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Investigation of Macro-Economic Factors Affecting Financial Fragility in G-20 Countries

G-20 Ülkelerinde Finansal Kırılganlığı Etkileyen Makroekonomik Faktörlerin İncelenmesi

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Abstract

This study examines the macroeconomic factors influencing financial fragility in G-20 countries, including both developed and emerging economies, between 2006 and 2021. The aim is to compare financial fragility in developed and emerging economies and identify key factors contributing to it. The dependent variable used is the financial fragility index, while independent variables include population growth rate, GDP, industrial growth, inflation rate, foreign direct investment, unemployment rate, consumer price index, current account balance, budget deficit, public debt, and import-export coverage ratio. The Dumitrescu-Hurlin Panel Causality Test was employed for the analysis. The findings reveal bidirectional causality between financial fragility and population growth rate, as well as public debt. Additionally, a one-way causality was observed from the unemployment rate to financial fragility and from financial fragility to inflation rate, current account balance, and budget deficit. These results highlight the complex interrelations between macroeconomic indicators and financial fragility, especially in the context of emerging economies.

Keywords: Financial Fragility, G-20 Countries, Dumitrescu Hurlin, Panel Causality.

Jel Classification Codes: F41, G17.

Öz

Bu çalışma, 2006-2021 yılları arasında hem gelişmiş hem de gelişmekte olan ekonomileri içeren G-20 ülkelerinde finansal kırılganlığı etkileyen makroekonomik faktörleri incelemektedir. Amaç, gelişmiş ve gelişmekte olan ekonomilerdeki finansal kırılganlığı karşılaştırmak ve buna katkıda

bulunan temel faktörleri belirlemektir. Bağımlı değişken olarak finansal kırılganlık endeksi kullanılırken, bağımsız değişkenler olarak nüfus artış hızı, GSYİH, endüstriyel büyüme, enflasyon oranı, doğrudan yabancı yatırım, işsizlik oranı, tüketici fiyat endeksi, cari işlemler dengesi, bütçe açığı, kamu borcu ve ithalat-ihracat karşılama oranı kullanılmıştır. Analiz için Dumitrescu-Hurlin Panel Nedensellik Testi kullanılmıştır. Bulgular, finansal kırılganlık ile nüfus artış hızı ve kamu borcu arasında çift yönlü nedensellik olduğunu ortaya koymaktadır. Ayrıca, işsizlik oranından finansal kırılganlığa ve finansal kırılganlıktan enflasyon oranı, cari işlemler dengesi ve bütçe açığına doğru tek yönlü bir nedensellik gözlemlenmiştir. Bu sonuçlar, özellikle gelişmekte olan ekonomiler bağlamında, makroekonomik göstergeler ile finansal kırılganlık arasındaki karmaşık ilişkilerin altını çizmektedir.

Anahtar Kelimeler: Finansal Kırılganlık, G-20 Ülkeleri, Dimitrescu Hurlin, Panel Nedensellik

Jel Kodları: F41, G17

Introduction

In our globalizing world, the concepts of fragility and financial fragility are of great importance for national economies. Whether the concept of fragility, which has been used in the economics literature since the 21st century, is attributed only to the state or society remains unclear. Leading to outcomes such as hunger, poverty, civil war, terrorism, uncontrolled migration, and global events, fragility affect the country's economy and sociology negatively. States that are described as fragile rely mostly on raw material production in terms of export. For this reason, their exports do not have a very complex structure, and they experience more fluctuations in trade (Akar, 2022, p. 119). As a result, fragile states demonstrate a lower level of financial development compared to other states.

In macro-economics, the concept of financial fragility is used to measure the sensitivity of enterprises in large-scale economic crises caused by small-scale, routine financial problems within an economic system. Fisher and Keynes' theory of financial fragility is based on their research conducted in 1930. Later, Minsky worked on financial fragility and in one of his studies he argued that the fragility of investment financing is caused by the nature of modern market economies (Minsky, 1995). However, the lack of supportive research to be conducted by Minsky weakens this view. Financial crisis is caused by a problem that occurs as part of the economic system and spreads to the whole economy resulting

in major macro-economic problems. In financial crises, which are the cause of financial fragility, excessive fluctuations in financial indicators such as exchange rate fluctuations, interest rates, stock market index cause the whole economy to deteriorate (Çitil and Görgün, 2022, p. 386).

The concept of economy has a considerable importance in terms of banks and companies. For this reason, banks and companies contribute to economic growth in the development of the country. Since any crisis that may occur in a bank will affect all sectors and therefore the economy, it is of great importance to conduct audits in institutions, measure financial vulnerabilities, and share research on these issues with the public. At the same time, countries should detect which indicators signal a crisis in their own economies and develop the policies to return these signals to a normal level.

Financial fragility emerges as an important problem in developing markets. The impacts of crises, vulnerabilities to macro-economic factors, changing market conditions and structural economic variables may cause negative effects on the financial structures of the markets and thus trigger fragility. Macro-economic variables such as constantly rising inflation in economies, a lower GDP than the ideal level, high interest and exchange rates cause various financial risks. This shows how strong of an impact macro-economic fluctuations have on financial fragility.

Financial fragility is a term that measures the resilience of economic crises in countries. Its main indicators can be exemplified as trade and exchange rate impacts, external supply-demand shocks as well as international volatility in interest rates, fluctuations in commodity prices, and instability in global trade. Political instability and unpredictability of changes in the country cause internal shocks. Financial fragility emerges as a result of a three-dimensional relationship. First, the magnitude and frequency of anticipated or expected external shocks; secondly, experiencing such shocks; and thirdly, the reaction, that is, the susceptibility of the country's economy, which is exposed to internal and external shocks. These situations reveal the importance of the concept of resilience to shocks in terms of fragility. If the natural and structural effects proceed in a different manner from the political effects as a characteristic of the economy, the concept of resilience emerges as a concept that helps combat macro-economic fragility (Ünlü, 2021, p. 4).

High current account deficit, low productivity in the country and weak domestic saving rates as well as the inevitability of foreign dependence and fluctuations in exchange rates are the main reasons for the increase in

the economic fragility of countries as these factors hinder the development and economic growth of the country. At the same time, the increase in the fragility of a country causes economic crises. The high fragility of a country's economy makes it more vulnerable to both national crises and international crises (external shocks) (Kılınç, 2021, p. 21).

After many economic crises, early warning systems have been developed in order to predict crises and steps have been taken to minimize economic vulnerabilities and to restore a solid financial system. For this purpose, governments have attempted to ensure budget discipline with a number of macroprudential measures, taking into account their fiscal and monetary policies. Countries with low economic fragility (economically resilient countries) are less affected by economic crises by implementing these policies and can achieve rapid economic development (Kılınç, 2021, p. 21).

Global, economic and financial shocks have been frequently experienced since 2000 and it has been determined that these shocks have a negative impact on the economies of developing countries (Seth and Ragab, 2012, p. 2). In this regard, they need to increase their resilience and efficiency against external shocks in order to achieve sustainable development and growth. Countries are expected to stimulate domestic demand by encouraging investments in innovation, social protection and infrastructure which are implemented with structural reforms in order to meet effective economic management. The forms of economic management that shape productive investments and structural reforms may also affect all aspects of sustainable development (United Nations, 2017, p. 1). Achieving financial resilience depends on creating structures that are resistant to shocks. As a result of effective management, the fragile economies of countries will become resilient and attain a structure that can cope with crises.

In the literature review, most of the factors that affect the financial fragility of the countries, whose data can be accessed, have been added to the data set. These factors are; Population Growth Rate, Gross Domestic Product, Industrial Growth, Inflation Increase Rate, Foreign Direct Investments, Unemployment Rate, Consumer Price Index, Current Account Balance, Budget Deficit, Public Debt and Export Coverage Ratio of Imports.

The G-20 countries are of great importance for the global economy and stability since they represent 85% of the world's population and 65% of the world's GDP. For this reason, the main purpose of the study is to determine which macro-economic indicators are affected by the financial fragility of the G-20 economies. This study aimed to determine which

macroeconomic indicators affect financial fragility in G-20 countries. Considering the broad scope of the macroeconomic factors used in the study, it is expected to contribute to the literature.

Literature

Since the economic variables affecting financial fragility are of significance in terms of their effects, many studies have been conducted on this subject. When the international literature is examined, studies related to financial fragility mostly focus on macro-economic variables, bank supervision and many bank-specific variables. It is noteworthy that the number of academic studies investigating the relationship between variables such as industrial growth, current account balance, budget deficit, CPI and a country's financial fragility index is quite low in the academic literature. In this section, literature review of studies conducted with similar variables are presented.

In his study, Topaloğlu (2018) aimed to determine the micro-economic factors that affect the financial fragility of commercial banks operating in Türkiye. Topaloğlu created two different models to determine the factors affecting financial fragility in the study. These models were analyzed using the panel data method. As a result of the analysis, a statistically significant and negative relationship was found between the bank size and the non-performing loan ratio in model 1 while a statistically significant and positive relationship was observed between liquid ratio and non-performing loan ratio in Model 2. Furthermore, a statistically significant and positive relationship was observed between capital adequacy ratio and net interest margin and return on assets while a statistically significant and negative relationship was observed between capital adequacy ratio and financial leverage and return on equity in model 2.

In their study, Aksoylu and Görmüş (2018) aimed to examine the causal relationship between the USD dollar exchange rate, VIX index and US bond interest rates, and CDS premiums of nine developing countries. For this purpose, they used Granger-causality analysis and Hatemi-J asymmetric causality analyzes using the data from 2005-2015. According to the Granger causality analysis conducted in the study, a single causality was found running from Indonesia and Poland exchange rates to CDS premiums. According to the Hatemi-J analysis, it was concluded that there was causality running from exchange rate to CD premiums in Argentina, Indonesia and Portugal during positive shocks as well as in Indonesia, Mexico and Portugal in case of negative shocks.

In their study, Büyükakın and Aydın (2018) wanted to measure the predictability of financial crises for the Turkish economy with leading indicator indices. For this purpose, they standardized each variable they used in the study between 1990-2017 and calculated them as weighted indices. As a result of the study, they found that the variables they selected were successful in predicting crises.

Akgül (2018) aimed to determine the variables that may have an impact on financial fragility in banks in Türkiye and to determine the effect of these variables on financial fragility. In the study, Logit multi-criteria logistic regression analysis was used for the period between 1998 and 2017. As a result of the coefficient analysis, it was determined that the variables of financial fragility and current account deficit/GDP, total loans/total liabilities, real interest rate, real exchange rate and M2/ international reserves are in the same direction. Furthermore, it was concluded that financial fragility and domestic loans/GDP, CB (Central Bank) reserves/CB assets, Exports/GDP and portfolio investment/GDP were inversely related.

In the study of İslatince (2018), it was aimed to examine the relationship between liquidity, asset quality, net interest margin ratio, capital adequacy, profitability variables, fragility and internal factors, which are the internal factors of deposit banks that show the relative size and strength of the banking system, for the 2008-2018 periods. For this purpose, the Herfindahl Hirschman (HHI) index was calculated with the Andersen-Rubin method, and the analysis of variance (ANOVA) was used to examine the difference according to the banks and years with the data obtained. As a result of the study, according to the HHI fragility index model, it was determined that equity/total assets was the most important ratio that affected fragility and kept fragility at low levels.

Şimşek et al. (2020) aimed to examine the causality between macro-economic factors affecting financial fragility and country score in their study. For this purpose, data sets were created by using the inflation rate, macro-economic indicators, financial fragility scores, growth rates, unemployment rates and import-export coverage ratios of Türkiye and the Fragile Eight. In the study, cointegration, Granger causality and error correction analyzes were conducted using the data between 2006 and 2018. According to the results of the analyses, it was found that inflation caused fragility while unemployment did not, yet impacted it.

In their study, Ünlü (2021) aimed to create a financial fragility index that reflected the fragility in the Turkish banking sector, to measure

the macro-economic variables affecting fragility and the effect of these variables on the fragility index. For this purpose, he conducted the VAR Granger causality test to analyze the bank data for the period of 2010-2020 by using the growth rate, real exchange rate, industrial production index, credit default swap and inflation rate variables. As a result of the analysis, Ünlü found that, among the selected macroeconomic factors, credit default swap and inflation rate increased financial fragility while the real exchange rate and industrial production index had a reducing effect on financial fragility.

Felek et al. (2021), aimed to determine the direction of the relationship between financial development and financial fragility and whether the institutional and legal regulations in the Turkish financial system are sufficient. In the study, in which the economic development index and the economic fragility index were calculated using the data of the variables in 2017-2019 and the Principal Component Analysis method, the relations between the two indices were analyzed with ARDL (boundary test). As a result of the analysis, it was found that financial fragilities gradually decreased during periods of increased financial development in Türkiye.

Chen (2021) conducted a case study of Hurricane Katrina to investigate whether nonprofits can regain their original financial performance after major natural disasters and what organizational capacity and capabilities impacted their ability to return. For this purpose, he conducted Pearson correlation and variance inflation factor (VIF) test, and according to the findings obtained from the study, it was determined that the factors associated with financial resilience were different from the factors of financial fragility.

Chletsos and Sintos (2021) aimed to examine the effect of financial fragility on employment. The study evaluated the relationship between financial fragility and employment using economic models. The results indicate that financial fragility has a negative impact on employment, and this effect becomes more pronounced during periods of economic uncertainty.

Chatziantoniou and Gabauer (2021) aimed to examine financial fragility from the perspective of EMU risk synchronization and dynamic interconnectedness. The study evaluated how financial fragilities among European Monetary Union countries are synchronized and their dynamic interactions. The results indicate that financial fragility is deeply related to inter-country connections, posing a threat to economic stability.

Haque and Varghese (2021) aimed to examine the effects of COVID-19 on corporate leverage and financial fragility. The study evaluates how corporate leverage ratios changed during the pandemic and their relationship with financial fragility. The results indicate that COVID-19 has had negative effects on corporate leverage, thereby increasing financial fragility.

Soufi et al. (2021) aimed to develop a model for calculating the financial performance, shock periods and financial resilience of the companies in the Tehran Stock Exchange by using the data from the 2010-2018 period. As a standard method, they calculated the financial flexibility of firms within the scope of their financial performance, after their performance decreased. As a second method, they calculated financial flexibility using the VaR model. As a third method, they took into account the source of the risk factor and used the concept of CoVaR to calculate financial resilience.

In their study, Yiğiter and Sarı (2022) aimed to measure the interaction between BIST 100 Index, dollar rate, credit default swap (CDS) and foreign trade volume with financial fragility. The study considered the ratio of non-performing loans to total loans as an indicator of financial fragility. They analyzed the data for the 2013-2021 period with the ARDL boundary test. The results of the analysis revealed that financial fragility was affected positively by BIST 100 Index in the short and long term, foreign trade volume had a negative effect in the short and long term, the exchange rate had a negative effect in the short term while it had no effect in the long term, and CDS premium had a negative effect in the short term while it had a positive effect in the long term.

Di Guilmi and Fujiwara (2022) aimed to investigate the dual labor market, financial fragility, and deflation within an agent-based model of the Japanese macroeconomy. The study evaluated the interactions and outcomes among these factors. The results indicate that financial fragility plays a deepening role in deflation and that the dual labor market significantly influences these dynamics.

Çitil and Görgün (2022) aimed to examine the financial fragility phenomenon of the logistics sector operating in the Southeastern Anatolia Region. They tried to determine the factors affecting the financial fragility of the companies by using the annual data of 2669 companies covering the period of 2006-2019. For this purpose, panel regression analysis was performed. In the study, Altman-Z Score was used as a measure of financial fragility, and Equity Turnover Rate, Current Ratio, Debt

EBITDA Ratio, Leverage Ratio and Long Term Debt Ratio were used as explanatory variables. As a result of the analysis, they determined that there was a negative relationship between financial fragility and current ratio while leverage ratio and long-term debt ratio were directly related.

Rezaee, Fareed, and Ansari Samani (2022) aimed to investigate the effect of financial fragility on macroeconomic variables within the framework of a TVP-VAR model in the Iranian economy. The study utilized quarterly data from the period 2001-2020 to assess the impact of the financial fragility variable on economic growth, inflation, and exchange rates. The results indicate that financial fragility negatively affects economic growth while positively influencing inflation and exchange rates.

Zungu and Greyling (2023) aimed to investigate the asymmetric effect of income inequality on financial fragility in South Africa and selected emerging markets. The study utilized a Bayesian approach with hierarchical priors. The results indicate that income inequality creates asymmetric effects on financial fragility, and this effect varies across countries.

When the literature is reviewed, it is observed that many studies have been conducted on measuring fragility in banks. Studies generally cover both Türkiye and developing countries. When the literature is summarized, it is seen that the fragility of the financial system and banking sector is affected by some basic macro-economic factors. In terms of the broad scope of the variables included in the analysis, it is thought that, unlike the previously conducted studies, this study will contribute to the literature with the factors affecting the financial fragility of the G-20 countries between the 2006-2022 period.

Dataset and models

In the study, the causality relationship between macroeconomic factors and financial fragility in G-20 countries regarding the period between 2006 and 2021 was discussed. The reason why G-20 countries are preferred in the data set is that they correspond to the 20 developed countries representing 85% of the world population and 65% of the world GDP. It is thought that the findings to be obtained with this specific focus will be of significance to other countries, as well. In the study, a data set was created using the annual data of the countries covering the period of 2006 and 2021. The data set in question was started as of 2006 due to major deficiencies in the scope of the variables used in the data before that specific year. Furthermore, since there are also deficiencies in the 2022 data of the countries, the longest complete time series was determined

as the period between 2006 and 2021.

In the study, the relationship between macroeconomic factors and financial fragility in G-20 countries was estimated by Dumitrescu and Hurlin (2012) panel causality test. One of the G-20 countries selected as the sample countries was not included in the study since it covers the whole of the European Union, and the data set of the study was created with the data of 19 countries. The list of sample countries is as shown in Table-1.

Table 1

List of Sample Countries

G-20 COUNTRIES				
1- European Union	5- Australia	9- Indonesia	13- India	17- Mexico
2- ABD	6- United Kingdom	10- France	14- Italy	18- Russia
3- Germany	7- Brazil	11- South Africa	15- Japan	19- Saudi Arabia
4- Argentina	8- China	12- South Korea	16- Canada	20- Türkiye

Since we think that the results obtained from a broad perspective in the study will contribute to the literature, macroeconomic factors have been kept as broad as possible. In the study, a data set was created with 12 different variables, including the fragility index. The fragility index, which is published regularly (Fund for Peace), was used as the dependent variable in the study. Population Growth Rate, Gross Domestic Product, Industrial Growth, Inflation Growth Rate, Foreign Direct Investments, Unemployment Growth Rate, Consumer Price Index, Current Account Balance, Budget Deficit, Public Debt and finally the Export Import Coverage Rate as independent variables. used. The explanations and abbreviations of the variables used in the study and the list of sources from which the data were obtained are given in Table-2.

Table 2

Variables Used in the Study

Variable	Abbreviation	Source
Fragility Index	FSI	Fund For Peace Data Bank
Population Growth Rate	POP	World Bank Data
Gross Domestic Product	GDP	World Bank Data
Industrial Growth	INDG	OECD Data Bank
Inflation	INF	World Bank Data
Foreign Direct Investments	FDI	World Bank Data
Unemployed	UNP	World Bank and Macro Trends Data Bank
Consumer Price Index	CPI	Fred Economic Data Bank
Current Account Balance	BLNC	Country Economy Data Bank
Budget Deficit	DFCT	Country Economy Data Bank
Public Debt	DEPT	Country Economy Data Bank
Export Import Coverage Ratio	EXIM	OECD and Macro Trends Data Bank

In the study, the models shown in Table-3 were estimated.

Table 3

Models

Model Order	Econometric Model	Model Order	Econometric Model
Model-1	$FSI_{it} = \alpha_0 + \alpha_1 POP + e_{it}$	Model-12	$POP_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-2	$FSI_{it} = \alpha_0 + \alpha_1 GDP + e_{it}$	Model-13	$GDP_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-3	$FSI_{it} = \alpha_0 + \alpha_1 INDG + e_{it}$	Model-14	$INDG_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-4	$FSI_{it} = \alpha_0 + \alpha_1 INF + e_{it}$	Model-15	$INF_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-5	$FSI_{it} = \alpha_0 + \alpha_1 FDI + e_{it}$	Model-16	$FDI_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-6	$FSI_{it} = \alpha_0 + \alpha_1 UNP + e_{it}$	Model-17	$UNP_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-7	$FSI_{it} = \alpha_0 + \alpha_1 CPI + e_{it}$	Model-18	$CPI_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-8	$FSI_{it} = \alpha_0 + \alpha_1 BLNC + e_{it}$	Model-19	$BLNC_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-9	$FSI_{it} = \alpha_0 + \alpha_1 DFCT + e_{it}$	Model-20	$DFCT_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-10	$FSI_{it} = \alpha_0 + \alpha_1 DEPT + e_{it}$	Model-21	$DEPT_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$
Model-11	$FSI_{it} = \alpha_0 + \alpha_1 EXIM + e_{it}$	Model-22	$EXIM_{it} = \alpha_0 + \alpha_1 FSI + e_{it}$

The models in Table-3 express causality running from both financial fragility to macro-economic factors and from macroeconomic factors to financial fragility.

Method

The study gives priority to the descriptive statistics of the variables included in the data set and then the Delta test results in order to tell whether the models are homogeneous or heterogeneous. Afterwards, the unit root test results according to the cross-sectional dependencies conducted for each model are mentioned. Finally, the panel causality test results from financial fragility index to macro-economic factors and from macro-economic factors to financial fragility index are presented.

The descriptive statistics of the variables used in the study are shown in Table-4 including the mean values, standard error values, minimum and maximum values of the variables.

Table 4

Descriptive statistics

Variables	Number of Observations	Mean	Standard Error	Minimum	Maximum
FSI	304	53.16217	20.9618	18.7	89.2
POP	304	0.8278541	0.7159698	-1.853715	3.958797
GDP	304	2.564631	3.776852	-11.03086	14.23086
INDG	304	2.000506	5.026024	-15.29437	19.32055
INF	304	4.730035	6.674404	-2.093333	53.55
DYY	304	2.156357	1.618417	-1.16467	12.03164
UNP	304	7.349112	4.602895	2.35	28.77
TUFE	304	105.9801	55.75172	45.64	643
BLNC	304	0.3689219	4.978832	-8.870446	26.2494
DFCT	304	-3.122287	4.529021	-15.84	29.8
DEPT	304	66.66859	48.02864	1.56	259.43
EXIMP	304	1.008202	0.2795725	0.0000938	2.172065

As can be seen in Table-4, a data set was created using a total of 304 observation values. It is seen that the standard error values are high regarding the FSI, CPI and DEPT variables. The main reason for this is that the G-20 countries differ in terms of financial development, national income and budget deficit.

Cross-sectional dependence and homogeneity tests are crucial for the selection of the unit root test. Whether the data set is homogeneous or heterogeneous determines the decision to employ the unit root test. The results of the Delta test developed by Pesaran and Yamagata (2008) are shown in Table-5. According to the results of the Delta test conducted separately for 22 models, Model-3, 13 and 14 were found to be homogeneous while all the other models were heterogeneous.

Table 5

Delta Test Results

Pesaran, Yamagata (2008) Delta Test							
Delta test		**Test Statistics**	**Probability**	**Delta test**		**Test Statistics**	**Probability**
FSI-POP	Delta_tilde	11.354	0.000***	**POP-FSI**	Delta_tilde	12.204	0.000
	Adjusted delta_tilde	12.596	0.000***		Adjusted delta_tilde	13.539	0.000
FSI-GDP	Delta_tilde	2.076	0.038**	**GDP-FSI**	Delta_tilde	0.091	0.928
	Adjusted delta_tilde	2.304	0.021**		Adjusted delta_tilde	0.101	0.920
FSI-INDG	Delta_tilde	1.334	0.182	**INDG-FSI**	Delta_tilde	-0.420	0.675
	Adjusted delta_tilde	1.479	0.139		Adjusted delta_tilde	-0.465	0.642
FSI-INF	Delta_tilde	2.598	0.009***	**INF-FSI**	Delta_tilde	4.386	0.000
	Adjusted delta_tilde	2.882	0.004***		Adjusted delta_tilde	4.866	0.000
FSI-DYY	Delta_tilde	5.515	0.000***	**DYY-FSI**	Delta_tilde	5.407	0.000
	Adjusted delta_tilde	6.119	0.000***		Adjusted delta_tilde	5.998	0.000
FSI-UNP	Delta_tilde	7.308	0.000***	**UNP-FSI**	Delta_tilde	9.811	0.000
	Adjusted delta_tilde	8.107	0.000***		Adjusted delta_tilde	10.885	0.000
FSI-TUFE	Delta_tilde	19.937	0.000***	**TUFE-FSI**	Delta_tilde	18.054	0.000
	Adjusted delta_tilde	22.118	0.000***		Adjusted delta_tilde	20.029	0.000
FSI-BLNC	Delta_tilde	6.338	0.000***	**BLNC-FSI**	Delta_tilde	6.480	0.000
	Adjusted delta_tilde	7.031	0.000***		Adjusted delta_tilde	7.189	0.000
FSI-DFCT	Delta_tilde	7.332	0.000***	**DFCT-FSI**	Delta_tilde	7.442	0.000
	Adjusted delta_tilde	8.134	0.000***		Adjusted delta_tilde	8.256	0.000

FSI-DEPT	Delta_tilde	12.298	0.000***	**DEPT-FSI**	Delta_tilde	10.996	0.000
	Adjusted delta_tilde	13.644	0.000***		Adjusted delta_tilde	12.198	0.000
FSI-EXIMP	Delta_tilde	4.191	0.000***	**EXIMP-FSI**	Delta_tilde	3.688	0.000
	Adjusted delta_tilde	4.650	0.000***		Adjusted delta_tilde	4.091	0.000

Another determining factor of the unit root test is the cross-sectional dependence test. Cross-sectional dependence plays an important role especially in the preference of first or second generation unit root test. Table-6 shows the results of Pesaran's cross-sectional dependence test, conducted to determine whether there is a cross-sectional dependence in the models.

Table 6

Cross-Section Dependency Test

Pesaran's test of cross sectional independence					
	Test Statistics	**Probability**		**Test Statistics**	**Probability**
FSI-POP	3.436	0.0006***	**POP-FSI**	20.750	0.0000
FSI-GDP	3.372	0.0007***	**GDP-FSI**	34.724	0.0000
FSI-INDG	3.505	0.0005***	**INDG-FSI**	27.837	0.0000
FSI-INF	4.902	0.0000***	**INF-FSI**	10.123	0.0000
FSI-DYY	3.736	0.0002***	**DYY-FSI**	5.557	0.0000
FSI-UNP	4.129	0.0000***	**UNP-FSI**	3.194	0.0014
FSI-TUFE	3.773	0.0002***	**TUFE-FSI**	48.767	0.0000
FSI-BLNC	3.889	0.0001***	**BLNC-FSI**	4.978	0.0000
FSI-DFCT	3.920	0.0001***	**DFCT-FSI**	28.605	0.0000
FSI-DEPT	3.701	0.0002***	**DEPT-FSI**	24.653	0.0000
FSI-EXIMP	3.889	0.0001***	**EXIMP-FSI**	2.880	0.0040

As can be seen in Table-6, it was determined that there was cross-sectional dependence in all of the 22 models in the study. It is essential that the time series of the variables are stationary in order to obtain accurate results from the analysis (Gujarati, 2003). In other words, the series must be stationary in order to obtain meaningful results among the dependent and independent variables. In panel data analysis, it is necessary to test whether the cross sections are independent before unit root testing, and the results determine whether first or second generation unit root tests should be conducted. For this reason, it is essential to identify the presence of a horizontal cross-sectional dependence between the variables. The test results on the basis of variables are shown in Table-7.

Table 7

Cross-Section Dependency Test on the Basis of Variables

Variables	Statistic	Probability
FSI	3.48	0.001
POP	21.728	0.000
GDP	34.509	0.000
INDG	27.724	0.000
INF	11.834	0.000
DYY	5.558	0.000
UNP	3.4	0.001
TUFE	48.664	0.000
BLNC	4.337	0.000
DFCT	28.721	0.000
DEPT	24.859	0.000
EXIMP	1.51	0.131

As can be seen in Table-7, cross-sectional dependence was detected in all the variables except for EXIMP variable. Since there is cross-sectional dependence in all models and all variables except for EXIMP, unit root analysis was conducted using the Pesaran CADF test, which is one of the second generation unit root tests while Im–Pesaran–Shin (2003) IPS test, which is one of the first generation unit root tests, will be employed for the EXIMP variable. Unit root test results will be shown in Table-8.

Table 8

Unit Root Tests

Pesaran's CADF test (Constant-Trend)						
Variables	**t-bar**	**Cv10**	**Cv5**	**Cv1**	**Z[t-bar]**	**p-value**
FSI	-2.298	-2.630	-2.730	-2.920	-0.078	0.469
FSI(I)	-3.576	-2.640	-2.760	-2.980	-5.206	0.000***
POP	-1.654	-2.630	-2.730	-2.920	2.701	0.997
POP(I)	-3.044	-2.640	-2.760	-2.980	-3.120	0.001***
GDP	-2.005	-2.630	-2.730	-2.920	1.188	0.883
GDP(I)	-2.297	-2.640	-2.760	-2.980	-0.184	0.427
INDG	-2.104	-2.630	-2.730	-2.920	0.761	0.777
INDG(I)	-2.578	-2.640	-2.760	-2.980	-1.287	0.099*
INF	-2.614	-2.630	-2.730	-2.920	-1.440	0.075*
INF(I)	-3.342	-2.640	-2.760	-2.980	-4.287	0.000***
DYY	-2.253	-2.630	-2.730	-2.920	0.116	0.546
DYY(I)	-3.007	-2.640	-2.760	-2.980	-2.974	0.001***
UNP	-2.111	-2.630	-2.730	-2.920	0.728	0.767
UNP(I)	-3.179	-2.640	-2.760	-2.980	-3.649	0.000***
TUFE	-1.225	-2.630	-2.730	-2.920	4.553	1.000
TUFE(I)	-1.742	-2.640	-2.760	-2.980	1.995	0.977
BLNC	-2.334	-2.630	-2.730	-2.920	-0.231	0.409
BLNC(I)	-3.967	-2.640	-2.760	-2.980	-6.742	0.000***
DFCT	-1.860	-2.630	-2.730	-2.920	1.814	0.965
DFCT(I)	-3.553	-2.640	-2.760	-2.980	-5.117	0.000***
DEPT	-1.467	-2.630	-2.730	-2.920	3.508	1.000
DEPT(I)	-3.010	-2.640	-2.760	-2.980	-2.983	0.001***
Im–Pesaran–Shin Unit Root Test						
	Statistic	Probability				
EXIMP	-3.5412	0.0002				

As can be seen in the unit root test results in Table-8, GDP, INDG and TUFE variables are neither stationary at level, nor can they be stationary at difference. For this reason, GDP, INDG and CPI macroeconomic factors were not included in the panel causality analysis. According to Table-8, while the EXIMP variable was stationary at level, all the other variables were not; however, they were made stationary by differencing.

In his study, Dumitrescu Hurlin (2012) stated that the causality relationship valid for any country in panel data analysis may be valid for other countries and that more effective results may be obtained with an increase in the number of observations. For this reason, it could be argued that the G-20 countries are the right sample in terms of obtaining effective results and the analysis method. Dumitrescu Hurlin (2012) is a causality test that produces effective results by ignoring whether the time dimension is larger or smaller than the cross-sectional dimension. In Table-9, the test results regarding the causality from macro-economic factors to financial fragility and the causality from financial fragility to macro-economic factors are given.

Table 9

Bidirectional Causality Test Results

Aspect of Causality	Panel Zwald	Panel Zwtilde	Aspect of Causality	Panel Zwald	Panel Zwtilde
POP => FSI	2.985 (0.003)	1.776 (0.076)	**FSI => POP**	6.462 (0.000)	4.325 (0.000)
INF => FSI	2.289 (0.022)	1.267 (0.205)	**FSI => INF**	5.017 (0.000)	3.266 (0.001)
DYY => FSI	2.109 (0.035)	1.135 (0.257)	**FSI => DYY**	1.215 (0.224)	0.480 (0.631)
UNP => FSI	3.864 (0.000)	2.421 (0.015)	**FSI => UNP**	1.741 (0.082)	0.865 (0.387)
BLNC => FSI	0.152 (0.879)	-0.299 (0.235)	**FSI => BLNC**	2.945 (0.003)	1.747 (0.081)
DFCT => FSI	2.069 (0.039)	1.105 (0.269)	**FSI => DFCT**	3.401 (0.001)	2.082 (0.037)
DEPT => FSI	3.029 (0.002)	1.809 (0.070)	**FSI => DEPT**	5.652 (0.000)	3.731 (0.000)
EXIMP => FSI	2.557 (0.011)	1.463 (0.143)	**FSI => EXIMP**	0.123 (0.902)	-0.320 (0.251)

As seen in Table-9, it is seen that there is a bidirectional causality between financial fragility index and population growth rate as well as public debt. In addition, it has been determined that there is a one-way causality from the unemployment increase rate to the financial fragility index, from the financial fragility index to the inflation rate, from the financial fragility index to the current account balance, and from the financial fragility index to the budget deficit. The causality relationships stated

in Table 9 are valid for all G-20 countries which may pave the way for generalizations. However, the countries for which the models with causalities are valid are indicated in Table 10 for further interpretation. No country-based evaluation was made regarding the models for which a causality could not be determined in Table-9.

Table 10

Evaluation by Country

Country	Wald	p-val	Country	Wald	p-val
POP => FSI			FSI => INF		
United Kingdom	16.123	0.000***	China	2.781	0.095*
Indonesia	3.645	0.056*	Indonesia	8.458	0.004***
France	3.127	0.077*	South Africa	15.522	0.000***
Japan	3.284	0.070*	India	3.432	0.064*
Russia	3.234	0.072*	Saudi Arabia	6.303	0.012**
UNP => FSI			Türkiye	4.389	0.036**
Germany	9.058	0.003***	FSI => BLNC		
Brazil	15.641	0.000***	ABD	6.391	0.011**
China	3.105	0.078*	Argentina	6.437	0.011**
Italy	2.782	0.095*	Italy	3.064	0.080*
DEPT => FSI			Canada	10.026	0.002***
ABD	3.764	0.052*	FSI => DFCT		
Australia	4.077	0.043**	United Kingdom	3.902	0.048**
Brazil	11.774	0.001***	China	9.022	0.003***
China	7.922	0.005***	Indonesia	7.440	0.006***
FSI => POP			South Africa	4.150	0.042**
ABD	6.756	0.009***	South Korea	3.649	0.056*
Brazil	3.921	0.048**	Saudi Arabia	2.742	0.098*
China	5.211	0.022**	FSI => DEBT		
South Korea	7.857	0.005***	Argentina	2.792	0.095*
India	8.357	0.004***	Indonesia	5.265	0.022**
			South Africa	6.215	0.013**
			Russia	6.889	0.009***
			Saudi Arabia	13.112	0.000***

According to the results in Table-10, the countries where the population growth rate is the cause of financial fragility are the United Kingdom, Indonesia, France, Japan and Russia while the countries where the unemployment increase rate is the cause are Germany, Brazil, China and Italy. Finally, the countries where public debt causes financial fragility are the USA, Australia, Brazil and China.

The countries where financial fragility causes population growth rate are USA, Brazil, China, South Korea and India. The countries where it causes inflation increase rate are China, Indonesia, South Africa, India, Saudi Arabia and Türkiye. The countries where Financial Fragility Index (FFI) causes current account balance are USA, Argentina, Italy and Canada while the countries where FFI causes budget deficits are the United Kingdom, China, Indonesia, South Africa, South Korea and Saudi Arabia, and the countries where FFI causes public debt are Argentina, Indonesia, South Africa, Russia and Saudi Arabia.

In the light of the information presented in Table-9 and Table-10, the causality between macroeconomic factors and financial fragility of countries was analyzed for G-20 countries. The interpretations of the findings obtained in this regard are discussed in detail in the conclusion section.

Conclusion and Evaluation

According to the financial instability theory of Fisher and Keynes, financial fragility, debt and financing of investments cause instability. Later, Minsky developed this theory further in 1977 and argued that fragility is due to the nature of modern capitalist economies that rely heavily on borrowing to finance investments. In general, financial fragility is defined as the possibility of economy being affected when exposed to sudden shocks.

Financial fragility, which was frequently mentioned along with the Asian Crisis (1990), was brought to the agenda again in 2013 in the case of "Fragile Five" when FED's decision to end bond trading caused emerging economies to experience sudden declines in the shares of companies, devaluation of currency etc. Due to the sudden crises experienced in the countries, the fragility indicators used to determine the resilience of the economies came back to the agenda which caused panic in the countries; consequently, sudden capital outflows were observed (Boğa, 2012; 35).

In the literature review, it is seen that financial fragility is generally used

to predict crises. In this study, an estimation was made regarding which macro-economic indicators affect the financial fragility of G20 economies. Unemployment rate, growth rate, inflation rate, export-import coverage ratio, CDS premiums, CPI, GDP, budget deficits of countries, foreign direct investments and real interest rates were used as control variables.

According to the results of Dumitrescu Hurlin Panel Causality analysis employed in the study, it is seen that there is a bidirectional causality between financial fragility and population growth rate as well as public debt. In general, countries with a high level of welfare have experienced an increase in population due to refugees in recent years. This situation has caused multiple problems as countries have spared some of their financial resources countries allocate some of their financial resources for refugees. In particular, the care, housing and employment costs of refugees directly affect the financial fragility of countries. The G-20 countries whose population growth rate is the cause of financial fragility are the United Kingdom, Indonesia, France, Japan and Russia. The countries where financial fragility affects the population growth rate are the USA, Brazil, China, South Korea and India. Countries whose population growth rate is the cause of financial fragility need to take political measures by reviewing their population growth and registered and unregistered immigration policies. Increasing public debt due to domestic and foreign debts in G-20 countries also increases the financial fragility of countries. The countries where public debt is the cause of financial fragility are the USA, Australia, Brazil and China. In these countries, the effect of public debt on financial fragility can be brought under control with strict measures to be taken regarding borrowing. The countries that cause financial fragility and public debt are Argentina, Indonesia, South Africa, Russia and Saudi Arabia. As the measures to prevent financial fragility are increased in these countries, it is predicted that there will be indirect decreases in domestic and foreign borrowings and the public debt will decrease accordingly.

Regarding the one-way causality relationships, it is seen that the unemployment rate is the cause of financial fragility. Countries whose unemployment rate casuses financial fragility are Germany, Brazil, China and Italy. Unemployment has become an increasing problem, especially in developed countries. Both the countries that have difficulties in creating employment and the increase in the unemployed population along with waves of migration in recent years have started to challenge the countries economically. In these countries, policies can be developed to employ people with labor force potential through new investments.

In addition, the effects of unemployment rate on financial fragility can be reduced by the measures to be brought to the entry of undocumented immigrants and ensuring safe ways for their return.

One of the findings of the study is that financial fragility causes inflation. It was concluded that financial fragility is the cause of inflation in China, Indonesia, South Africa, India, Saudi Arabia and Türkiye, which are among the G-20 countries. Inflation is one of the major macroeconomic factors that weakens economies and the purchasing power of households in both developed and developing countries. Financial fragility is not dependent on only one factor. On the contrary, many factors can affect or be affected by financial fragility. For this reason, financial fragility should not be considered as a single factor regarding inflation control. For inflation control, it is necessary to examine the factors that cause financial fragility. In general, it could be argued that inflation rates increase in countries with high financial fragility. The findings obtained from the study support this result.

Another macroeconomic variable caused by financial fragility is the current account balance variable. In general terms, it refers to the balance between the incomes and expenditures of the countries from current transactions. Among the G-20 countries, the countries where financial fragility causes current account balance are USA, Argentina, Italy and Canada. One of the most important factors forming the current account balance is the balance of imports and exports. Financial fragility negatively affects both imports and exports of countries. When financial fragility cannot be controlled, the current account balance may deteriorate in the context of imports and exports. The last macroeconomic variable to be caused by financial fragility is the budget deficit. In general terms, it means that the budget expenditures of the countries are higher than the budget revenues. The UK, China, Indonesia, South Africa, South Korea and Saudi Arabia are among the G-20 countries where financial fragility is the cause of the budget deficit. Countries opt for borrowing or printing money in order to cover their budget deficits which affects the country's economy negatively. Efforts to improve financial fragility will indirectly affect budget deficits positively. For this reason, the administrative authorities' policies to reduce their financial fragility in general, rather than only focusing on improving budget deficits, will lead to the improvement of both budget deficits and other macroeconomic factors that create negative effects.

In conclusion, instead of separate intervention to the broad scope of

macroeconomic factors by executive authorities, the development and implementation of policies to reduce their financial fragility will also allow the macroeconomic factors with negative effects to improve. It is thought that the study will be an important source for other studies that will be enriched and contribute to the literature in the future in terms of time series and variables used. In addition, in the light of the findings obtained, the study presents a comparison data among the studies to be carried out with other country groups such as G-20 countries.

Declaration

In all processes of the article, TESAM's research and publication ethics principles were followed.

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