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THE EFFECT OF CLIMATE CHANGE ON FINANCIAL MARKET STABILITY IN IRAN

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ABSTRACT

The fluctuation of financial markets is one of the main factors that can affect the economic conditions of society and leads to increase or decrease inflation. One of the factors affecting the stability of the financial market is climate fluctuations, which can lead to fluctuations in the financial market. Given that the stability of the financial market is important in any economy, the present study is aimed at investigating the impact of climate change on the stability of the financial market. For this purpose, the statistical population of this study is the Iranian economy during the years 1395 to 1397. Financial data extracted from Tehran Stock Exchange, and Central Bank, also for the data related to climate change we have used the site of the Meteorological Organization, and the results were analyzed by using Eviews9 software. The results of data analysis showed that climate change has a significant effect on the stability of the financial market, which includes changes in temperature, cloud cover per day, humidity, wind, snow, and rain. Considering the importance of financial market stability, it can be concluded that in the case of climate fluctuations, financial market stability will also fluctuate.

Abbreviations: AIC: Akaike information criterion, CO2: Carbon Dioxide, FPE: Final Prediction Error, GDP: Gross Domestic Product, HQ: Hannan Quinn, VAR: Vector Autoregressive, SC: Schwarz-Bayesian criterion.

1. INTRODUCTION

The stability of the financial market indicates the proper performance and strength of all the components constituting a financial system in the market. All components of a financial system in the economy are interconnected, and if one of these components becomes unbalanced, it will make the whole system unstable (Todorović et al., 2019). Financial markets are directly related to depositors and investors. Financial infrastructure includes private and public institutions and operating institutions such as the payment and settlement system for financial transactions, as well as legal, accounting, and monitoring infrastructure (Krause et al., 2016). On the other hand, the climate is one of the factors that can affect the economic conditions of society. So with temperature fluctuations and climate-related events, we can expect fluctuations in the financial market. In general, increasing the losses from severe phenomena that are influenced by climate change, can affect gross domestic product (GDP) growth, population, per capita income, and insurance penetration.

The physical effects of climate change pose direct and indirect risks to the financial market. The direct risk imposes great insurance claims for insurance companies while indirect risks of uninsured losses are considered as a threat to government assets and enterprises that have been invested in the financial market (Lutz & Stadelmann, 2016). Increasing the productivity in financial markets contributes to improving the performance of the economy, which in turn reduces risk. This purpose can only be achieved in a developed financial environment. Financial markets undertake this vital role in the intermediation process by directing budgets from surplus units (savers) to deficit units (investors) (Selvadurai, 2019).

2. THEORETICAL FOUNDATIONS

Financial stability can refer to the absence of a financial crisis or the proper performance of key elements of the financial system, and it can also be defined as a financial system that is able to resist various shocks. In economics, markets are divided into real and nominal (financial) forms. The labor, commodity, and service market are related to the real sector of the economy and the money and capital markets are related to the nominal (financial) sector. The importance of the financial sector, as one of the main sectors of any economy, is one of the important issues in the economy of countries. Having a strong economy requires complementary and powerful financial and real sectors. In fact, the financial sector is a communication channel between savers and investors that by reducing costs and increasing confidence, diverts surplus funds in the economy to productive activities and strengthens economic growth by allocating resources optimally and financing economic activities (Andersson, 2016). The major participants in the financial markets include households, individuals, and companies that enter these markets to provide funds and are often known as surplus units, also individuals and companies that seek to receive and gain funds from these markets are known as deficit units (Supriyanto, 2016). Many factors affect financial stability, the most important of them including macroeconomic

variables (inflation, GDP, exchange rate, etc.), banks' special conditions, income diversification, banks' profitability, banks' loan-to-assets ratio, banks' cost-to-income ratio, and climate fluctuations (Zelazny, 2017).

Financial stability has a positive effect on the performance of financial institutions and banks and improves the efficiency of their activities. The mass connection of the emerging economy to the international system shows that disruptions in any other market, whether developed or emerging, can be rapidly transmitted to other markets. With the development and attention to financial crises, the focus on the financial system has increased. The crisis in Mexico and East Asia and its consequences could clarify the role of the financial system (Akar, 2013). Climate changes will usually have severe effects on the stability of the financial system, so a wide climate-related financial risk has been identified. One of the most important ones is the physical risks related to the economic losses of climate-related events. So far, most studies have focused on the risk consequences of climate change and less attention has been paid to accurate analysis of physical risks, which helps to better understand which policies are more effective in reducing financial instability that may be caused by climate damage (Dafermos et al., 2018).

Climate change can affect a country's economic situation. One of the factors is to blame for climate change is the high level of carbon emissions. Specifically, CO2 emissions lead to increased CO2 concentrations in the atmosphere. The evolution of CO2 concentration is influenced by the carbon cycle. Its accumulation in the atmosphere and other greenhouse gases leads to an increase in radiant energy, which raises the air temperature and affects the amount of rainfall in the atmosphere (Skott & Zipperer, 2010). One of the risks of potential climate change is that it could stop progress toward a world without hunger by undermining financial market stability and could have consequences for food access. In addition to exacerbating food insecurity and creating hunger and malnutrition in society, climate change is likely to disrupt financial market stability, which can also affect food prices. Similarly, it can be predicted that the availability and use of food would be indirectly affected through its effects on incomes of households and individuals, and this would lead to harm to human health (Jerez et al., 2015).

One of the environmental factors that has been observed to have potential effects on market performance is the weather conditions. As Nelson put in 1902: "In a typical market, brokers believe that on rainy and boring days the effect of psychological factors is so strong that professional traders and marketers cannot perform their main duties as they do on a refreshing sunny day when people are lively". Symeonidis (2010) believes that climate affects the behavior of investors in the capital market by affecting their mood. Any major climate change can be effective in financial market plans and results. Reaction to climate changes is the result of a physiological adaptation in the financial market, the speed of reaction to these changes depends on the degree and level of climate stimulation, the mental state of individuals in the financial market, etc. One of the crucial environmental elements that affects the financial market is climate (Batten et al., 2016). Given the importance of

financial market stability and its role in improving the financial performance of the country and the economy, the objective of this research is to examine the effect of climate change on financial market stability in Iran. The results of the research could be helpful for policymakers to make a more accurate and efficient decision.

3. RESEARCH LITERATURE

In a survey in 2018, Dafermos et al. applied a stock-flow-fund ecological macroeconomic model and concluded that financial instability caused by climate change has a harmful effect on credit expansion and economic activity. Campiglio et al. (2019) investigated the effect of climate risk on financial assets. The results show that climate-related events such as storms and droughts, i.e. physical risks through lower returns and higher non-profit loans, had a negative impact on stock values and debt instruments. Also, the results indicate that the detrimental effect of climate risk on some financial assets is higher than others. Furthermore, by studying the consequences of future climate expenses on financial assets, they found that even in case conservative estimation methods had been adopted, the financial risks related to these assets are economically remarkable. Recently, some central banks, as financial regulators, started investigating the effect of climate change and the low carbon policy on the financial sector and suggested that undiminished climate change has the potential to affect financial stability (Diez et al., 2016). Klomp (2014) studied the impact of natural catastrophes on the distance-to-default of commercial banks in more than 160 countries and suggested that these disasters escalate the probability of a banks' default. Obviously, this issue threatens financial stability and is a hinder to economic growth.

In another research, the effect of hurricanes and tropical storms on stock and foreign exchange markets in Jamaica was investigated by Robinson and Bangwayo-Skeete (2019). The findings suggest that the damage to the Jamaican stock and foreign exchange markets caused by these natural phenomena is usually remarkable and even at times it even overtakes the losses to property and infrastructure. The consequence of this is that not responding to financial market losses can increase the vulnerability of the economy to climate change in developing countries. These results strengthen the vulnerability of small island developing countries such as Jamaica to natural disasters and provide other dimensions of the scale of negative effects of climate change on these countries. Furthermore, the results indicate that efforts to alleviate the effects of climate change and natural phenomena decrease the casualties, property, and infrastructure, while it would probably preserve investments' value in the stock market. Kahn and Zhao (2018) examined the relationship between climate change scepticism and adaptation in a market economy. Climate change increases the risk of rising temperature and innovation can compensate some of these threats. In this paper, the supply and demand of climate adaptation innovation were investigated in a market

economy. Such an innovation reduces the relationship between mortality and extreme heat. The results showed that in the model of "climate suspects" the claim of increasing the average world temperature has been rejected and scepticism about climate change affects the adaptation in the market economy.

Christophers (2017) examined climate change, financial instability, and the problems of neoliberal governance. In recent years, climate change is increasingly seen as one of the main threats to global financial stability in the future. The paper identifies and critiques the emerging consensus among international financial regulators on how to better manage this threat, whose core components have also been identified. This indicates that the monitoring performance approach plays a controlling role in the serious crisis against the risk of financial instability. The paper describes this approach as a completely neoliberal method. It also argues that this approach relies on financial market performance and financial institutional behaviors. Lutz and Stadelmann (2016) in a study entitled "The potential impact of climate change on financial market stability" states that climate risks have a wide potential to affect financial markets. Fossil fuel assets can lose their value through the process of increasing the temperature movement towards 1.5 to 2 degrees Celsius. One way is through frequent natural disasters that can lead to significant losses to the property value along with insurance losses. Within the scope of this study, it was assessed whether climate change poses a risk to financial market stability or not. For this purpose, CO2 emissions as an indicator of climate change were analyzed and a series of specialized interviews were conducted focusing on potential short-term to medium-term risks. This study distinguishes between physical risks (e.g., increased hurricane damage) and transfer risks (e.g., regulations that severely limit fossil fuel consumption). Risks related to liability are not considered. While physical risks appear to pose very little risk to the stability of the German financial market in the short- and medium-term, transfer risks are significantly more relevant. Sudden CO2 price adjustments or other sudden monitoring measures lead to significant losses in the financial market, which, along with other risks, can lead to instability in the financial market. That is why regular transfer to a low-carbon economy, which is economically stable, is a clear and long-term signal of favorable policy.

Furthermore, Wade and Jennings (2016) assessed how climate change affects the global economy. Using the comprehensive research conducted, it was examined how climate change shapes the global economy. According to them, as global temperatures rise, operating costs increase, that hinders global growth. Studies showed that this leads to a one percent decline in annual GDP growth. Research results also indicate that its effect will disproportionately damage developing economies and that the long-term financial consequences of climate change can be improved only through collective efforts to formulate strict carbon emissions policies. Indeed, as Burke et al. (2015) concluded in their survey, if countries do not change their policies, climate change not only

will affect the global economy but also existing inequalities in the global economy will increase significantly.

4. RESEARCH METHODOLOGY

In this research, data has been collected by the archival method. In the next stage, data related to exchange rate fluctuations are collected from the Central Bank of the Islamic Republic of Iran. The website of the Meteorological Organization has also been used to extract data related to climate change. The statistical population of this study is the Iranian economy during the years 2016 to 2018. To this end, the data in the present research are considered on a daily basis. Furthermore, in order to measure the effect of climate fluctuation criteria on financial stability, we apply the Vector Autoregressive model (VAR) and the regression model is as follows:

$$\mathrm{Drs}_t = \beta_1 + \beta_2 \mathrm{CC}_t + \beta_3 \mathrm{TEMP}_t + \beta_4 \mathrm{HUM}_t + \beta_5 \mathrm{WIND}_t + \beta_6 \mathrm{SNOW}_t + \beta_7 \mathrm{RAIN}_t + \varepsilon_t \qquad \text{Equation (1)}$$

Drs_t: Indicates financial market stability. Exchange rate fluctuations have been used to measure the stability of the financial index. Where rs indicates the exchange rate and Drs_t shows the first order difference for logarithm of the exchange rate variable.

CC_t: The cloud cover ratio on day t, which rank 1 to 5 is considered based on Saunders (1993) research. Thus, number one is considered for cloudless conditions, number two for semi-cloudy conditions, number three for cloudy conditions, number four for rainy conditions, and number five for snowy or foggy conditions.

TEMP_t: Temperature on day t

HUM_t: Humidity on day t

WIND_t: Virtual variable for wind on day t

SNOW_t: Virtual variable for snow on day t

RAIN_t: Virtual variable for rain on day t

Therefore, the research hypothesis is as follows:

Climate change has a significant effect on the financial market stability.

5. RESEARCH FINDINGS

5.1.The descriptive statistics of the variables:

Table 1. Descriptive statistics of the variables

Variable	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
Financial market stability	1.922	1.644	3.799	0.897	0.912	0.569	1.884
Cloud cover ratio on day	1.258	1	5	0	1.514	0.833	2.356
Temperature	20.207	19	42	0	10.331	-0.007	1.926
Humidity	0.455	0.46	0.66	0.113	0.12	-0.108	1.864
Wind	0.642	1	1	0	0.479	-0.595	1.354
Snow	0.432	0	1	0	0.495	0.273	1.074
Rain	0.203	0	1	0	0.403	1.47	3.161

As shown in Table 1, the highest mean value is related to temperature and the lowest mean value is related to rain. The standard deviation indicates the degree of dispersion of each variable from the mean value. The results indicate that all variables are within a reasonable range in terms of kurtosis and normality. All research variables have values close to normal in terms of kurtosis.

5.2.Examining the stationarity of the research variables

Before estimating the model, it is essential to test the stationarity of its variables. Dickey-Fuller unit root tests were used in order to examine the stationarity (reliability) of the research variables.

Table 2. Examining the stationarity of the research variables

	Level		First Order Difference	
Variable	Dickey-Fuller Statistic	Significance Level	Dickey-Fuller Statistic	Significance Level

Financial market stability	-2.71800	0.0712	-17.51648	0.0000
Cloud cover ratio on day	-2.504	0.011	-19.020	0.000
Temperature	-20.699	0.000	-20.709	0.000
Humidity	-12.482	0.000	-23.562	0.000
Wind	-10.232	0.000	-19.154	0.000
Snow	-9.429	0.000	-20.834	0.000
Rain	-10.865	0.000	-18.931	0.000

According to the results observed in Table 2, the test statistic level for all variables except financial market stability is at a level equal to a value of less than 5%. Therefore, given that the significance level is less than 0.05, the research variables have the necessary stationarity and the financial market stability variable with a first-order differentiation has a significance level of less than 0.05 and is significant.

5.3.Collinearity test of research variables

Table 3. Collinearity of the research variables

	Cloud cover ratio on day	Temperature	Humidity	Wind	Snow	Rain
Cloud cover ratio on day	1					
Temperature	-0.7848	1				
Humidity	0.026	-0.023	1			
Wind	0.041	-0.060	0.020	1		
Snow	0.077	-0.066	-0.027	-0.003	1	
Rain	0.348	-0.397	0.013	0.008	0.08	1

As the results of the collinearity test show, there is no strong collinearity between the variables that can cause problems in estimating the hypotheses. Therefore, these variables can be used to perform tests.

5.4.Determining the optimal lag

After identifying the stationarity of the model variables, the first problem in the Vector Auto-regression models is to determine the optimal lag length. Here, the Schwarz-Bayesian (SC) criterion, Akaike (AIC) criterion, the final prediction error (FPE), Hannan Quinn (HQ), and the likelihood ratio are used to determine the lag length.

Table 4. Determining the optimal lag in the VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-8185.957	NA	0,007969	15.03295	15.06502	15.04509
1	-4982.059	6360.766	0.000024	9.244145	9.500714	9.341250
2	-4792.690	5266.373*	1.89e+05*	8.986587*	9.467654*	9.168659*
* indicates lag order selected by the criterion						

The results of Table 4 show that in the model, the lag is the optimal lag of the model based on most criteria, including 2 Akaike and Hannan Quinn. Therefore, considering that the stability of the system will be provided in the optimal lag 2, this lag will be selected as the optimal lag of the model based on the above criteria.

Table 5. Results of examining the effect of climate change on financial market stability

Variable	Coefficient	Deviation Standard	Z statistic	Sig. Level
C(1)	0.776269	0.016626	46.69047	0
C(2)	0.101745	0.018363	2.09504	0
C(3)	0.170655	0.069783	3.012499	0
C(4)	0.150637	0.00365	5.174654	0
C(5)	0.110574	0.009099	6.1621	0
C(6)	0.115026	0.010478	4.434008	0
C(7)	0.11153	0.009354	2.232609	0
C(8)	0.606254	0.012985	46.69047	0
C(9)	0.229849	0.069593	3.302766	0.001
C(10)	0.320326	0.00365	4.089439	0
C(11)	0.308375	0.009094	4.920876	0
C(12)	0.201916	0.010473	3.182992	0
C(13)	0.211776	0.009348	3.259798	0
C(14)	2.291859	0.049086	46.69047	0
C(15)	0.313191	0.003649	5.8745	0
C(16)	0.308179	0.009091	4.899665	0
C(17)	0.206108	0.010472	3.583221	0

Table 5. Continued: Results of examining the effect of climate change on financial market stability

Variable	Coefficient	Standard Deviation	Z statistic	
C(18)	0.214591	0.009339	3.562362	0

C(19)	0.320464	0.00258	46.69047	0
C(20)	0.307418	0.009088	2.816244	0
C(21)	0.212035	0.010468	3.149708	0
C(22)	0.304031	0.009333	3.431915	0
C(23)	0.299992	0.006425	46.69047	0
C(24)	0.219943	0.010456	3.907239	0
C(25)	0.403911	0.009333	5.419092	0
C(26)	0.344928	0.007388	46.69047	0
C(27)	0.010734	0.009329	2.150612	0
C(28)	0.307915	0.006595	46.69047	0

Table 5 measures the impact response of the effect of a shock on the endogenous variable of the system on other variables. In this study, the impact response function measures the rate of change of fluctuations of climatic variables at the 95% confidence level. The values in Table 5 show the shocks caused by financial market fluctuations relative to climate change. Considering the shocks, the significance level for testing this hypothesis to examine the climate indicators is less than 0.05, so the null hypothesis is rejected at the 95% confidence level. That is, climate change has a significant effect on financial market stability. By observing computational z values and in the last column, the probability level values are low; therefore, both coefficients statistically are significant.

5. CONCLUSION

In this research we examined the effects of climate change on financial market stability and the findings indicate that the research hypothesis is confirmed. Financial stability shows that the financial system not only plays its role in allocating resources, transferring and managing risk, stimulating depositors, and facilitating the accumulation of wealth and its growth, but also it is a system for payments of economic operations (between private and public companies, retail and wholesale, formal and informal payment mechanisms). To perform these tasks, it requires that the central bank's money and its close alternative money, derivatives such as current deposits and other bank accounts properly to play its role as a means of payment, accounting unit, and (in the short term) maintaining value. In other words, financial stability is a vital part of monetary stability, which largely overlaps. Since climate fluctuations can affect market conditions, policies should be taken into account to control financial market stability. Considering that research results showed that climate change affects the financial market stability, so we can say that the results are consistent with the study by Campiglio et al. (2019), Christophers (2017), Kahn and Zhao (2018), Robinson et al. (2019), and Lutz and Stadelmann (2016). In future studies, financial market control instruments could be assessed during the period of climate fluctuations.

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