FUZZY OPTIMIZATION AND MODELLING 3(4) (2022) 37-50

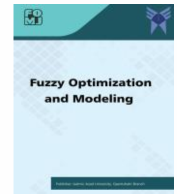
E-ISNN: 2676-7007

IAU Qaemshahr Branch

Contents lists available at FOMJ

Fuzzy Optimization and Modelling

Journal homepage: http://fomj.qaemiau.ac.ir/



Paper Type: Research Paper

A Framework for Identifying and Analyzing Drivers Affecting the Futures of Cryptocurrency FinTechs in Iran with Fuzzy Delphi and Fuzzy Dematel

Mohammad Hasan Maleki [a, *], **Mohammad Javad Zare Bahnamiri** [a], **Iman Dadashi** [a]

[a] *Department of Accounting, Faculty of Economic and Administrative Sciences, University of Qom, Qom, Iran*

ARTICLE INFO

Article history:
Received 29 January 2023
Revised 02 February 2023
Accepted 06 March 2023
Available online 01 April 2023

Keywords:
Driver
Future
Crypto Fin Tech
Fuzzy Decision Making

ABSTRACT

The present research aimed to identify and analyze effective drivers in the future of crypto fintechs using a fuzzy approach. The research was applied in terms of purpose and had a quantitative methodology. The theoretical population consisted of financial experts in fintechs and block chain technology. Judgmental sampling was performed based on the expert's expertise. A sample size of 10 was studied. Two quantitative techniques, fuzzy Delphi and DEMATEL, were utilized in the study, and the expert and effect assessment questionnaires, which had desired validity and reliability, were used to collect data. The research had three stages; first, 22 drivers were obtained using the literature review and interviews with experts. Second, the drivers were screened by distributing expert assessment questionnaires and the fuzzy Delphi method. Third, 10 drivers were selected for the final analysis due to the suitable deffuzification number. Such drivers were evaluated by distributing effect assessment questionnaires and the fuzzy DEMATEL technique. The drivers of national regulatory policies, the development of national RegTechs, and the development of smart contracts in the financial industry respectively had the highest net effects. Practical suggestions were extracted based on prior drivers and interviews with focus groups.

1. Introduction

One of the most competitive industries and the most complex markets is the financial services industry, including banking, insurance, and investment. A large number of banks and insurance companies in Iran are operating as large investment groups or independent companies. Financial technology (Fintech) is one of the requirements for the development of the financial services industry. More than 90% of the total gross domestic product in the American economy is dedicated to financial services and insurance. This industry has caused the

* Correspondig author
E-mail address: mh.maleki@qom.ac.ir (Mohammad Hasan Maeki)

DOI: 10.30495/fomj.2023.1987397.1084

formation of new ways of providing services through the new forces of technological innovation and business transformation [22].

Fintech will completely change the future of the financial services industry. Some traditional financial institutions whose processes and service delivery methods will be transformed are banks and insurance companies [50]. Fintech personalizes financial services by using new financial technologies and innovations influenced by artificial intelligence, data analytics, the Internet of Things, and blockchain and improves customer satisfaction through service diversity, speed, agility, and ease of access [5,4]. Fintech operates in various fields such as payment, financing, investment, wealth management, cryptocurrencies, insurance, and banking. These changes have brought challenges for many traditional financial institutions such as banks and even consumers [30]. The development of Fintech will change the nature of financial services, which is referred to as the Fintech revolution by thinkers. This revolution will take place through the rapid development of hardware and software and the growing convergence of ICT [41].

Iranian Fintech is mostly of the payment type. There are many obstacles facing Fintech in Iran such as weak infrastructure and regulation. Crypto-Fintech in Iran has received less attention despite its many functions. Using technologies such as blockchain, this type of Fintech can bring about significant changes in the banking industry through the development of smart contracts.

Blockchain is a continuous ledger database that is complete, distributed, and immutable [10].The main feature of blockchain is that it is a decentralized system with a very long security chain. This technology significantly contributes to building trust, reducing transaction costs, saving time, and reducing concentration. In this way, blockchain is expected to form an industrial and commercial revolution and cause economic reforms in different parts of the world [13].

There are many studies on Fintech. These studies try to provide an accurate and comprehensive definition of Fintech and explain its various fields and models. They also try to describe the development and evolution of Fintech over time [6,15]. Another important focus of studies in this field is to examine trends and the future of Fintech. In these studies, an attempt has been made to evaluate the trends and drivers that shape the future of Fintech. These factors and trends have been proposed in various fields of technology, economy, finance, and organization [8, 39, 24]. Another important focus of studies in the field of Fintech is the relationship between Fintech and traditional financial institutions, especially banks. The most important topics investigated in this field are the opportunities and threats of Fintech for the banking industry [9], the role of Fintech in the performance of banks [17,49,16], the strategies cooperation between banks and Fintech, and risks and challenges of cooperation between Fintech and bank [36,43].

Studies on blockchain and smart contracts are in their infancy. Most of the studies on blockchain and smart contracts have reviewed their applications and challenges in previous studies [14,25,41,28]. Another field of study in smart contracts is to identify the weaknesses and security problems of smart contracts[27,40]. Some studies have focused on the implementation of smart contracts in areas such as real estate, supply chain, health, finance, and insurance [47,30,37,38]. Due to the effective role of crypto-Fintech and blockchain in the development of the financial industry and the theoretical necessity of investigating this field, this study seeks to identify and analyze the drivers affecting the future of crypto-Fintech in Iran.

Most Iranian fintechs are of the payment type. Fintechs in Iran have a limited variety due to obstacles such as bank competition and regulation. Advances in artificial intelligence and blockchain will aid the development of cryptocurrency fintechs in the coming years. Identifying the factors that affect the future of this field will help policymakers to make the necessary plans. Improvement scenarios are a suitable tool for the preparation of actors in the future.

2. Literature Review

By publishing a whitepaper in 2008, Nakamoto introduced the concepts of Bitcoin and Blockchain. This was a turning point in the history of blockchain. Nakamoto is the nickname of the person who invented the Bitcoin and Blockchain technology. The blockchain-based infrastructure of this cryptocurrency enables safe and peer-to-peer transactions without the need for intermediary institutions such as governments or central banks based on the Bitcoin Whitepaper. In addition to inventing Bitcoin, Nakamoto introduced the concept of blockchain to the world of technology. New blocks can be added to a single chain without having to be signed and verified by a third party based on this concept. Nakamoto introduced the e-coin as a chain of digital signatures in which each owner transfers the coin to the next owner. According to the Bitcoin Whitepaper, this is done by using the digital signature of the previous transaction's hash and the public key of the subsequent owner and adding these to the end of the coin, but the publication of the whitepaper was the first step. Bitcoin turned from an abstract concept into a real entity in 2009.

Blockchain is the underlying technology of many cryptocurrencies such as Bitcoin. Blockchain, with its unique combination of features including decentralization, immutability, and transparency, offers great potential to improve various sectors [48]. In a blockchain, records are stored in blocks. Two hashes precede the records of every block except the first block in a blockchain. The hash is generated by a hash function and uses data from a block as input. The first hash of a block is generated from the second hash and the data in the block. On the other hand, the second hash in the block is a copy of the first hash of the previous block. Hashes link blocks of data. So, such a network is called a blockchain. Tamper detection of existing records is made possible by sorting data into blocks chained by hashes [45].

Blockchain is used in many areas such as payment systems, cryptocurrency development, database record management, and smart contract development [1]. By partnering with Fintech such as cryptocurrency, many financial institutions such as banks and insurance companies can take advantage of blockchain technology [20]. This Fintech has important capabilities such as the development of smart contracts in addition to facilitating the transactions of various cryptocurrencies.

As a computer protocol to create or improve a contract, a smart contract enables the creation of reliable transactions without intermediaries. These transactions are traceable and irreversible. Smart contracts include all information about the terms of the contract and all targeted actions automatically. The term smart contract was first used in 1994 by Szabo [34]. Crypto-Fintech has developed less than other Fintechs such as payment Fintech in Iran. Due to the development of artificial intelligence and smart contracts in the financial industry, this Fintech will play an important role in the development of the financial industry in the future. This study seeks to identify and analyze the drivers affecting the future of crypto-Fintech in Iran.

In a study by Ahmadi et al. [2], the future of marketing in the banking industry was identified with a focus on blockchain technology. 47 drivers were obtained from meta-synthesis and were categorized into 9 main drivers. The drivers were then screened in two stages using theory-based inference screening and the binomial test, and 12 drivers were considered for ranking using the COPRAS method. The other drivers were evaluated by using the COPRAS technique and three indicators of the severity of importance, degree of certainty, and expert expertise. According to the findings, the drivers of marketing researchers' interest in digital Fintech, blockchain, and the development of decentralized banking had the highest priority. So, they were selected for scenario writing. Four scenarios of crypto banking, conservative banking, progressive banking, and traditional banking were developed based on these two drivers.

Deepa et al. [10] reviewed blockchain approaches, opportunities, and future directions in big data. The results showed that despite the many benefits and applications, there are many challenges facing big data that must be faced for better service quality. Some of these challenges include big data analytics, big data management, privacy, and big data security. With its decentralized and secure nature, blockchain has great potential to improve big data applications and services. In this study, a comprehensive survey of blockchain for big data is conducted with an emphasis on approaches, opportunities, and future directions. A brief overview of blockchain and big data, as well as the motivation behind their integration, is first provided. Various blockchain services for big data such as blockchain for secure big data collection, data storage, data analytics, and data privacy are then explored. In the next step, various studies on the use of blockchain for big data applications in various fields such as smart cities, smart healthcare, smart transportation, and smart grid are reviewed. Besides, some blockchain-based big data projects are presented and analyzed for better understanding. Finally, challenges and future directions are discussed to advance further studies in this promising field.

In their study, Shayesteh et al. [39] identified the future of project-oriented organizations operating in the financial services industry with a scenario-based approach. They used the binomial test, the modified fuzzy VIKOR method, root definitions, and the SECA technique to analyze the data. 25 drivers were obtained through a literature review and expert interviews. They were then screened by using the binomial test. 17 drivers had a significance coefficient above 5% and were excluded from the analysis. The remaining 8 drivers were investigated using the modified fuzzy VIKOR method. The two drivers of the legal environment of the financial services industry and the type of interaction of traditional financial institutions with Fintech had the highest priority. Four scenarios were developed for the future of project-oriented organizations operating in the financial services industry in the form of Dreamland, Paranoia Age, Baseless World, and Ice Age based on these two drivers. Finally, the Baseless World was chosen as the most likely scenario by using the SECA technique.

In a study by Koshesh Kordsholi, Maleki & Gholami Jamkarani [24], the drivers affecting the future of Fintech in Iran were identified and analyzed. The drivers extracted from the literature review and expert interviews were screened using fuzzy Delphi and expert opinions for data analysis. 7 out of 14 identified drivers were removed using fuzzy Delphi analysis, and the remaining drivers were analyzed using type 2 FAHP. According to the weights, the drivers of ease of international exchange and transactions, the models of cooperation between Fintech institutions and traditional financial institutions, and paying attention to the interests and views of stakeholders in the formation of rules and regulations had the highest effect on the future of Fintech.

Suryono, Badi & Purvandari [44] identified Fintech challenges and trends to determine the status of the latest developments in Fintech studies and identify existing gaps in Fintech studies and potential challenges and trends for future studies. They used a systematic review to extract challenges and trends and strengthen the theoretical foundations of Fintech.

In a study by Chang et al. [7], the effect of Fintech and blockchain evolution on the financial services industry was described and the key features of such technology were outlined. Three important challenges and three ethical concerns concerning the application of blockchain were then discussed. The results suggested how financial services should respond to this new technology and how to manage knowledge more structurally by sharing.

Hu et al. [21] identified and categorized the types of Ethereum smart contracts. This study was conducted to identify and classify Ethereum smart contracts to investigate the problems caused by these contracts. For this purpose, 10,000 Ethereum smart contracts were collected and the behavior of data generated by smart contracts and users was investigated. Four different behavioral models were then extracted from these contracts. The min-max cutting algorithm and LSTM network were used to analyze the experimental data. This framework was used to identify the weaknesses of the contracts.

Schär [35] reviewed and evaluated the characteristics of decentralized finance (DeFi). The term DeFi refers to an alternative financial infrastructure built on the Ethereum blockchain. DeFi uses smart contracts to develop protocols that make available financial services more open, interoperable, and transparent. In this study, the potential opportunities and threats of the DeFi ecosystem were described and a multilayer framework was proposed to analyze the implicit architecture and building blocks of DeFi, such as token standards, decentralized exchanges, decentralized debt markets, blockchain derivatives, and on-chain asset management protocols. According to the results, DeFi is still a niche market with specific risks but it has interesting features in terms of efficiency, transparency, accessibility, and compatibility. Accordingly, DeFi can potentially contribute to a stronger and more transparent financial infrastructure.

In a study by Drasch, Schweizer & Urbach [12], the model of cooperation between banks and Fintech was classified into six groups as follows: 1. Investing in Fintech to form cooperation and access to the Fintech ecosystem, 2. Preparation and integration of channel solutions and innovations of the excellence platform, 3. Innovation to optimize the processes of providing banking services to customers, 4. Access to capital markets for fintech to provide banking services, 5. Fintech to bank cross-services for innovation in providing banking services to customers, and 6. Cooperation in the early stage of access to technology.

In a study by Deshpande et al. [11], the prospects of developing industry standards for blockchain were examined, and increasing efficiency, increasing transaction security, increasing user trust in transactions, and using smart contracts were considered to be the most important advantages and applications of blockchain technology. Moreover, technological immaturity, uncertainty in regulations, maintaining security, and privacy were identified as some of the most important threats to blockchain technology.

3. Methodology

This study is conducted to identify and analyze the future drivers of crypto-Fintech in Iran. The data are analyzed using fuzzy Delphi and fuzzy DEMATEL quantitative techniques. The fuzzy Delphi technique is used to screen the drivers, and the fuzzy DEMATEL technique is used to identify the most effective drivers. The study has a quantitative methodology due to the quantitative nature of the techniques used. It is also an applied study because of the benefit of the findings for the financial industry and crypto-Fintech in Iran.

The data are collected using interviews and questionnaires. The drivers are obtained by reviewing the literature on fintech and crypto-Fintech and interviewing financial experts. Expert questionnaires and effect measurement questionnaires are distributed among experts for data analysis. Expert questionnaires are analyzed using the fuzzy Delphi method, and effect measurement questionnaires are analyzed using the fuzzy DEMATEL method.

Since the contents of the questionnaires are obtained from reviewing valid literature and interviewing experts in the field of Fintech and crypto-Fintech, both expert questionnaires and effect measurement questionnaires are highly valid. Furthermore, effect measurement questionnaires are highly reliable due to the appropriate sample size (10 people), screening of drivers, and their significant reduction.

The experts are members of the Fintech Association, senior experts of the Central Bank, and managers of crypto-Fintech. Purposive sampling is used due to the expert-oriented nature of the method used, and the subjects are selected based on their expertise in the fields of Fintech, crypto-Fintech, and blockchain. The sample size is 10, which is appropriate for expert-oriented techniques with a purposive nature.

The study is done in three steps. In the first step, the future drivers of crypto-Fintech are obtained through a literature review and interviews with Fintech experts. In the next step, these drivers are screened using the fuzzy Delphi method. In the third step, the degree of the drivers' effect and being affected is determined through the fuzzy DEMATEL technique. The drivers with higher effect are selected as the final drivers.

The drivers are screened using the fuzzy Delphi technique. The fuzzy Delphi algorithm for screening includes the following steps [18]:

1) Identifying the optimal spectrum for fuzzification of verbal expression;
2) Fuzzy aggregation of the fuzzified values;
3) De-fuzzing the values;
4) Choosing the threshold intensity and filtering the criteria.

Step 1. Gathering and fuzzifying experts' views. In the fuzzy Delphi algorithm for screening, an optimal fuzzy spectrum should be developed first to fuzzify the experts' verbal expressions. Conventional phase spectra can be used for this purpose. In this study, a five-point Likert scale is used, which is shown in Table 1. In addition to simplicity, triangular fuzzy numbers also have good accuracy in expressing experts' opinions.

Table 1. The fuzzy spectrum of the Delphi method

Verbal variable	Fuzzified value	Triangular fuzzy number
Very low	$\tilde{1}$	(0, 0, 0.25)
Low	$\tilde{2}$	(0, 0.25, 0.5)
Moderate	$\tilde{3}$	(0.25, 0.5, 0.75)
High	$\tilde{4}$	(0.5, 0.75, 1)
Very high	$\tilde{5}$	(0.75, 1, 1)

Step 2. Fuzzy aggregation of the fuzzified values. Expert opinions are gathered and fuzzified after choosing the desired fuzzy spectrum. Several methods have been proposed for the fuzzy aggregation of expert opinions. The simplest method is to calculate the fuzzy average of expert opinions if each expert's opinion is represented as triangular fuzzy numbers (l, m, u):

$$F_{AVE=}\frac{\sum l}{n},\frac{\sum m}{n},\frac{\sum u}{n}$$

Step 3. De-fuzzifying the values. In various methods implemented by the fuzzy approach, the researcher finally converts the final fuzzy values into a crisp number. This is known as fuzzification. One of the simple methods for defuzzification is the averaging of triangular fuzzy numbers:

$$if\ \widetilde{F}\ =\ (l,m,u)\ then\ \ F=\frac{l+m+u}{3}$$

Or we can use a more complicated method as follows:

$$x_m^1\ =\frac{L+M+U}{3};\ x_m^2\ =\frac{L+2M+U}{4};\ x_m^3\ =\frac{L+4M+U}{6}$$

$$Crisp\ number=Z*=max(x_{max}^1,x_{max}^2,x_{max}^3)$$

There are several other methods for defuzzification, center of gravity (COG), center of area (COA), and maximum average. The modified COA method for defuzzifying triangular fuzzy numbers is as follows:

$$DF_{ij}=\frac{\left[\left(u_{ij}-l_{ij}\right)+\left(m_{ij}-l_{ij}\right)\right]}{3}+l_{ij}$$

Step 4. Determining a threshold limit after choosing the appropriate method and de-fuzzifying the values. This threshold limit is often different in different studies based on the researcher's opinion. The desired factor will remain in the calculations if the crisp value of defuzzification of the aggregated expert opinions is greater than the threshold. It will be removed otherwise [18].

The DEMATEL technique is used to extract the causal model and identify the most effective drivers. The fuzzy approach is used when there is uncertainty. The steps of the fuzzy DEMATEL technique are as follows [33]:

Step 1. Gathering expert opinions as fuzzy numbers and combining them through weighted arithmetic mean to calculate the matrix of direct relations.

Step 2. Normalizing the fuzzy matrix of direct relations: The linear normalization method is used to normalize the matrix of average expert opinions.

Step 3. Calculation of the matrix of total relations: Convergence $lim_{k\to\infty}\tilde{X}^k$ must be ensured to calculate the fuzzy matrix of total relations (T). As in the crisp case, the matrix of total relations is then obtained according to the following equation:

$$\tilde{T}=\lim_{k\to\infty}\left(X+\tilde{X}^2+\cdots+\ \tilde{X}^k\right)$$

Step 4. Calculation of the de-fuzzified values of the matrix of total relations: The values of the matrix of total relations are de-fuzzified using the following formula.

$$\bar{X}\left(\tilde{A}\right)=\frac{1}{4}\left(l+2m+u\right).\tilde{A}=(l.m.u)$$

It will be possible to calculate the indices $\widetilde{R}+\widetilde{D}$ and $\widetilde{D}-\widetilde{R}$ after extracting the defuzzification matrix. The first index indicates the degree of interaction of the desired factor with other factors, and the second index indicates the net effect of the factor. The higher the net effect of the factor, the higher its degree of effect than its being affected. The values of D and R are the sum of the entries of the rows and columns of the defuzzification matrix, respectively. The values of D and R indicate the factor's degree of effect and being affected, respectively.

Step 5. Extracting the structure of relations between the factors: A causal structure and model of factors can be obtained based on the values of D and R and the sum of the entries of the rows and columns of the defuzzification matrix.

Step 6. Determining the threshold of relations: The threshold of relations is calculated through the average of the defuzzification matrix. Only some factors whose effects on the defuzzification matrix are higher than the threshold value are then selected and displayed in the relation map.

In this research, the one-step Delphi method was used to screen and reduce the factors. Also, Fuzzy Dematel was used as a modeling method to measure the effectiveness of factors. The net effect index indicates that the desired factor is more effective compared to other factors.

4. Research results

The future drivers of crypto fintechs in Iran were extracted using an analytical literature review and interviews with experts. Table 2 presents these drivers. Studies on financial technology and crypto fintechs in reliable scientific databases from 2010 to 2023 were examined to extract research drivers. A total of 19 drivers were obtained using the literature review, and 3 items were also added to this list by the experts.

Table 2. Future drivers of crypto fintechs

Research drivers	References
Development of national technology-based banking	[2,32]
National regulatory policies	[39,11,44]
The performance of the national fintech association	Interview
Strategies of large financial institutions about various types of fintech businesses	[39,36,43]
National information technology infrastructure	[24]
Performance of national incubators and technology parks	Interview
The level of tendencies towards open innovation in financial institutions such as banks and insurance firms	[12]
The level of acceptance of digital technology advances among managers of large financial institutions	[2]
Development of national cryptocurrencies	[2]
The customers' financial literacy levels in the financial industry	[13,44]
Utilization of blockchain technology in other industries and supply chains	[47,30,37,38]
The intensity of competition in the financial industry	[24]
Financial and technological sanctions	[24]
Capital market policies on corporate governance	[23]
The development of national regulatory technologies (RegTechs)	[26,3]
Development of smart contracts in the financial industry	[14,25,41,28]
Development of new financial markets such as the cryptocurrency market	[19]
Diversity of national fintech models and businesses	[8]
Development of interdisciplinary courses in the fields of financial and accounting sciences	Interviews
Government support for startups, especially financial startups	[2]
Variety of national financing methods	[46]
Ethical and security considerations of artificial intelligence development	[35]

A total of 22 drivers extracted from the literature review and interviews were screened using the fuzzy Delphi method and the distribution of expert questionnaires. Techniques such as DEMATEL are extremely sensitive to numerous factors. In this step, 12 drivers were excluded from the analysis and 10 factors were selected to extract the effective model of the drivers.

Drivers with defuzzified numbers greater than 0.7 were selected for extracting the causal model of the research with fuzzy DEMATEL. In this study, 10 drivers had defuzzy numbers greater than 0.7. A value of 0.7 was considered a threshold for screening the drivers. The threshold limit has a value of 0.5 to 0.7 in research. In this research, 0.7 was considered the threshold limit. Table 3 presents the list of final screened drivers of the future crypto fintechs along with their deffuzified numbers.

Table 3. Screened drivers

Screened drivers	Mean expert view			Defuzzy number
	Upper limit	Median	Lower limit	
Development of national technology-based banking (A)	0.64	0.81	0.95	0.8
National regulatory policies (B)	0.62	0.83	0.97	0.81
Strategies of large financial institutions about various types of fintech businesses (C)	0.58	0.79	0.88	0.75
National information technology infrastructures (D)	0.61	0.75	0.9	0.75
Development of national cryptocurrencies (E)	0.55	0.72	0.87	0.71
The development of national regulatory technologies (RegTechs) (F)	0.6	0.81	0.93	0.78
Development of smart contracts in the financial industry (G)	0.64	0.85	0.92	0.8
Development of new financial markets such as the cryptocurrency market (H)	0.57	0.81	0.91	0.76
Development of interdisciplinary courses in the fields of financial and accounting sciences (I)	0.56	0.68	0.93	0.72
Variety of national financing methods (J)	0.64	0.8	0.92	0.79

Thereafter, the screened drivers were inserted into the fuzzy DEMATEL technique. The fuzzy DEMATEL technique identifies the most effective factors in a system. The experts expressed their opinions using DEMATEL fuzzy range in a pairwise comparison matrix. These matrices were integrated using the mean method. The aggregate matrix data were then normalized using the linear method. Due to the vast calculations, Tables 4 and 5 present the results of the normal matrix.

Table 4. Normal matrix (first five drivers)

Normal matrix	A			B			C			D			E		
A	0	0	0.03	0.05	0.07	0.1	0.04	0.07	0.1	0.03	0.06	0.09	0.07	0.1	0.11
B	0.07	0.1	0.11	0	0	0.03	0.09	0.11	0.11	0.03	0.06	0.09	0.08	0.11	0.11
C	0.06	0.09	0.11	0.03	0.06	0.09	0	0	0.03	0.03	0.06	0.09	0.05	0.08	0.1
D	0.06	0.09	0.11	0.03	0.06	0.09	0.02	0.05	0.08	0	0	0.03	0.01	0.04	0.07
E	0	0.03	0.06	0.01	0.04	0.07	0	0.03	0.06	0.02	0.04	0.07	0	0	0.03
F	0.06	0.09	0.11	0.01	0.04	0.07	0.02	0.05	0.08	0.02	0.04	0.07	0.01	0.04	0.07
G	0.08	0.11	0.11	0.06	0.09	0.1	0.03	0.06	0.09	0.03	0.05	0.08	0.08	0.11	0.11
H	0.02	0.04	0.06	0	0.03	0.06	0.02	0.05	0.07	0	0	0.03	0	0.03	0.06
I	0	0.01	0.03	0.01	0.04	0.07	0	0.03	0.06	0.03	0.06	0.09	0	0.03	0.06
J	0	0.03	0.06	0	0.03	0.06	0.01	0.03	0.06	0	0.03	0.06	0.02	0.03	0.06

Table 5 presents the normal matrix values for the next five drivers. In these tables, three numbers are applied for each driver instead of one.

Table 5. **Normal matrix (second five drivers)**

Normal matrix	F			G			H			I			J		
A	0.03	0.05	0.08	0.07	0.1	0.11	0.05	0.08	0.096	0.06	0.09	0.11	0.03	0.06	0.09
B	0.06	0.09	0.1	0.09	0.11	0.11	0.06	0.09	0.102	0.06	0.09	0.11	0.07	0.1	0.11
C	0.03	0.06	0.09	0.04	0.07	0.09	0.02	0.05	0.074	0.06	0.09	0.1	0.02	0.05	0.08
D	0.03	0.04	0.06	0.05	0.07	0.1	0.04	0.06	0.085	0.02	0.03	0.06	0.01	0.03	0.06
E	0.01	0.03	0.06	0	0	0.03	0	0	0.028	0.02	0.05	0.08	0.02	0.05	0.07
F	0	0	0.03	0.04	0.07	0.1	0.02	0.05	0.074	0.02	0.03	0.06	0.05	0.07	0.1
G	0.07	0.1	0.11	0	0	0.03	0.07	0.1	0.113	0.06	0.09	0.11	0.06	0.09	0.11
H	0.01	0.01	0.04	0.02	0.05	0.08	0	0	0.028	0.03	0.05	0.08	0.02	0.03	0.06
I	0	0.01	0.03	0.03	0.06	0.09	0.01	0.04	0.068	0	0	0.03	0.06	0.09	0.11
J	0	0.03	0.06	0.02	0.05	0.07	0	0	0.028	0.03	0.05	0.08	0	0	0.03

The normal total relations matrix is obtained by multiplying the normal matrix (N) by the inverse of the identity matrix vs. the normal matrix (I-N). This multiplication must be performed separately for each column of triangular numbers, and finally, these calculations are aggregated as a matrix. The values of the total relations matrix are also displayed in two separate tables. Tables **6** and **7** present the data of the total relations matrix.

Table 6. **Total relations matrix (first five drivers)**

Matrix T	A			B			C			D			E		
A	0.02	0.08	0.32	0.06	0.13	0.37	0.05	0.13	0.37	0.05	0.12	0.35	0.09	0.18	0.4
B	0.09	0.19	0.42	0.02	0.08	0.32	0.1	0.19	0.4	0.05	0.13	0.36	0.1	0.2	0.42
C	0.08	0.15	0.37	0.04	0.11	0.33	0.01	0.06	0.28	0.04	0.11	0.33	0.07	0.15	0.37
D	0.08	0.15	0.35	0.04	0.1	0.31	0.03	0.1	0.31	0.01	0.04	0.24	0.03	0.1	0.31
E	0	0.06	0.2	0.01	0.06	0.23	0	0.05	0.22	0.02	0.06	0.22	0	0.03	0.21
F	0.07	0.14	0.35	0.02	0.09	0.29	0.03	0.1	0.31	0.03	0.08	0.28	0.03	0.1	0.31
G	0.1	0.19	0.41	0.07	0.15	0.38	0.05	0.14	0.38	0.04	0.11	0.35	0.1	0.19	0.42
H	0.03	0.07	0.25	0	0.06	0.23	0.03	0.07	0.25	0	0.03	0.19	0.01	0.07	0.24
I	0.01	0.05	0.24	0.01	0.07	0.25	0	0.06	0.24	0.03	0.08	0.26	0.01	0.07	0.26
J	0	0.06	0.24	0	0.06	0.23	0.01	0.06	0.23	0	0.05	0.22	0.02	0.07	0.25

The next matrix indicates the total relations matrix values for the next five drivers. The total relations matrix is a criterion for measuring the four indices of the fuzzy DEMATEL technique.

Table 7. **Total relations matrix (second five drivers)**

Matrix T	F			G			H			I			J		
A	0.04	0.11	0.17	0.09	0.17	0.41	0.07	0.14	0.35	0.08	0.17	0.42	0.06	0.14	0.4
B	0.08	0.16	0.2	0.11	0.2	0.43	0.08	0.16	0.38	0.09	0.18	0.44	0.1	0.19	0.44
C	0.04	0.11	0.14	0.06	0.14	0.37	0.04	0.11	0.31	0.08	0.16	0.38	0.04	0.12	0.37
D	0.04	0.09	0.13	0.06	0.13	0.35	0.05	0.11	0.3	0.03	0.09	0.32	0.03	0.09	0.32
E	0.01	0.06	0.03	0	0.03	0.21	0	0.03	0.19	0.03	0.08	0.26	0.03	0.08	0.26
F	0.01	0.04	0.12	0.05	0.12	0.34	0.03	0.09	0.29	0.03	0.09	0.32	0.06	0.13	0.35
G	0.09	0.16	0.09	0.03	0.09	0.34	0.08	0.16	0.38	0.09	0.18	0.43	0.08	0.17	0.43
H	0.01	0.04	0.08	0.03	0.08	0.27	0	0.03	0.19	0.03	0.09	0.27	0.02	0.07	0.26
I	0	0.04	0.09	0.03	0.09	0.29	0.02	0.07	0.24	0.01	0.04	0.24	0.06	0.12	0.32
J	0	0.05	0.08	0.03	0.08	0.26	0	0.03	0.19	0.03	0.08	0.27	0	0.04	0.22

The data of the total relations matrix are deffuzified using the equation presented in the fourth step (weighted data mean). Table **8** presents the deffuzification matrix data.

Table 8. Deffuzification matrix

Deffuzification	A	B	C	D	E	F	G	H	I	J
A	0.13	0.17	0.17	0.16	0.21	0.11	0.21	0.18	0.21	0.18
B	0.22	0.12	0.22	0.17	0.23	0.15	0.24	0.19	0.22	0.23
C	0.19	0.15	0.1	0.15	0.18	0.1	0.17	0.14	0.19	0.16
D	0.18	0.14	0.14	0.08	0.14	0.09	0.17	0.14	0.13	0.13
E	0.09	0.09	0.08	0.09	0.07	0.04	0.07	0.06	0.11	0.11
F	0.17	0.12	0.13	0.12	0.13	0.05	0.16	0.13	0.13	0.17
G	0.22	0.19	0.17	0.15	0.22	0.12	0.14	0.2	0.22	0.21
H	0.1	0.09	0.1	0.06	0.09	0.04	0.12	0.06	0.12	0.11
I	0.08	0.1	0.09	0.11	0.1	0.04	0.13	0.1	0.08	0.16
J	0.09	0.09	0.09	0.08	0.1	0.04	0.11	0.06	0.12	0.08

D values of (dependence of each driver) and R (influence of each driver) are measured according to the deffuzification matrix values. The degree of influence is obtained by the addition of rows of the deffuzification matrix, and the degree of dependence is measured by the addition of columns of the deffuzification matrix. The interaction index is obtained from the addition of the influence and dependence of the drivers, and the net effect index is measured by the subtraction of the influence from the dependence of the target driver. Table 9 presents four indices of the fuzzy DEMATEL technique (influence, dependence, interaction, and net effect).

Table 9. Four values of the fuzzy DEMATEL technique

Deffuzification	**D**	**R**	**D+R**	**D-R**
A	1.73	1.48	3.21	0.25
B	2	1.26	3.26	0.74
C	1.55	1.31	0.86	0.23
D	1.34	1.18	2.52	0.16
E	0.82	1.48	2.3	-0.67
F	1.32	0.79	2.11	0.52
G	1.85	1.52	3.37	0.34
H	0.9	1.27	2.17	-0.36
I	1	1.55	2.55	-0.54
J	0.87	1.54	2.41	-0.67

According to the $\tilde{D} - \tilde{R}$ values or net effect, the drivers of national regulatory policies (B), the progress of national RegTechs (F), the development of smart contracts in the financial industry (G), the development of national technology-based banking (A), strategies of large financial institutions about various types of fintech businesses (C), and national IT infrastructures (D) respectively have the highest net effects. Drivers with positive net effects are considered the influence drivers, but those with negative net effects are known as dependent drivers. The research suggestions are developed based on the most effective drivers.

5. Discussion and Conclusion

The present research aimed to identify and analyse effective drivers of the future of crypto fintechs in Iran. The research had several stages; first, research drivers were extracted using the literature review and interviews with experts. Therefore, 19 drivers were obtained from the literature and three others from the interviews. Thereafter, the extracted drivers were screened using the distribution of expert assessment questionnaires and the fuzzy Delphi method. A total of 10 drivers had deffuzy numbers greater than 0.7 and were thus selected for the final analysis. Finally, the factors were examined by distributing effect assessment questionnaires and the fuzzy DEMATEL technique. The drivers of national regulatory policies, the development of national RegTechs, the development of smart contracts in the financial industry, the development of national technology-based banking, the strategies of large financial institutions about relationships with various types of fintech businesses, and national information technology (IT) infrastructures respectively had the highest net effects and influence.

Regulatory policies were considered the most important drivers. Proper regulation increases transparency and decreases the risk of cooperation between financial institutions and fintechs. This factor has been confirmed in many studies such as research by Shayesteh Hadi et al.[39], Deshpande et al.[11], and Suryono, Budi, & Purwandari [44]. Comprehensive and fair regulation leads to the development of fintechs and increases their diversity by taking into account all stakeholders, especially large financial institutions and fintechs in preparing upstream documents and regulatory laws, avoiding multi-work in policymaking, and adopting policies that encourage innovation in the financial industry. It is worth noting that the scope and diversity of policies should be vast to consider all types of fintech models and businesses.

As a model of fintechs, the development of RegTechs greatly helps increase the diversity of fintechs and the development of crypto fintechs. Using data-based technologies and creating test environments, RegTechs provide a suitable space for the cooperation of large financial institutions such as banks with fintechs. RegTechs specify risks and challenges of cooperation and provide greater assurance for financial institution managers. Many studies such as Mugani et al. [26] have confirmed attention to RegTechs and their importance for the development of the financial industry and fintechs. The growth and development of national RegTechs depend on factors such as the development of regulatory platforms, the support of incubators and science and technology parks, as well as regulatory policies.

The development of smart contracts improves the performance of financial industry institutions by reducing transaction costs, increasing security, and providing proper transparency. These blockchain-based contracts are rapidly expanding in different countries in many fields such as real estate, insurance, health, and supply chain. This factor has been approved in many studies such as Stayu [41] and Nguyen et al. [28]. The development of such contracts in the financial industry as an important driver for the development of crypto fintechs needs prerequisites such as the development of national IT infrastructures, training employees and managers of large financial institutions such as banks, the recruitment of senior managers of large financial institutions in the country such as banks, and movement of financial industry towards artificial intelligence and digital technologies.

Technology-based banking and expanded use of new technologies are practically impossible without collaboration and the use of fintech capacities. Since banks may not have the necessary capabilities to utilize new technologies, cooperation with fintechs and their investment in fintechs plays an important role in the movement of banks towards providing technology-based services. This factor has also been confirmed in studies such as research by Ahmadi et al. [2] on blockchain and banking. Some requirements and measures should be taken to achieve technology-based banking. Some of these requirements are as follows: Senior managers' support, the tendency of large financial institutions and banks towards cooperation with research and development projects, a cooperative look at fintechs instead of a competitive and destructive approach, and a tendency towards open innovation in large financial institutions.

Traditional financial institutions such as banks and insurance firms should seek strategic partnerships and collaboration with fintechs instead of confronting them. Banks and insurance firms can improve their services and take the advantage of financial innovations of fintechs using strategic partnerships with fintechs. This factor was also taken into consideration in many studies such as Shayesteh Hadi et al. [39], Shah-Hosseini et al.[36]. The development of collaboration between large financial institutions and fintechs depends on strengthening RegTechs in the country, improving the regulator's policies in regulatory measures, and modifying the banking structure (to increase competition among banks).

Infrastructural weaknesses are major barriers to the movement of the financial industry, especially the banking sector, toward the utilization of new technologies and innovations. In this regard, governmental support for technology startups, especially new technologies, using experiences of successful countries, especially surrounding countries, attempts to enter new technologies, especially in the field of digital technologies, and the collaboration of large financial institutions in joint investments in technology projects lead to the improvement of infrastructures.

In terms of content, part of the drivers of this research is related to the field of cryptocurrency and cannot be generalized to other fintech models. From a methodological point of view, the methods used in this research have a judgmental nature. Research suggestions include conducting future research on crypto fintechs and formulation of a normative scenario for the development and growth of these fintechs in Iran.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Ahmad, R. W., Salah, K., Jayaraman, R., Yaqoob, I., Ellahham, S., & Omar, M. (2023). Blockchain and COVID-19 pandemic: Applications and challenges. *Cluster Computing*, 1-26.
2. Ahmadi, M., Rousta, A., Maleki, M. H., & Asayesh, F. (2022). Future Study of Marketing in the Banking Industry with a focus on Blockchain Technology. *Journal of System Management*, *8*(4), 133-146.
3. Arner, D. W., Barberis, J., & Buckey, R. P. (2016). FinTech, RegTech, and the reconceptualization of financial regulation. *Nw. J. Int'l L. & Bus.*, *37*, 371.
4. Baliker, C., Baza, M., Alourani, A., Alshehri, A., Alshahrani, H., & Choo, K. K. R. (2023). On the Applications of Blockchain in FinTech: Advancements and Opportunities. *IEEE Transactions on Engineering Management*.
5. Bhat, J. R., AlQahtani, S. A., & Nekovee, M. (2023). FinTech enablers, use cases, and role of future internet of things. *Journal of King Saud University-Computer and Information Sciences*, *35*(1), 87-101.
6. Chakraborty, S. (2018). Fintech: evolution or revolution. *Business analytics research lab India*.
7. Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How Blockchain can impact financial services–The overview, challenges and recommendations from expert interviewees. *Technological forecasting and social change*, *158*, 120166.
8. Das, S. R. (2019). The future of fintech. *Financial Management*, *48*(4), 981-1007.
9. Daud, S. N. M., Khalid, A., & Azman-Saini, W. N. W. (2022). FinTech and financial stability: Threat or opportunity? *Finance Research Letters*, *47*, 102667.
10. Deepa, N., Pham, Q. V., Nguyen, D. C., Bhattacharya, S., Prabadevi, B., Gadekallu, T. R., ... &
11. Deshpande, A., Stewart, K., Lepetit, L., & Gunashekar, S. (2017). Distributed Ledger Technologies/Blockchain: Challenges, opportunities and the prospects for standards. *Overview report The British Standards Institution (BSI)*, *40*, 40.
12. Drasch, B. J., Schweizer, A., & Urbach, N. (2018). Integrating the 'Troublemakers': A taxonomy for cooperation between banks and fintechs. *Journal of economics and business*, *100*, 26-42.
13. Firmansyah, E. A., Masri, M., Anshari, M., & Besar, M. H. A. (2023). Factors affecting fintech adoption: a systematic literature review. *FinTech*, *2*(1), 21-33.
14. Gao, W., Hatcher, W. G., & Yu, W. (2018, July). A survey of blockchain: Techniques, applications, and challenges. In *2018 27th international conference on computer communication and networks (ICCCN)* (pp. 1-11). IEEE.
15. Giglio, F. (2022). Fintech: A literature review. *International Business Research*, *15*(1), 80-85.
16. Guang-Wen, Z., & Siddik, A. B. (2023). The effect of Fintech adoption on green finance and environmental performance of banking institutions during the COVID-19 pandemic: the role of green innovation. *Environmental Science and Pollution Research*, *30*(10), 25959-25971.
17. Guo, P., & Zhang, C. (2023). The impact of bank FinTech on liquidity creation: Evidence from China. *Research in International Business and Finance*, *64*, 101858.
18. Habibi, A., Jahantigh, F. F., & Sarafrazi, A. (2015). Fuzzy Delphi technique for forecasting and screening items. *Asian Journal of Research in Business Economics and Management*, *5*(2), 130-143.
19. Haddad, C., & Hornuf, L. (2019). The emergence of the global fintech market: Economic and technological determinants. *Small business economics*, *53*(1), 81-105.
20. Harris, W. L., & Wonglimpiyarat, J. (2019). Blockchain platform and future bank competition. *Foresight*.
21. Hu, T., Liu, X., Chen, T., Zhang, X., Huang, X., Niu, W., ... & Liu, Y. (2021). Transaction-based classification and detection approach for Ethereum smart contract. *Information Processing & Management*, *58*(2), 102462.
22. Jones, L. S., & Maynard Jr, G. (2022). Unfulfilled Promises of the FinTech Revolution. *California Law Review*, *111*.
23. Kaal, W. A. (2021). Blockchain solutions for agency problems in corporate governance. In Information for Efficient Decision Making: Big Data, Blockchain and Relevance. 313-329.

24. Koshesh Kordsholi, R., Maleki, M. H., & Gholami Jamkarani, R. (2021). A Framework for Identifying Affecting Drivers on the Future of Financial Technology Using Fuzzy Delphi and Fuzzy AHP Type 2. *Financial Engineering and Portfolio Management*, *12*(49), 357-374.
25. McGhin, T., Choo, K. K. R., Liu, C. Z., & He, D. (2019). Blockchain in healthcare applications: Research challenges and opportunities. *Journal of Network and Computer Applications*, *135*, 62-75.
26. Muganyi, T., Yan, L., Yin, Y., Sun, H., Gong, X., & Taghizadeh-Hesary, F. (2022). Fintech, regtech, and financial development: evidence from China. *Financial innovation*, *8*(1), 29.
27. Ndiaye, M., & Konate, K. (2022). Security Strengths and Weaknesses of Blockchain Smart Contract System: A Survey. *International Journal of Information and Communication Engineering*, *16*(5), 134-143.
28. Nguyen, D. C., Pathirana, P. N., Ding, M., & Seneviratne, A. (2020). Integration of blockchain and cloud of things: Architecture, applications and challenges. *IEEE Communications surveys & tutorials*, *22*(4), 2521-2549.
29. Pathirana, P. N. (2022). A survey on blockchain for big data: approaches, opportunities, and future directions. *Future Generation Computer Systems*.
30. Prause, G. (2019). Smart contracts for smart supply chains. *IFAC-PapersOnLine*, *52*(13), 2501-2506.
31. Romānova, I., & Kudinska, M. (2016). Banking and fintech: A challenge or opportunity? In *Contemporary issues in finance: Current challenges from across Europe*. Emerald Group Publishing Limited.
32. Sardana, V., & Singhania, S. (2018). Digital technology in the realm of banking: A review of literature. *International Journal of Research in Finance and Management*, *1*(2), 28-32.
33. Saroha, M., Garg, D., & Luthra, S. (2022). Identification and analysis of circular supply chain management practices for sustainability: a fuzzy-DEMATEL approach. *International Journal of Productivity and Performance Management*, *71*(3), 722-747.
34. Sayeed, S., Marco-Gisbert, H., & Caira, T. (2020). Smart contract: Attacks and protections. *IEEE Access*, *8*, 24416-24427.
35. Schär, F. (2021). Decentralized finance: On blockchain-and smart contract-based financial markets. *FRB of St. Louis Review*.
36. Shah Hosseini, M. A., Keimasi, M., Shami Zanjani, M., & Haghighikhah, M. (2022). A Systematic Literature Review of Bank-fintech Collaboration. *Journal of Business Management*, *14*(2), 199-227.
37. Sharma, A., Sarishma, Tomar, R., Chilamkurti, N., & Kim, B. G. (2020). Blockchain based smart contracts for internet of medical things in e-healthcare. *Electronics*, *9*(10), 1609.
38. Sharma, P., Jindal, R., & Borah, M. D. (2023). A review of smart contract-based platforms, applications, and challenges. *Cluster Computing*, *26*(1), 395-421.
39. Shayesteh, H., Abazar, M., Hasan, M., Mirarab Baygi, S. A., & Yazdanian, N. (2021). A Future Study of Project-based Organizations Active in Financial Services Industry. *Industrial Management Journal*, *13*(3), 391-414.
40. Son, Y., & Lee, Y. (2022). A smart contract weakness and security hole analyzer using virtual machine based dynamic monitor. *Journal of Logistics, Informatics and Service Science*, *9*(1), 36-52.
41. Steiu, M. F. (2020). Blockchain in education: Opportunities, applications, and challenges. *First Monday*.
42. Stulz, R. M. (2019). Fintech, bigtech, and the future of banks. *Journal of Applied Corporate Finance*, *31*(4), 86-97.
43. Suprun, A., Petrishina, T., & Vasylchuk, I. (2020). Competition and cooperation between fintech companies and traditional financial institutions. In *E3S Web of Conferences* (Vol. 166, p. 13028). EDP Sciences.
44. Suryono, R. R., Budi, I., & Purwandari, B. (2020). Challenges and trends of financial technology (Fintech): a systematic literature review. *Information*, *11*(12), 590.
45. Tan, B. S., & Low, K. Y. (2019). Blockchain as the database engine in the accounting system. *Australian Accounting Review*, *29*(2), 312-318.
46. Udeagha, M. C., & Muchapondwa, E. (2023). Green finance, fintech, and environmental sustainability: fresh policy insights from the BRICS nations. *International Journal of Sustainable Development & World Ecology*, 1-17.
47. Ullah, F., & Al-Turjman, F. (2023). A conceptual framework for blockchain smart contract adoption to manage real estate deals in smart cities. *Neural Computing and Applications*, *35*(7), 5033-5054.
48. Wu, B., & Duan, T. (2019, June). The advantages of blockchain technology in commercial bank operation and management. In *Proceedings of the 2019 4th International Conference on Machine Learning Technologies* (pp. 83-87).
49. Yudaruddin, R. (2023). Financial technology and performance in Islamic and conventional banks. *Journal of Islamic Accounting and Business Research*, *14*(1), 100-116.
50. Zhao, J., Li, X., Yu, C. H., Chen, S., & Lee, C. C. (2022). Riding the FinTech innovation wave: FinTech, patents and bank performance. *Journal of International Money and Finance*, *122*, 102552.

Maleki, M. H., Zare Bahnamiri, M. J., & Dadashi, I. (2023). A Framework for Identifying and Analyzing Drivers Affecting the Futures of Cryptocurrency FinTechs in Iran with Fuzzy Delphi and Fuzzy Dematel. *Fuzzy Optimization and Modeling Journal*, 3(4), 37-50.

https://doi.org/10.30495/fomj. 2023.1987397.1084

Received: 22 June 2022 Revised: 30 July 2022 Accepted: 30 July 2022