4kngjy9ggt.2.

OECD (2016) *Multi-Dimensional Review of Kazakhstan: Initial Assessment*, Vol. 1, OECD Development Pathways, OECD Publishing, Paris [online] https://doi.org/10.1787/9789264246768-en.

Oskonbaeva, Z. (2018) 'Causal link between financial development and economic growth: the case of transition countries', *Financial and Credit Activity-Problems of Theory and Practice*, Vol. 3, No. 26, pp.418–424.

Özesmi, U. and Özesmi, S.L. (2004) 'Ecological models based on people's knowledge: a multi-step fuzzy cognitive mapping approach', *Ecologic Modelling*, Vol. 176, Nos. 1–2, pp.43–64.

Pachura, P. and Hajek, P. (2013) 'Mapping regional innovation strategies in central Europe: a fuzzy cognitive map approach', *International Conference: Hradec Economic Days 2013 – Economic Development and Management of Regions*, Pt. 3, pp.307–313.

Papageorgiou, E.I. and Salmeron, J.L. (2013) 'A review of fuzzy cognitive maps research during the last decade', *IEEE Transactions on Fuzzy Systems*, Vol. 21, No. 1, pp.66–79.

Papageorgiou, E.I., Markinos, A.T. and Gemtos, T.A. (2011) 'Fuzzy cognitive map based approach for predicting yield in cotton crop production as a basis for decision support system in precision agriculture application', *Applied Soft Computing*, Vol. 11, No. 4, pp.3643–3657.

Power, D.J. (2002) *Decision Support Systems: Concepts and Resources for Managers*, Greenwood/Quorum, Westport, CT.

Ramlall, I. (2018) 'Concept of financial stability demystified. Understanding financial stability', *The Theory and Practice of Financial Stability*, Vol. 1, pp.13–31, DOI: doi.org/10.1108/978-1-78756-833-420181013.

Refsgaard, J.C., Van Der Sluijs, J.P., Hojberg, A.L. and Vanrolleghem, P.A. (2007) 'Uncertainty in the environmental modelling process – a framework and guidance', *Environmental Modelling and Software*, Vol. 22, No. 11, pp.1543–1556.

Rogachev, A.F. (2017a) 'Two-level economic and mathematical model of monotown development on the basis of cognitive maps', in *Integration and Clustering for Sustainable Economic Growth*, pp.339–345, DOI: 10.1007/978-3-319-45462-7_35.

Rogachev, A.F. (2017b) 'Computer modeling of the development of Russian small towns on the basis of cognitive maps', in *Russia and the European Union: Development and Perspectives*, pp.113–118, DOI: 10.1007/978-3-319-55257-6_16.

Rotmans, J. (1998) 'Global change and sustainable development: towards an integrated conceptual model', *Earth Systems Analysis: Integrating Science for Sustainability – Complemented Results of a Symposium*, pp.421–453.

Ruziev, K. and Majidov, T. (2013) 'Differing effects of the global financial crisis on the central Asian countries: Kazakhstan, the Kyrgyz Republic and Uzbekistan', *Europe-Asia Studies*, Vol. 65, No. 4, pp.682–716, DOI: 10.1080/09668136.2013.766044.

Saaty, T.L. (1977) 'Scaling method for priorities in hierarchical structures', *Journal of Mathematical Psychology*, Vol. 15, No. 3, pp.234–281, DOI: 10.1016/0022-2496(77)90033-5.

Sacchelli, S. and Fabbrizzi, S. (2015) 'Minimisation of uncertainty in decision-making processes using optimised probabilistic fuzzy cognitive maps: a case study for a rural sector', *Socio-Economic Planning Sciences*, Vol. 52, pp.31–40.

Sadovnikova, N.P. and Zhidkova, N.P. (2012) 'The choice of territorial development strategies based on cognitive analysis and scenario modeling', *VolgGASU Internet-Bulletin, Ser.: Builds, Computer Science*, Vol. 7, No. 21, pp.1–7 [online] http://www.vestnik.vgasu.ru (accessed 25 February 2019).

Salmeron, J.L. (2009) 'Supporting decision makers with fuzzy cognitive maps', *Research-Technology Management*, Vol. 52, No. 3, pp.53–59.

Salmeron, J.L. (2012) 'Fuzzy cognitive maps for artificial emotions forecasting', *Applied Soft Computing*, Vol. 12, No. 12, pp.3704–3710, DOI: 10.1016/j.asoc.2012.01.015.

Schwab, K. (2016) *The Global Competitiveness Report 2016–2017*, WEF, Geneva.

Schwab, K. (2017) *The Global Competitiveness Report 2017–2018*, WEF, Geneva.

Schwab, K. (2018) *The Global Competitiveness Report 2018–2019*, WEF, Geneva.

Schwenk, C.R. (1984) 'Devils advocacy in managerial decision-making', *Journal of Management Studies*, Vol. 21, No. 2, pp.153–168.

Schwenk, C.R. (1989) 'Linking cognitive, organizational and political factors in explaining strategic change', *Journal of Management Studies*, Vol. 26, No. 2, pp.177–187.

Shahbaz, M., Bhattacharya, M. and Mahalik, M.K. (2017) 'Finance and income inequality in Kazakhstan: evidence since transition with policy suggestions', *Applied Economics*, Vol. 49, No. 52, pp.5337–5351.

Simon, H.A. (1957) *Models of Man*, Wiley, New York.

Sohag, K., Nabilah, A.B. and Begum, R.A. (2015) 'Dynamic impact of financial development on economic growth: heterogeneous panel data analysis of island economies', *International Journal Economic Policy in Emerging Economies*, Vol. 8, No. 1, pp.77–95.

Sprague, R.H. and Carlson, E.D. (1982) *Building Effective Decision Support Systems*, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Stephens, C. and Skinner, C. (2013) 'Banks for a better planet? The challenge of sustainable social and environmental development and the emerging response of the banking sector', *Environmental Development*, Vol. 5, pp.175–179.

Stylios, C.D. and Groumpos, P.P. (1999) 'Fuzzy cognitive maps: a model for intelligent supervisory control systems', *Computers in Industry*, Vol. 39, No. 3, pp.229–238.

Tobin, J. (1984) 'On the efficiency of the financial system', *Lloyds Bank Review*, Vol. 153, pp.1–15.

Tommasetti, A., De Maio, C., Fenza, G., Loia, V., Botti, A., Troisi, O. and Vesci, M. (2015) *What-If Analysis Combining Fuzzy Cognitive Map and Structural Equation Modeling* [online] https://www.researchgate.net/publication/284030714_Whatif_analsysis_combining_Fuzzy_Cognitive_Map_and_Structural_Equation_Modeling (accessed 14 August 2019).

United Nations (UN) (2017) *Roadmap for a Sustainable Financial System. A UN Environment – World Bank Group Initiative*, UN Environment Inquiry into the Design of a Sustainable Financial System [online] http://unepinquiry.org/wpcontent/uploads/2017/11/Roadmap_for_a_Sustainable_Financial_System.pdf (accessed 14 August 2019).

Van Der Sluijs, J.P. (2012) 'Uncertainty and dissent in climate risk assessment: a post-normal perspective', *Nature + Culture*, Vol. 7, No. 2, pp.174–195.

Van Vliet, M., Kok, K. and Veldkamp, T. (2010) 'Linking stakeholders and modellers in scenario studies: the use of fuzzy cognitive maps as a communication and learning tool', *Futures*, Vol. 42, No. 1, pp.1–14.

Warmink, J.J., Janssen, J., Booij, M.J. and Krol, M.S. (2010) 'Identification and classification of uncertainties in the application of environmental models', *Environmental Modelling and Software*, Vol. 25, No. 12, pp.1518–1527.

WFE (2019) *Statistics World Federation of Exchanges* [online]: https://www.world-exchanges.org/our-work/statistics (accessed 25 January 2019).

Wongpiyabovorn, O. (2016) 'Financial development and economic growth: the cases of Thailand, Malaysia, and the Philippines', *International Journal of Economic Policy in Emerging Economies*, Vol. 9, No. 2, pp.103–126.

World Bank (WB) (2013) *Global Financial Development Report 2013: the Role of the State in Finance*, World Bank, Washington, DC.

World Bank (WB) (2015) *Global Financial Development Report 2015–2016: Long-Term Finance. Global Financial Development Report 2015*, World Bank, Washington, DC.

World Bank (WB) (2018) *Global Financial Development Report 2017/2018: Bankers without Borders*, World Bank, Washington, DC.

World Bank (WB) and IMF (2005) *Financial Sector Assessment: A Handbook*, World Bank, International Monetary Fund [online] http://openknowledge.worldbank.org (accessed 25 February 2019).

World Commission on Environment and Development (WCED) (1987) *Our Common Future: the Brundtland Report*, Oxford University Press, Oxford.

Wu, H-Y. (2012) 'Constructing a strategy map for banking institutions with key performance indicators of the balanced scorecard', *Evaluation and Program Planning*, Vol. 35, No. 3, pp.303–320, DOI: 10.1016/j.evalprogplan.2011.11.009.

Wu, L. and Broadstock, D.C. (2015) 'Does economic, financial and institutional development matter for renewable energy consumption? Evidence from emerging economies', *International Journal of Economic Policy in Emerging Economies*, Vol. 8, No. 1, pp.20–39, DOI: 10.1504/ijepee.2015.068246.

Xirogiannis, G. and Glykas, M. (2004) 'Fuzzy cognitive maps in business analysis and performance-driven change', *IEEE Transactions on Engineering Management*, Vol. 51, No. 3, pp.334–351.

Yaman, D. and Polat, S. (2009) 'A fuzzy cognitive map approach for effect-based operations: an illustrative case', *Information Sciences*, Vol. 179, No. 4, pp.382–403.

Zadeh, L.A. (1965) 'Fuzzy sets', *Information and Control*, Vol. 8, No. 3, pp.338–353.

Zavadskas, E.K., Turskis, Z. and Kildienė, S. (2014) 'State of art surveys of overviews on MCDM/MADM methods', *Technological and Economic Development of Economy*, Vol. 20, No. 1, pp.165–179, DOI: 10.3846/20294913.2014.892037.

Zhang, L.R., Qiao, X.D. and Zhu, L.J. (2014) 'The analytic network processes method and fuzzy cognitive map method in decision making: a comparative study', *Thirteenth Wuhan International Conference on E-Business*, pp.244–251.

Ziyadin, S. (2012) 'Effect of the world global economic crisis on the condition of banking systems', *Actual Problems of Economics*, Vol. 134, No. 8, pp.419–429.

Appendix

Table A1 System orientors: the application to the economic and financial systems

Origin system orientors	*Economic and financial system orientors*
Existence	Depth
Effectiveness	Efficiency
Freedom of action	Accessibility
Security	Stability
Adaptability	Innovativeness
Coexistence	Integration
Psychological needs	Economic and financial behaviour

Source: Author's development

Table A2 The matrix of mutual influence of factors (see online version for colours)

CM	*Initial tendency*	*Initial concept*	*Codes*	*x1*	*x2*	*x3*	*x4*	*x5*	*x6*	*x7*	*x8*	*x9*	*x10*	*x11*	*x12*	*y1*	*y2*	*y3*	*y4*	*y5*	*y6*	*y7*	*y8*	*y9*	*y10*	*z1*	*z2*	*z3*	*z4*	*z5*	*z6*	*z7*	*z8*	*z9*
Economic system	**0.0278**	–0.0407	x1		0.1		0.20	–0.05	–0.10	–0.05		–0.10	–0.20		0.25	–0.20	–0.10		0.10		–0.10	–0.05					0.10			0.10	0.05	–0.05		
	–0.0036	0.0163	x2	–0.10		0.20	–0.1	0.10	0.20	0.10	0.50					0.30	0.40	0.30							0.10	0.20	0.20	0.10	0.30	0.10		0.10		
	0.0750	0.0124	x3	0.20	0.20			0.10	0.20	0.10	0.15	0.20				0.30					–0.20					0.20	0.20	0.20					–0.20	0.20
	0.0614	–0.0126	x4		–0.20			–0.01		0.10	–0.30				0.20				0.30				0.30	–0.20			–0.15	–0.15	0.4					–0.10
	0.0015	0.0414	x5	0.01	0.01	0.15			0.15			0.10								0.10		0.15										0.10		
	–0.0046	0.0506	x6		0.10						0.02					0.02		0.25		0.15										0.15				
	0.0612	0.0465	x7	–0.25									0.10			0.20			–0.10	0.02	0.15						0.10			0.10				0.10
	–0.0041	0.0264	x8				–0.20											0.15			0.15	0.05									0.15			
	0.0652	0.0363	x9			–0.30		–0.20	0.01					0.10	–0.10	0.02	0.05		–0.10		0.05		–0.10	0.05		0.10						0.15	–0.10	0.15
	0.0590	0.0018	x10	–0.20				0.10								0.20							–0.15											
	0.0661	0.0498	x11									0.01	–0.30		–0.05	0.01					0.15			0.10			0.10		0.15			0.10	–0.10	0.20
	0.0854	–0.0078	x12	0.15	0.40	0.50	0.02			–0.05						–0.10			0.10		–0.05			–0.10					0.20					–0.10
Financial institutions	**0.0246**	0.0207	y1		0.10	0.10					0.20	0.20			–0.05		0.40		–0.20												0.15			
	–0.0629	0.0235	y2															0.20		0.20			–0.20											
	0.0375	0.0204	y3						0.10	0.10		0.01			0.10	0.10	0.02					0.02								0.10				
	–0.0305	–0.0248	y4		–0.30	0.20	0.10		–0.10							–0.30				–0.14						0.10				0.10				
	0.0508	0.0212	y5		0.40	0.20			0.10			0.05															0.10	0.10		0.15				
	0.0284	0.0148	y6			0.50								0.10		0.40	0.20		–0.10				0.20			0.05	0.05					0.15		
	0.0454	0.0350	y7		0.20				0.10			0.05						0.10												0.05			–0.05	0.10
	0.0051	–0.0183	y8									–0.15			0.15		–0.20		–0.25					–0.20										
	0.0702	0.0122	y9					0.20																										
	–0.0213	0.0208	y10										0.20	0.15																				
Financial markets	**–0.0101**	–0.0339	z1	–0.10	0.01	0.10					0.10	0.10				0.20					0.10						0.20	0.15						
	0.0023	–0.0162	z2			0.20		0.02	0.10						–0.10					0.05						0.10		0.10					–0.15	
	–0.0435	0.0152	z3		0.15	0.10																				0.10						0.10		
	–0.0664	0.0160	z4			–0.30					–0.15				0.15		0.20		0.10								–0.07			0.20	0.20	–0.01	0.20	
	–0.2294	–0.0137	z5		0.10	0.10	0.10			0.10		0.15					0.10									0.12	0.14	0.08						
	–0.0448	–0.0057	z6		0.10	0.10	0.10										0.10				0.15					0.13	0.16	0.17		0.20		0.15		
	0.1536	–0.0217	z7	–0.15		0.10						0.15														0.05		0.08						
	0.0276	–0.0149	z8												0.10			0.10					0.10	–0.10		–0.15	–0.10		0.20			–0.10		–0.10
	0.1017	0.0004	z9			0.15			0.20												0.20													

Table A3 The conceptual model learning process fragment (see online version for colours)

Convergence criterion			*0.00001*														
Iteration limit			*30*			*Iterations*											
2024	*2025*	*Initial tendency*	*Initial concept value*	*Codes*	*1*	*2*	*3*	*4*	…	*15*	*16*	*Increment*	*Concept value*	*1 – negative; 0 – positive*	*Orientors*	*1 – includes in mean value*	*Sub system*
45.91	49.97	**0.074994**	**–0.040724**	X1	–0.0002	–0.0001	–0.0001	–0.0002		–0.0005	–0.0005	–0.00056	–0.04128	1	4	1	1
14,640.71	16,580.62	**0.061361**	**0.016278**	X2	0.0008	0.0011	0.0016	0.0021		0.0050	0.0052	0.00603	0.02231	0	2	1	1
28.65	26.65	**0.001479**	**0.018507**	X3	0.0016	0.0017	0.0021	0.0024		0.0043	0.0044	0.00491	0.02342	0	3	1	1
12.25	6.39	**–0.004586**	**–0.012619**	X4	–0.0002	–0.0005	–0.0006	–0.0008		–0.0020	–0.0021	–0.00245	–0.01506	1	4	1	1
64,976.02	66,067.55	**0.061180**	**0.032824**	X5	0.0012	0.0012	0.0014	0.0015		0.0024	0.0024	0.00268	0.03550	0	5	1	1
23	24	**–0.004084**	**0.050635**	X6	0.0000	0.0002	0.0004	0.0005		0.0015	0.0016	0.00188	0.05251	0	6	1	1
1,397,852	1,456,694	**0.065165**	**0.011428**	X7	0.0003	0.0006	0.0008	0.0009		0.0021	0.0022	0.00251	0.01394	0	5	1	1
37	39	**0.058992**	**0.016953**	X8		0.0002	0.0004	0.0006		0.0016	0.0016	0.00190	0.01886	0	5	1	1
270	280	**0.066065**	**0.015971**	X9	–0.0005	–0.0006	–0.0005	–0.0006		–0.0009	–0.0009	–0.00098	0.01499	0	1	1	1
77,996	78,959	**0.085406**	**0.001813**	X10	0.0003	0.0004	0.0004	0.0004		0.0008	0.0008	0.00089	0.00270	0	4	1	1
87	89	**0.024570**	**–0.010813**	X11	0.0001	0.0002	0.0003	0.0004		0.0009	0.0009	0.00102	–0.00979	0	6	1	1
3	3	**–0.062945**	**0.017493**	X12	0.0004	0.0008	0.0009	0.0012		0.0028	0.0029	0.00336	0.02085	1	7	1	1
52.88	54.26	**0.037529**	**0.020679**	Y1	0.0011	0.0012	0.0014	0.0016		0.0029	0.0030	0.00334	0.02401	0	1	1	2
3.36	2.74	**–0.030550**	**0.023502**	Y2		0.0001	0.0002	0.0002		0.0007	0.0007	0.00088	0.02438	0	2	1	2
2,066.57	2,122.93	**0.050837**	**0.020384**	Y3	0.0001	0.0002	0.0003	0.0004		0.0011	0.0011	0.00130	0.02169	0	3	1	2
7.27	7.29	**0.028406**	**–0.024765**	Y4	–0.0001	–0.0002	–0.0004	–0.0006		–0.0019	–0.0020	–0.00234	–0.02711	1	7	1	2
80.22	83.08	**0.045419**	**0.021206**	Y5	0.0003	0.0008	0.0010	0.0013		0.0034	0.0036	0.00414	0.02534	0	5	1	2
36.15	48.54	**0.005089**	**0.014775**	Y6	0.0010	0.0014	0.0015	0.0019		0.0040	0.0042	0.00475	0.01953	0	6	1	2
86.10	90.70	**0.070188**	**0.034960**	Y7		0.0002	0.0003	0.0005		0.0014	0.0015	0.00175	0.03671	0	7	1	2
16.66	21.12	**–0.021256**	**–0.018323**	Y8		0.0001	0.0002	0.0002		0.0008	0.0008	0.00093	–0.01739	1	4	1	2
3.88	3.51	**–0.010101**	**0.012236**	Y9	0.0002	0.0002	0.0002	0.0003		0.0005	0.0005	0.00053	0.01276	1	7	1	2
134.07	127.50	**0.002324**	**0.020767**	Y10		0.0001	0.0001	0.0001		0.0003	0.0003	0.00032	0.02109	1	7	1	2
0.86	0.74	**–0.043491**	**–0.033900**	Z1	0.0005	0.0007	0.0009	0.0010		0.0022	0.0022	0.00256	–0.03134	0	1	1	3
4.95	5.57	**–0.066380**	**–0.016245**	Z2	0.0012	0.0014	0.0015	0.0016		0.0023	0.0024	0.00257	–0.01368	0	2	1	3
–1.20	–3.07	**–0.229376**	**0.015178**	Z3	0.0001	0.0003	0.0004	0.0005		0.0014	0.0015	0.00168	0.01686	0	3	1	3
29.92	36.34	**–0.044801**	**0.016050**	Z4	–0.0004	–0.0004	–0.0004	–0.0004		–0.0006	–0.0006	–0.00062	0.01543	1	4	1	3
5,908.86	6,422.29	**0.153642**	**–0.013666**	Z5	0.0002	0.0004	0.0005	0.0007		0.0015	0.0016	0.00180	–0.01186	0	5	1	3
98	100	**0.027582**	**–0.005744**	Z6	0.0003	0.0007	0.0009	0.0011		0.0026	0.0027	0.00308	–0.00267	0	6	1	3
21.556	22.925	**0.101747**	**–0.021716**	Z7	0.0001	0.0001	0.0002	0.0002		0.0006	0.0006	0.00067	–0.02104	0	6	1	3
20.46515863	21.91772875	**–0.009102**	**–0.014872**	Z8	–0.0001	–0.0003	–0.0003	–0.0003		–0.0005	–0.0005	–0.00052	–0.01539	1	7	1	3
50,420.4	52,762.5	**0.065726**	**0.000423**	Z9	0.0002	0.0004	0.0006	0.0007		0.0017	0.0018	0.00202	0.00244	0	1	1	3

Table A4 The frame of the conceptual model and data (see online version for colours)

Economic system	*Financial institutions*	*Financial markets*

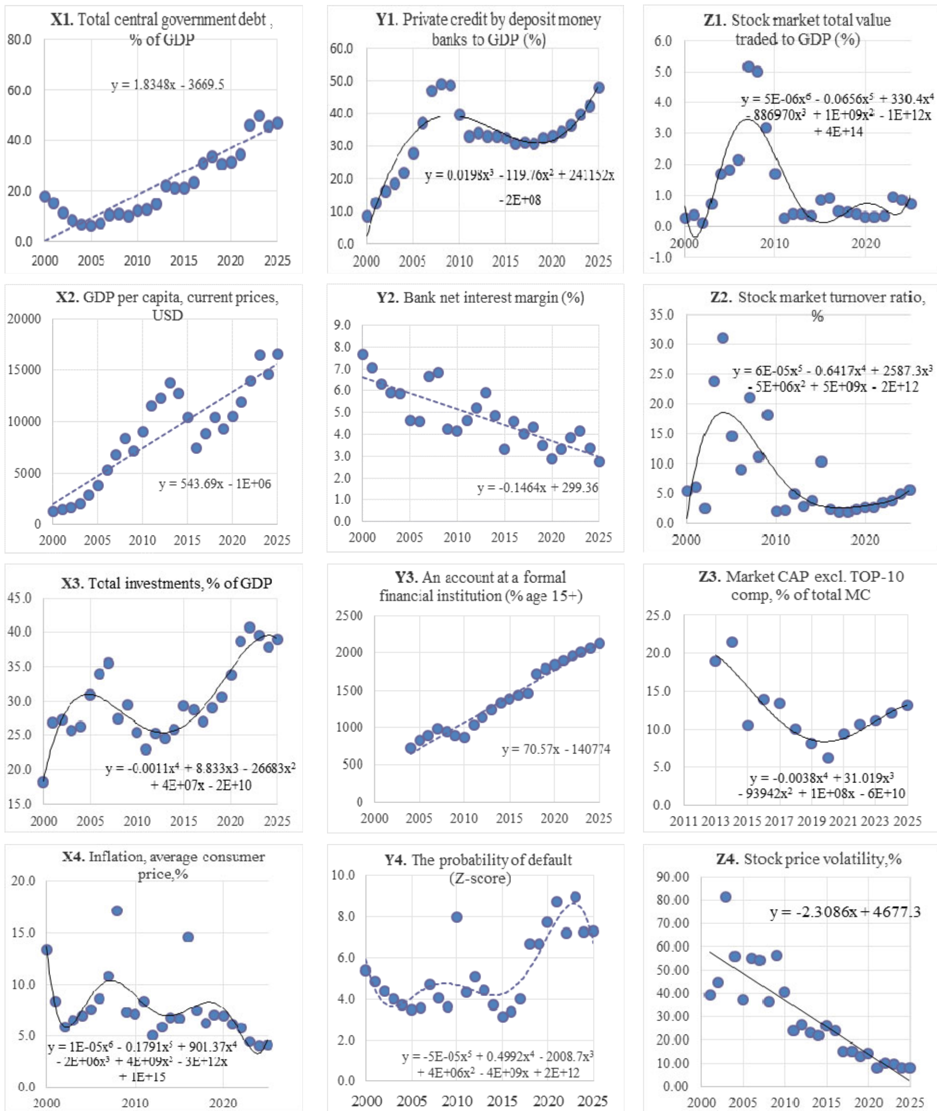


Table A4 The frame of the conceptual model and data (continued) (see online version for colours)

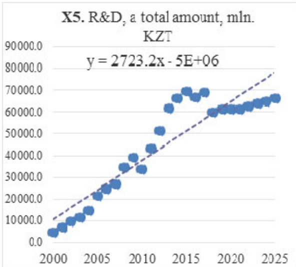
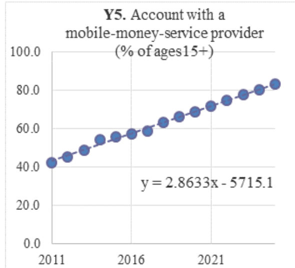
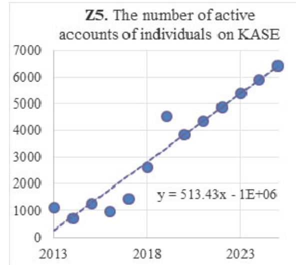
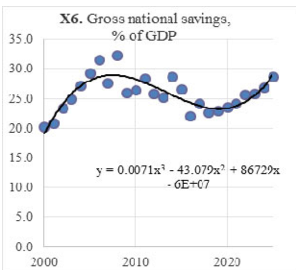
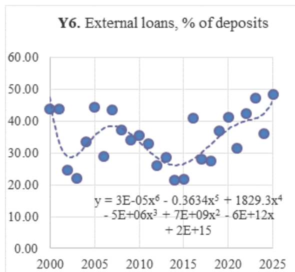
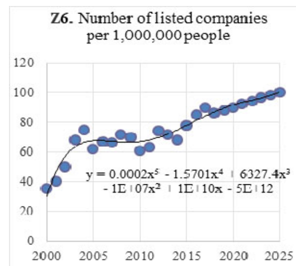
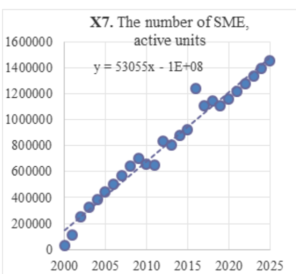
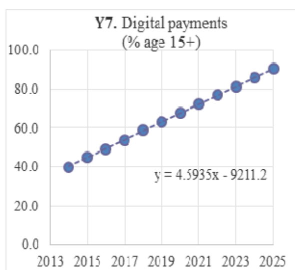
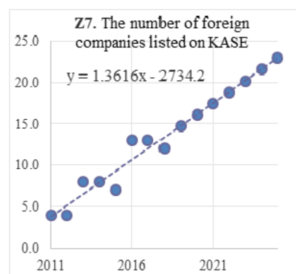
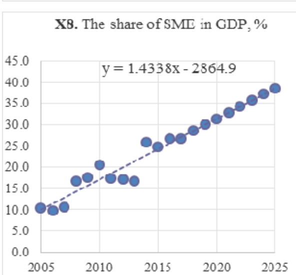
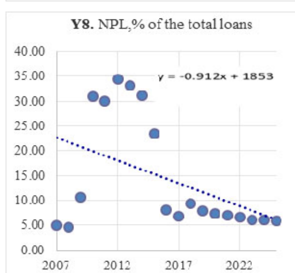
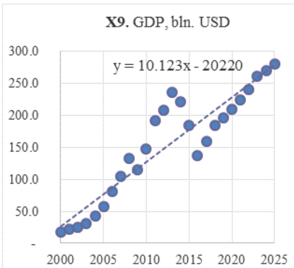
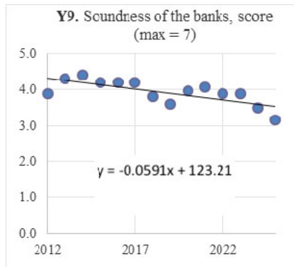
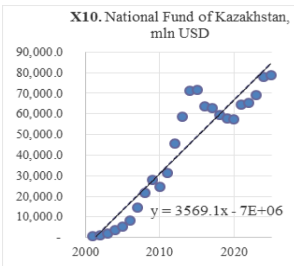
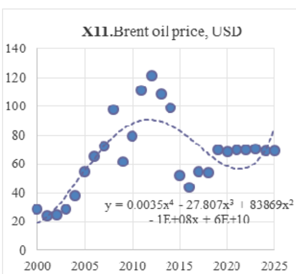
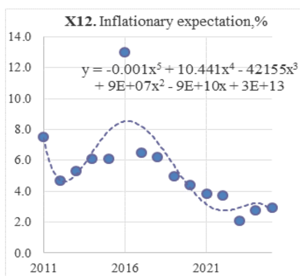
Economic system	*Financial institutions*	*Financial markets*
		
		
		
		

Table A4 The frame of the conceptual model and data (continued) (see online version for colours)

Economic system	*Financial institutions*	*Financial markets*
		
		
		

FigureA1 Self-development of the sub-system 2010–2025 (coefficients data output) (see online version for colours)

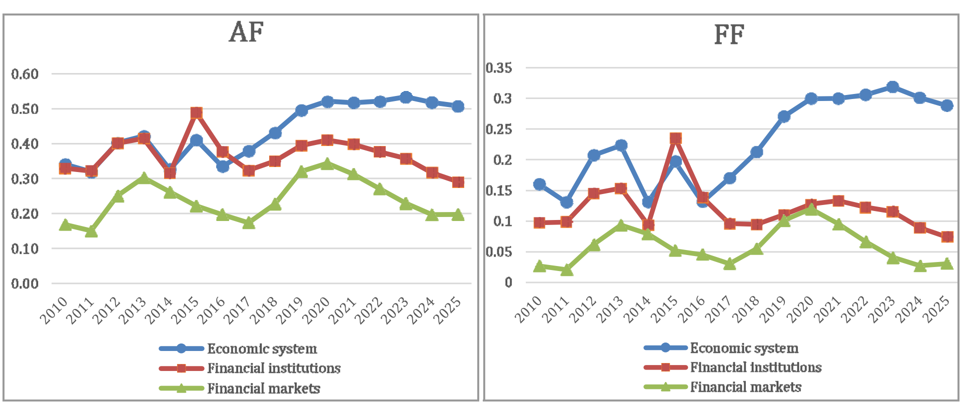
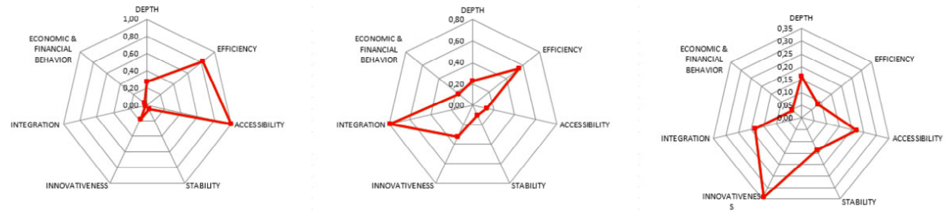


Figure A2 Self-development of the sub-system (orientors output) (see online version for colours)

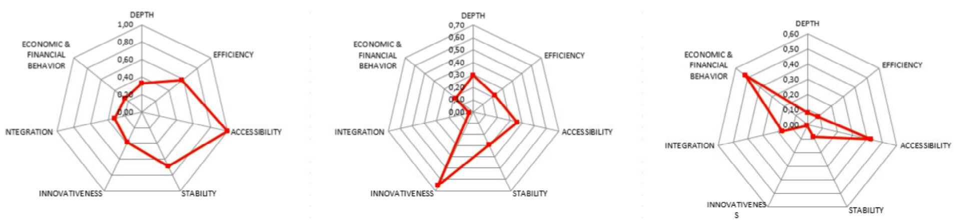
2005

Economic system | Financial institutions | Financial markets



2018

2025



Source: Author's development