World Economy Brief

August 3, 2022 | Vol. 13 No. 28 | ISSN 2233-9140

Decoding Financial Crises: Analyzing Predictors and Evolution

Young Sik JEONG Senior Research Fellow, Int'l Finance Team, Int'l Macroeconomics and Finance Dept. (ysjeong@kiep.go.kr)
Yaein BAEK Associate Research Fellow, Int'l Macroeconomics Team, Int'l Macroeconomics and Finance Dept. (yibaek@kiep.go.kr)

I. Introduction

Since 2022, global financial turmoil has been recurring. The prices of various assets, including stocks, bonds, digital assets, and real estate, plummeted in 2022. Amid heightened market volatility, UK pension funds faced a liquidity crisis, and vulnerable emerging markets such as Argentina, Sri Lanka, Egypt, Lebanon, and Pakistan faced currency crises.

Although the pattern is different, financial instability continued in 2023. In the U.S., Silicon Valley Bank (SVB) and First Republic Bank, as well as Signature Bank and Silvergate Capital, which specialize in virtual assets, went bankrupt or were shut down by U.S. regulators due to a liquidity crisis. The repercussions of financial instability spread around the world, and Switzerland's second largest investment bank, Credit Suisse Group (CS), also faced a liquidity crisis. Eventually, CS was sold to UBS as the Swiss policy authorities intervened.

Therefore, we examine factors that predict financial crises and the evolution of financial crises using non-traditional methodologies such as machine learning and system dynamics. These methodologies can better reflect real-world situations, including heterogeneity, bounded rationality of economic agents, and nonlinearity of system dynamics. Based on this analysis, we diagnose the current situation, identify potential risk factors, and present policy implications.

II. Machine Learning Analysis of Financial Crisis Predictors

We use machine learning techniques to examine which factors are important in predicting financial crises. Specifically, machine learning methodologies such as regression tree, random forest, and CRAGGING are used as models to predict the occurrence of financial crises in 18 countries from 1870 to 2017 based

on the Jorda-Schularick-Taylor (JST) Macrohistory Database. The predictors consist of a total of 12 macroeconomic and financial indicators[1], and the contribution of each predictor is measured using the Shapley additive explanations method.

For the entire period (1870-2017), our random forest model shows that the top six most important predictors are the slope of the yield curve, the CPI, consumption, the debt service ratio, equity return and public debt. According to our analysis, the recent developments of these six predictors indicate an increase in the likelihood of a financial crisis (Table 1).

Recently, major countries are showing inverted yield curves and the CPI recorded its largest increase in 40 years since the 1980s. In addition, the slowdown in consumption, the increase in the debt service ratio, the decline in stock prices, and the high level of government debt are also factors that indicate the possibility of a financial crisis.

In the case of the global financial crisis (2007-2008), the most important factors are the slope of the yield curve, the debt service ratio, consumption, the CPI, public debt and return on equity, in order of their contribution to the pre diction. Compared to the whole period, the ra-

Table 1. [Random Forest] Ranking of predictors' Shapley Values

The Rankings	Entire period (1870-2017)	Global Financial Crisis (2007- 2008)	Nordic Banking Crisis (1988-1993)
1	The slope of yield curve	The slope of yield curve	The slope of yield curve
2	CPI	Debt service ratio	CPI
3	Consumption	Consumption	Debt service ratio
4	Debt service ratio	CPI	Consumption
5	Equity return	Public debt	Equity return
6	Public debt	Equity return	Public debt
7	Investment	Credit	Broad money
8	The slope of global yield curve	The slope of global yield curve	Investment
9	Credit	Global credit	Credit
10	Broad money	Broad money	Current account
11	Global credit	Investment	The slope of global yield curve
12	Current account	Current account	Global credit

Note: All 18 countries are analyzed for the entire period (1870~2017). For the global financial crisis (2007~2008) and the Nordic banking crisis (1988~1993), countries that experience crises during those periods are analyzed.
Source: Author's calculation based on the Jordà-Schularick-Taylor Macrohistory Database.

[1] Credit, debt service ratio, CPI, consumption, investment, public debt, broad money, current account, the slope of yield curve, equity return, global credit, the slope of global yield curve.

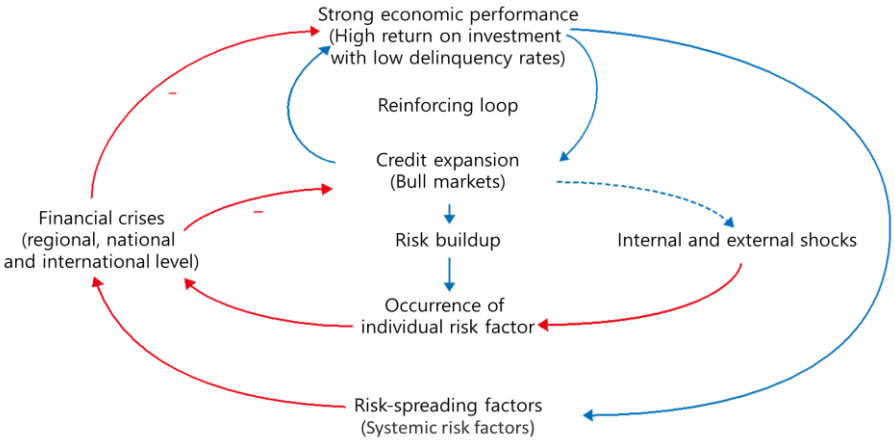
nkings of the debt service ratio and public debt have increased (Table 1).

In predicting the Nordic banking crisis (1988-1993), the slope of the yield curve slope, the CPI, the debt service ratio, consumption, equity return and public debt are important and the contribution of the debt service ratio has increased. Therefore, the recent global inflation suggests that the future financial crisis may be closer to the Nordic crisis than to the global financial crisis (Table 1).

III. Understanding the Evolution of Financial Crises through System Dynamics

System dynamics employs a holistic and causality-driven approach to describe and understand the relationship between components or variables within a system that influence it internally or externally.[2] In other words, it offers the advantage of deriving financial crises from feedback loop structures that exist between system factors, rather than focusing solely on individual factors. This study first establishes an archetype for a causal loop diagram of financial crises (Figure 1) and then defines the variables and system structures related to financial crises, and based on this archetype, constructs causal loop diagrams for major financial crisis cases that have occurred since 1970. The financial crises cases analyzed include the oil crisis in the 1970s, the Latin American debt crisis in the 1980s, the bubble burst in Japan and the Nordic banking crisis in the 1990s, the financial crises in Mexico and Asia, the global financial crisis in the U.S. in the 2000s, and the financial crises in emerging economies in the late 2010s.

Figure 1. An Archetype for A Casual Loop Diagram of Financial Crises



Note: The blue color represents the channel that occurs before the internal and external shock, while the red color represents the channel that occurs after the internal and external shock.
Source: Authors.

[2] https://www.uib.no/en/rg/dynamics/39282/what- system-dynamics

As a result of examining various past financial crisis cases using a system dynamics approach (causal loop diagram), five common characteristics have been identified, even though the manifestations of financial crises differ in each case (Table 2). The first characteristic is a feedback loop that reinforces credit expansion. A combination of monetary easing policies and various factors leads to the expansion of credit. As this expansion is further coupled with successes such as high growth, rising asset prices, increased profits for financial institutions, and stable currency values, a feedback loop structure emerges that supports the continuous expansion of credit (Table 2).

Next, a feedback loop that reinforces credit expansion leads to the accumulation of financial crisis risk. Specifically, at the national level, high inflation, fiscal and current account deficits, currency overvaluation, and external debt expansion occur. At the financial institution level, there are maturity and currency mismatches, increased investment in high-risk assets, and increased lending to groups with low credit (Table 2).

Third, there is the shock that triggers the financial crisis. While a tight monetary policy is the main factor, various policy and institutional changes (e.g., the policy shift from monetary targeting to inflation targeting), major political and economic events (e.g., German reunification, the dissolution of the Soviet Union, political unrest in Mexico), and changes in investment behavior (e.g., speculative attacks by hot money, falling natural resource prices) also act as triggers for these crises (Table 2).

Fourth, there are risk-spreading factors. The degree of spread for each financial crisis depends on the level of risk spreading factors, which include the connectivity of networks and the synchronization of actions among economic agents, such as financial firms and countries. In addition, the degree of spread of a financial crisis differs depending on whether a financial crisis has occurred in a global money-supplying country such as the U.S. and the U.K. or not (Table 2).

Lastly, individual financial crises do not end in themselves but have the common characteristic of becoming the seeds of new crises. Previous cases illustrate how new crises were conceived in the aftermath of the financial crisis or in policy responses to overcome the financial crisis. These include changes in monetary policy (e.g., a policy shift from monetary tightening to monetary easing), asset prices (e.g., rising stock and real estate prices), fund management behavior (e.g., expansion of credit and investment in new regions and industries, a shift from corporate loans to household loans), or shifts in the economic structure (e.g., a widening current account deficit due to ultra-high interest rates and the strong U.S. dollar) (Table 2).

An assessment of the recent situation based on these five common characteristics suggests that the risk of a financial crisis is rising. This is due to the fact that shocks, such as monetary tightening in major countries and escalating

geopolitical risks that can trigger a financial crisis, are adding to the accumulation of risks. These risks include the overheating in various asset markets, the pursuit of leverage-based high returns, and the deterioration of the current account balance and external debt of resource-importing countries (Table 2).

Due to the structural changes that have occurred since 2008, such as deglobalization, low growth in the Chinese economy, high inflation, a noticeable increase in the size of non-banking and capital markets, and digital asset bubbles, it is likely that any future financial crisis will be different from those of the past. In particular, with respect to the financial system, the risk of a financial crisis stemming from market risk rather than credit risk, which was one of the key risks of the 2008 global financial crisis, has increased. In addition, with respect to cross-country capital flows, the risk of a financial crisis through portfolio investment is now greater than it was in the past.

IV. Conclusions and Policy Implications

The study draws two conclusions. First, the financial crisis is a systemic problem rather than an individual risk factor. Second, in diagnosing the recent situation, the results point to the risk of the financial crisis spreading beyond a few vulnerable emerging markets and the failure of several financial firms in developed countries.

These findings lead to the following three policy implications. First, since the essence of a financial crisis is systemic collapse, policymakers need to strengthen their systemic approach. This is because without a systemic approach, it is difficult to effectively manage all processes of crisis management, such as risk diagnosis, prevention, shock mitigation, and post-crisis management.

Second, as the risk of a financial crisis has increased recently, it is necessary to identify vulnerabilities at the systemic level and seek ways to mitigate them. Asset bubbles in areas such as stocks, bonds, real estate, or crypto assets, along with highly leveraged derivative financial products traded under prolonged periods of ultra-low interest rates, high volatility of natural resources prices, and portfolio investment channels among cross-border capital flows, are being identified as the representative vulnerability factors. Therefore, the management and supervision of these vulnerable factors should be strengthened.

Lastly, combining machine learning and system dynamics methodologies with traditional statistical techniques has great potential for improving financial stability in Korea. Existing financial risk monitoring indicators using traditional techniques in Korea include the Systemic Risk Assessment Model for Macroprudential Policy (SAMP), an early warning system, financial stress index, the financial vulnerability index, and the financial stability index.

Table 2. Major Financial Crisis Cases and Current Situation Based on the System Dynamics Analysis Framework

Category	Latin American Foreign Debt Crisis (early 1980s)	Banking Crisis in the Nordic · Japan (early and mid-1990s)	Asian Financial Crisis (1997)	Global Financial Crisis (2008)	Recent (2022)
Credit Expansion Loop	· Oil Money (Petrodollars) · Expansionary monetary and fiscal policy in the U.S. · Financial liberalization in developed countries · Latin America: Promote economic development plan	· Plaza Accord (1985) · Sharp base rate cuts, boosting the domestic economy · Financial liberalization · Bull markets in stock and real estate	· Global funds exploring new investment opportunities · Boosting trade and financial liberalization · Convenient access to low-interest funds abroad	· Low global inflation (China's role as deflator) · Continued monetary easing in the U.S, etc. · The spread of fintech and securitization · Rising household debt increases in the U.S. etc.	· Continued global monetary and fiscal policy easing · Continued ultra-low interest rates · Expansion of capital inflows into emerging markets
Economic Performance	· Latin America: High economic growth · Developed countries: High profits and rapid expansion of financial firms	· The Nordic · Japan: High economic growth, wealth effect, high profits of financial firms · Japan: Exporters overcome yen appreciation through FDI	· High economic growth · Strong profits for financial firms · Stable currency values	· High growth in developed and emerging economies · Strong financial firm profits · Stable currencies in emerging markets	· Economic recovery · Rising prices of all assets including real estate, crypto coins, and stocks · High economic growth in natural resource-exporting countries
Risk Buildup	· Developed countries: Rising inflation, fiscal account deficits · Latin America: Current account deficits, currency appreciation, external debt expansion	· The Nordic · Japan: A surge in stock and real estate prices, sharp rise in financial firm, corporate, and household debt · Nordic countries: Current account deficits · Japan: Sustained current account surpluses	· Increased lending to high-risk, low-credit borrowers · Maturity and currency mismatches · Expansion of short-term external debt · Currency overvaluation, current account deficits	· Housing bubble, increase in mortgage lending to low-credit borrowers in the U.S. etc. · Emerging markets: currency overvaluation, current account deficits, and expansion of short-term external debt	· Overheating of all asset markets · Pursuit of leverage-based high returns, and deterioration of the current account balance and external debt of resource-importing countries · High global inflation
Risk-Spreading Factors	· Latin America: Massive public debt · Financial institutions in developed countries: High share of South American loans in total loans	· Financial firms: High proportion of real estate loans in total loans · Households, Corporations: High share of real estate holdings	· High share of short-term external debt in total external debt · South Korea: Commercial bank's guarantee for corporate bond issuance,	· Financial firms' high exposure to housing and housing-related products · Strengthen linkage between financial companies through	· The extent of the financial crisis contagion depends on the size of the highly leveraged financial sector and whether a crisis occurs in a ma-

			Korean government support for commercial banks in foreign exchange	ABS and financial derivatives · High ratio of non-deposit liabilities to total bank liabilities · High share of short-term external debt in total external debt	jor money-supplying country such as the U.S., U.K., etc.
Triggers	· Second oil shock · Implementation of monetary targeting (soaring interest rate)	· A steep rate hike after German reunification, dissolution of the Soviet Union · The Nordic · Japan: Rising interest rate	· U.S. policy rate hikes (1997) · Speculative attacks by hot money	· U.S. policy rate hikes ⟶ falling house prices ⟶ bankruptcy of mortgage lenders and investment banks	· Sharp tightening of monetary policy in the U.S. and other countries · Increased geopolitical risk

Source: Authors. KIEP