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Exploratory Scenario Analysis Considering the Growing Presence of Domestic and Foreign Investment Funds

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Exploratory Scenario Analysis Considering the Growing Presence of Domestic and Foreign Investment Funds*

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Abstract

Central banks around the globe have increasingly incorporated the NBFI (Non-Bank Financial Intermediary) sector into their stress testing exercises, including exploratory scenario analyses, reflecting its growing importance in recent years. This paper outlines the methodology used to develop the scenario for the exploratory analysis presented in the Financial System Report (April 2025) issued from the Bank of Japan, which explicitly examines the impact of stress amplified by investment funds on Japanese financial institutions. The scenario considers a case in which investment funds, predominantly open-end funds, liquidate their securities holdings in response to a negative shock in the global financial market and the real economy, similar to what happened during the Global Financial Crisis. The negative shock is amplified through three primary channels: (i) a further decline in asset prices, (ii) a deeper slowdown in the real economy triggered by the asset price decline, and (iii) impairments of investments and loans to overseas funds. The resulting amplifying impact on the capital adequacy ratio by the end of the simulation period (end of FY 2027) is approximately a 1 percentage point reduction for IABs (internationally active banks). The increase in credit costs, stemming from the deterioration of the real economy, broadly reduces the ratio across all banks, while the declines in asset prices and impairments of investments and loans also contribute to the decrease for IABs. Immediately following the onset of stress, the sharp decline in asset prices exacerbates the valuation gains and losses of securities. It is notable, however, given limited data and research available on the NBFI sector, including open-end funds and hedge funds and their potential ripple effects on the broader financial system, our findings should be considered exploratory. They are based on a certain set of assumptions and therefore warrant careful interpretation.

JEL classification: G12, G15, G17, G21, G23.

Keywords: *global investment funds, stress tests, price elasticity.*

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1. Introduction

Stress tests have been used since the 1990s as a tool to evaluate the adequacy and robustness of financial institutions' capital under stressed conditions, primarily for internal risk management purposes.[1] Following the Global Financial Crisis (GFC), the deterioration of the financial market environment in the United States and the stagnation of financial intermediation underscored the importance of stress tests. These tests gained recognition as a critical tool for evaluating the vulnerabilities of financial institutions and improving their ability to withstand financial shocks. This growing recognition has led to their widespread adoption by financial supervisory authorities, central banks, and international organizations globally, as well as a continuous evolution of the stress testing methodologies. The Bank of Japan (BOJ) conducts macro stress tests to assess the stability of the Japanese financial system as a whole, and publishes the results in the semi-annual "Financial System Report" (FSR), released every April and October.

There is broad consensus that stress test scenarios should involve a "severe but plausible" macroeconomic shock (Adrian et al., 2022; Greenlaw et al., 2012; Basel Committee on Banking Supervision (BCBS), 2009). Although the likelihood of such an event occurring is low, it represents a potential tail risk that could have a significantly negative impact on the financial system if it were to materialize. In practice, when quantifying these scenarios, historical events, such as the GFC or pandemics, are often referenced,[2] and scenarios assuming a similar magnitude of deterioration in the real economy and decline in asset prices are considered. These scenarios are then used to assess the capital adequacy of banks and the resilience of the banking sector, whether at the global or the national level.

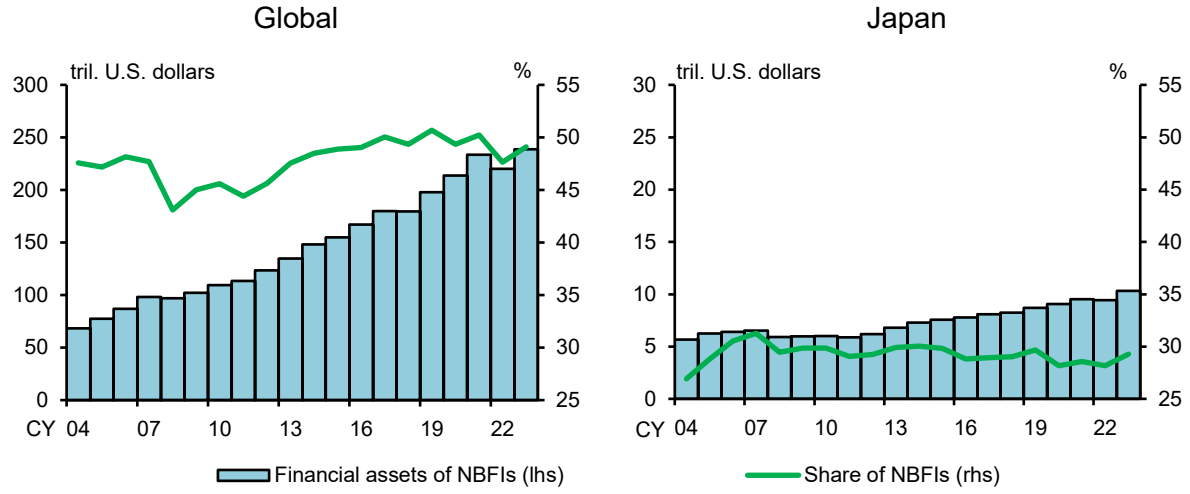
In addition to traditional stress tests which focus exclusively on the banking sector, stress tests and analyses explicitly accounting for the impact of the non-bank sector have increasingly been conducted in recent years by central banks abroad. This shift has been driven by the expansion of the NBFI sector following the GFC, which had temporarily contracted but has since grown once again (IMF, 2023; BOJ, 2025; see Figure 1). For example, the Federal Reserve Board (FRB, 2025) has employed a stress test framework to conduct "exploratory analysis," which assumes the default of the five hedge funds most exposed to each bank, to assess the impact. Similarly, the

[1] The history of stress tests and the methods for scenario setting are described in Adrian et al. (2022) and Baudino et al. (2018). See Anderson et al. (2018), Aymanns et al. (2018), and Greenlaw et al. (2012) for surveys of stress tests conducted in various countries.

[2] For example, BOJ (2021) conducted stress tests by setting a downside scenario that assumed the resurgence of the pandemic. Baudino (2020) provides a review of stress tests conducted by central banks considering the impact of the pandemic.

European Central Bank (ECB) has advanced related research, incorporating a theoretical model to capture the amplification mechanisms of the NBFI sector (Sydow et al., 2024). Furthermore, the Bank of England (BOE, 2024) conducted a System-Wide Exploratory Scenario Exercise (SWES), in which both banks and NBFIs participated. The primary aim of this exercise is to examine the impact on the overall liquidity of the financial system, especially during the early stages of stress. These efforts are referred to as exploratory analyses because, while there is a growing recognition of the need to understand the impact of the expanding presence of the NBFI sector on the economy and financial markets, there are no past stress events readily available that can be used for reference. As a result, understanding the comprehensive mechanisms at work and quantifying their impact are challenging.[3] The purpose of these exploratory analyses is to enhance understanding of the overall stability of the financial system, rather than directly assess individual banks' capital requirements. Moreover, when accounting for the NBFI sector, the scope and methodology vary considerably, reflecting differences in the significance of the NBFI sector and data availability across jurisdictions. These variations can lead to different test designs (see Chapter 2).

Figure 1: Asset size of the NBFI sector



Note: Indicates the share of NBFIs within the financial sector. Latest data as of 2023. The Financial Stability Board defines NBFIs as various types of financial entities, composed of all financial institutions that are not depository financial institutions, central banks, or public financial institutions.

Source: FSB; BOJ.

[3] Exploratory analyses have also been conducted for purposes other than estimating the impact of the NBFI sector. Two examples are the analysis conducted by the Bank of England (BOE) on the effects of low growth and low interest rates on banks' revenue bases and the analysis of climate change risks (BOE, 2017; BOE, 2022).

In the April 2025 issue of the FSR, the BOJ conducted a stress test that explicitly took into account the NBFI sector. The scenario incorporated the amplification mechanisms of shocks originating in investment funds to assess the capital resilience of financial institutions, with the results published as an exploratory analysis.[4] This analysis incorporates the growing interconnectedness between the domestic banking sector and foreign NBFIs (BOJ, 2025), utilizing highly granular data on open-end funds to capture the amplification effects of shocks originating abroad. In particular, the scenario was designed to model asset price declines resulting from the sale of securities held by open-end funds and how these declines are propagated through the deterioration of the real economy. The use of the FRB/US model (Brayton et al., 2014), a macro-econometric model developed by the FRB, alongside the BOJ's Financial Macro-econometric Model (FMM), enabled the integration of asset prices and the real economy in formulating scenarios. This approach represents a notable contribution compared to previous studies.[5] This paper provides a detailed explanation of the mechanisms underlying the scenario and its assumptions, along with an interpretation of the results.

The mechanisms assumed in this exploratory analysis are as follows. First, a significant adjustment in the global financial economy, of a magnitude similar to that observed in the GFC, is assumed to occur in international financial markets. Simultaneously, large-scale redemptions are assumed to take place in investment funds, particularly open-end funds.[6] As a result, these investment funds are compelled to sell their holdings of securities, particularly those that are illiquid. This leads to a sharp decline in prices and triggers a negative feedback loop, including a deterioration in investment performance, an increase in redemptions, and asset sales due to liquidity shortages. Moreover, the substantial decline in asset prices due to these sales is assumed to exacerbate the downturn in the real economy.[7] Additionally, the analysis assumes that the drop in the prices of overseas funds in which Japanese financial institutions have invested, combined with an increase in default rates, will lead to investment losses and higher credit costs.[8]

[4] The simulation utilizes the Financial Macro-econometric Model (FMM) developed by the Financial System and Bank Examination Department of the Bank. For the basic structure of the model, see Abe et al. (2023).
[5] Acharya et al. (2024a) highlight that the interconnectedness between banks and the NBFI sector can further slow the real economy down during periods of market stress. They emphasize that a comprehensive understanding of these stress transmission mechanisms is crucial for effective financial regulation and monitoring of systemic risks.
[6] The expansion of the presence of open-end funds and the implications for financial stability have been discussed by Eguchi et al. (2025), among others.
[7] Gilchrist et al. (2009) use corporate bond data to argue that shocks in the corporate bond market (after removing factors such as bond spreads, stock market factors, and macroeconomic factors like GDP and inflation) have a significantly persistent negative impact on production activity.
[8] Recent trends in financing of investment funds and the risk characteristics associated with such financing arrangements are discussed in Box 3 of Bank of Japan (2025) and in Kaneguchi et al. (2023).

When quantifying the magnitude of shocks, it is assumed that open-end bond funds, particularly those that experienced large-scale capital outflows globally in March 2020 during the pandemic, sell off their bond holdings, further driving the decline in asset prices.[9] The extent of this decline in asset prices is calculated by multiplying the volume of sales by the price impact, which represents the price drop for each unit sold of similar bonds. For the volume of asset sales, the analysis refers to the sales observed during the GFC, while also considering the steady growth in the global holdings of bond funds since 2009. The scale of bond sales during the stress scenario is adjusted in proportion to the rise in holdings from the GFC to the start of the simulation (September 2024). Regarding the price impact, the price fluctuation per unit of transaction increases due to reduced market liquidity in a stressed financial market. Additionally, for risk assets other than bonds, it is assumed that prices decline in line with the specific characteristics of each asset type and that the dollar funding cost rises under conditions of heightened market volatility.

The magnitude of the further slowdown in foreign economies is estimated using the FRB/US model, a large-scale macroeconomic model developed by the FRB, to project the impact on the real economy when prices of risk assets change. For the Japanese economy, the magnitude of the slowdown is estimated endogenously within the Financial Macro-econometric Model (FMM) using the relationships between these variables and domestic GDP and considering changes in both domestic and foreign financial environments as well as foreign economies.[10] This approach captures the mechanism in which an increase in US corporate bond spreads, coupled with a decline in other asset prices, resulting from the sale of bonds by open-end funds, reduces US corporate investment sentiment and depresses personal consumption. This, in turn, weakens the foreign economy, leading to a contraction in the Japanese economy as well.

The decline in asset prices, along with the corresponding drop in fund prices, results in losses on investments in funds.[11] Additionally, in the case of loans to foreign funds, some investment

[9] The impact of asset sales by open-end funds on asset prices has been estimated by studies such as Cetorelli et al. (2016) and Fricke and Fricke (2021). This paper sets the magnitude of the asset price decline following the methodology of these studies.

[10] When estimating the extent of the slowdown in Japan's real economy using the FMM, the linkages with the US real economy through trade and other channels, as well as the impact of global financial markets on the Japanese economy, are formulated based on the historical relationships among these variables. Note that the results do not change significantly even when the estimation period is altered, indicating that the relationships among the variables remain stable.

[11] Fund prices generally depend on the value of the companies in which the funds invest. In this analysis, the decline in the price of funds linked to specific securities is determined based on the price decline of related securities, while for funds investing in companies, the decline is assumed to be based on the extent of the slowdown in the real economy (see Section 3 for details).

funds increase their borrowing duration and expand their leverage. In this context, when unexpected negative shocks occur in both the domestic and foreign economies, credit costs are expected to rise due to the increased default probability in some high-credit-risk loans.

The simulation results, which take into account the amplification mechanism through investment funds, suggest that for international active banks (IAB), the capital adequacy ratio would decline by approximately 1 percentage point by the end of the simulation period (end of fiscal 2027, three years after the onset of stress). This reduction is primarily driven by the valuation gains and losses on securities due to the additional decline in asset prices. Furthermore, the high exposure to overseas markets leads to an increase in credit costs related to loans to some foreign funds, as well as a rise in dollar funding costs, both of which also contribute to the reduction in the capital adequacy ratio. Additionally, across all banks, the slowdown in the domestic economy leads to a deterioration in the interest coverage ratio (ICR) of the borrowing companies, which increases credit costs. In contrast, for domestic banks (including *shinkin* banks), the reduction in the capital adequacy ratio at the end of the simulation period is limited compared to IABs.

In terms of short-term dynamics, under this scenario, the rise in long-term interest rates and corporate bond spreads reach their peaks in the period of April to June 2025, reflecting the movements of financial variables during the GFC. This is also the period in which the decline in the prices of risk assets, such as stocks, is also the largest. While it is assumed that asset prices gradually return to pre-shock levels in the latter half of the simulation period, the valuation gains and losses on securities temporarily worsen markedly at the point of highest volatility in the financial markets. When comparing the valuation gains and losses on securities for risk assets in April-June 2025, the exploratory analysis indicates that the capital adequacy ratios are further reduced by approximately 1 percentage point for IABs and domestic banks (excluding *shinkin* banks), and by nearly 2 percentage points for domestic *shinkin* banks, when taking into account the shock amplification mechanism through investment funds.

However, regarding the impact of the NBFI sector, including investment funds, on global financial intermediation activities and the real economy, including Japan, the analysis is constrained by the limited frequency and granularity of data on the financial conditions and positions of the NBFI sector. This body of knowledge remains insufficient at this point.[12]

[12] Efforts to collect data related to the NBFI sector continue through standard-setting bodies and other entities. For example, the Global Monitoring Report on Non-Bank Financial Intermediation published by the

Furthermore, there are challenges in terms of the frequency and granularity of available data regarding the interconnections among these investment funds, as well as the multilayered credit and leverage exposure involving the insurance and pension fund sector, often referred to as the traditional non-bank sector, and the banking sector.[13] Therefore, when examining the results of the stress test in this paper, the results call for careful interpretation in terms of the quantitative magnitude and persistence, in addition to the potential for unconsidered transmission mechanisms that may not have been captured in the analysis.

The paper is organized as follows. In Section 2, we review the related literature and discuss our contribution. In Section 3, we explain the assumptions made when constructing the scenarios. Section 4 presents the results of the stress test. In Section 5, we conclude by summarizing the findings and discussing future challenges.

2. Related Literature

This paper builds on stress tests and related analyses conducted by central banks in Europe and the U.S. that explicitly consider the NBFI sector during times of stress (see Aikman et al. (2023) for a more detailed review). For example, the FRB has estimated the impact of the 2025 Dodd-Frank Act Stress Test for the banking sector in an exploratory analysis in two ways (FRB, 2025). Specifically, it assumes (i) stress on the NBFI sector as the borrower and estimates the impact on capital adequacy ratios through credit costs associated with downgrades, and (ii) a situation where hedge funds are unable to meet margin calls and calculates the potential losses assuming the default of the five hedge funds with the largest exposure for each bank. The ECB has also been conducting related research, using a model that incorporates the amplification mechanism of a shock through the interconnectedness between banks and the NBFI sector. Specifically, they incorporate the fire-sales of assets by funds when a negative shock hits financial markets (similar to the additional decline in asset prices assumed in this analysis). This model was used to set

Financial Stability Board (FSB) aggregates data on financial assets and liabilities, vulnerabilities, and interconnections with the banking sector within the NBFI sector (Oishi et al., 2025). The data are used in discussions within the FSB and the Basel Committee on Banking Supervision (BCBS) regarding the monitoring of financial institutions and financial regulations. Additionally, in Japan, the Financial Services Agency (FSA) publishes over-the-counter derivatives transaction data, and data collection efforts are also being conducted by authorities in various countries.

[13] The relationship between the NBFI sector and banks is not one of mutual independence. It is argued that both have evolved to become interconnected in order to minimize regulatory constraints and costs (Acharya et al., 2024b). Specifically, banks leverage their advantage in liquidity, stemming from access to household and corporate deposits as well as central bank reserve deposits, to provide liquidity to the NBFI sector. If the assets of the NBFI sector deteriorate, banks that have extended credit to this sector would also be affected.

scenarios where the real economy deteriorates due to the spread of an epidemic and the corresponding paper assesses the quantitative impacts of the amplification mechanism of the NBFI sector (Sydow et al., 2024). Furthermore, the ECB plans to consider counterparty credit risk to the NBFI sector in the 2025 stress test. The BOE has conducted the SWES, a stress test directly involving both banks and the NBFI sector, with results published in November 2024 (BOE, 2024).[14] In the SWES, the focus is on whether or not financial institutions can secure liquidity under conditions of capital outflows during periods of stress. Financial institutions were asked to provide their endogenous reactions to hypothetical stress in the financial markets. The test then assesses the impact on the overall liquidity of the financial system, incorporating the amplification of shocks by the NBFI sector.[15] Aikman et al. (2019), published as a working paper on the website of the BOE, constructs a model that incorporates the interactions among the banking sector, investment funds, hedge funds, insurance and pension funds, and financial markets (government bonds, corporate bonds, equities), as well as derivative markets and repurchase markets. The paper analyzes the trends in bank funding from financial markets during times of stress. As such, there is a wide range of analyses that consider the NBFI sector, conducted by foreign central banks, depending on their objectives, targets, and methods, due to the differing vulnerabilities they face. Compared to the research in this area, the exploratory analysis presented in this paper takes into account the credit costs related to loans to foreign funds, similar to the FRB's approach, as well as the asset price declines amplified by the sale of securities by investment funds. Notably, the contribution of this paper is that it explicitly considers the impact of asset price declines on the financial system through the deterioration of the real economy. On the other hand, this exploratory scenario does not explicitly incorporate the propagation of stress coming from the trading relationships of individual financial institutions or the interactions among different types of financial sectors, which are considered in FRB (2025), BOE (2024), and Aikman et al. (2019).

Another relevant body of related literature includes studies that quantitatively assess the impact of securities sales by investment funds on asset prices[16] in the aim of evaluating the resilience of

[14] See Benjamin (2025) for a history of stress tests conducted by the Bank of England (BOE) and background for implementing stress tests that consider the NBFI sector.

[15] Specifically, in the SWES, the focus is on whether financial institutions can secure liquidity during stress scenarios. The response to hypothetical stress in financial markets is surveyed from various financial institutions, including pension funds, insurance companies, open-end funds, hedge funds, and other non-bank financial institutions. Based on the responses, the SWES examines how the NBFI sector amplifies stress and assesses the overall impact on the financial system.

[16] The sale of securities held by the banking sector is analyzed by Greenwood et al. (2015). They propose a

financial institutions (Cetorelli et al., 2016; Gourdel et al., 2019; Fiedor et al., 2019; Fricke and Fricke, 2021; ESMA, 2019).[17] These studies assume exogenous negative shocks to the real economy or financial markets and quantitatively simulate their propagation mechanisms. Specifically, they assume the sale of securities held by financial institutions leads to a deterioration in the performance of investment funds, triggering redemptions in response to these shocks. Under this scenario, the depletion of liquid assets held by investment funds facing redemptions results in the sale of assets, causing a decline in the prices of these securities. This not only worsens the performance of the corresponding fund but also leads to a deterioration in the performance of other investment funds holding similar securities (second-round effects). For example, Cetorelli et al. (2016) analyze the impact of a +1% parallel shift in the U.S. yield curve on the performance of U.S. bond funds. They further examine the subsequent impact of asset sales by these funds on the prices of similar bonds. Additionally, Fricke and Fricke (2021) analyze the secondary impact on stock prices from the sale of assets by U.S. equity funds, assuming a 5% decline in the prices of individual U.S. stocks. Drawing upon the insights of these prior studies, this paper quantitatively assesses the amplification mechanism through the economic behavior of open-end funds. Regarding the interconnectedness between banks and the NBFI sector, Sydow et al. (2024) use highly granular supervisory data from the Euro area on each bank's exposure to the NBFI sector. They quantitatively assess the degree of impairment of bank investments and loans to investment funds. Figure 2 summarizes the key results of prior research as well as the results of this paper, outlining the target countries, the assumed exogenous shocks, the assumed fund outflows from investment funds, and the price impact assumptions used. Compared to prior studies, this paper does not use highly granular data for banks' exposures to the NBFI sector. However, this study employs aggregate financial information of individual banks and funds, calibrates the additional asset price declines resulting from asset sales by investment funds, and analyzes the impact on banks' securities valuation gains and losses and related profit and loss. Additionally, this paper incorporates the further economic slowdown that results from asset price declines, which is a major contribution.

model that considers a mechanism whereby banks, when incurring losses, are forced to sell assets, which in turn triggers fire sales of assets by other financial institutions.

[17] Empirical analyses of the impact of liquidity mismatches in open-end funds on asset price vulnerabilities include studies such as IMF (2022) and Jin et al. (2022). Using data from 17,000 open-end funds across 43 countries, IMF (2022) highlights that assets held by funds with low liquidity experience greater price volatility during market stress. Additionally, Jin et al. (2022) use transaction data from U.K. corporate bond funds and suggest that the introduction of swing pricing (a mechanism that charges investors for costs incurred when one side of the fund's transactions, either subscriptions or redemptions, significantly exceeds the other, in order to protect the interests of existing investors) reduces capital outflows during market stress.

Figure 2: Related literature estimating losses of financial institutions considering securities sales by investment funds

	This analysis	Cetorelli et al. (2016)	Fricke and Fricke (2021)	Aikman et al. (2019)	Sydow et al. (2024)
Target	Japan and U.S.	U.S.	U.S.	U.K.	E.U.
Shock	Shock similar to GFC	Parallel shift of U.S. yield curve	Decline in U.S. stock prices	Deterioration in corporate sector outlook	Deterioration of real economy due to pandemic
Assumption of redemption flows from funds	Redemption rate during GFC	Estimate based on the relationship between redemption rates and returns	Estimate based on the relationship between redemption rates and returns	Estimate based on the relationship between redemption rates and returns	Estimate redemption shocks using the model
Price impact	Liquidity measure	Estimate assuming linearity between transaction volume and price fluctuations	Liquidity measure	Liquidity measure	Estimated assuming a non-linear relationship between transaction volume and price fluctuations
Data	Financial data by bank and fund	Financial data by fund	Financial data by fund	Aggregated financial data by each sector	Financial data by bank and fund, and granular data on bank investments and loans to funds
Additional decline in real economy	✓	-	-	-	-

Note: 1. The table is based on Aikman et al. (2023), with the analysis in this paper added.
2. The liquidity measure in the table refers to the use of the measure proposed by Amihud (2002), the price change rate per unit of transaction, when estimating the asset price decline triggered by the sale of securities.

There is also related research on the expansion in size of investment funds in Japanese financial system (Hogen et al., 2025; Yamamoto et al., 2025). Hogen et al. (2025) demonstrate that the spillover effects of market shocks across jurisdictions and among asset classes have increased in financial systems in various countries, including Japan, by using a model of asset sales based on Greenwood et al. (2015) and currency in circulation statistics. Additionally, Yamamoto et al. (2025) use highly granular data on open-end funds to quantitatively discuss the characteristics of fund inflows and outflows, as well as the impact of their trading trends on Japanese financial markets. Compared to these previous studies, this paper analyzes the impact of the growing presence of investment funds on the robustness of the financial system using the framework of stress testing.

3. Scenario

This section explains the scenarios used in the analysis. In addition to the exploratory analysis, we provide an overview of the baseline scenario and financial stress scenario, which were used for benchmarking the exploratory analysis. In the baseline scenario, no stress is assumed in the economy or financial markets and simulations are conducted to test deviations of the downside

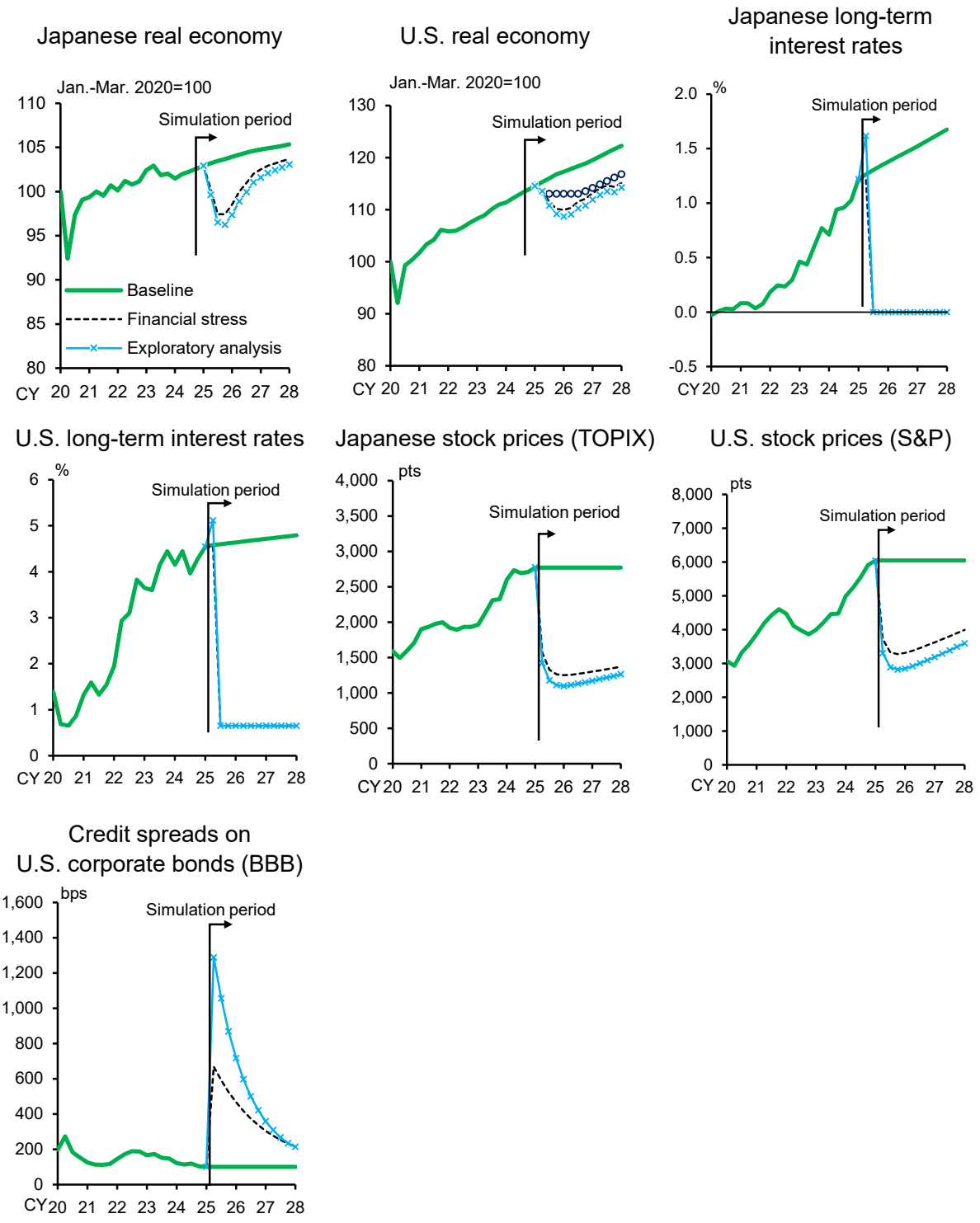
scenario. The financial stress scenario assumes a shock of a magnitude similar to the GFC in international financial markets. In the exploratory analysis, we explicitly incorporate the amplification mechanisms of shocks from both domestic and foreign investment funds into the financial stress scenario.

The analysis focuses on 107 banks and 247 *shinkin* banks, with the simulation period set from October-December 2024 to January-March 2028. In the financial stress scenario and the exploratory analysis, a significant negative shock in international financial markets is assumed to occur in April-June 2025. These assumptions are the same as those used in the macro stress test conducted by BOJ (2025).

3.1 Baseline Scenario

In the baseline scenario, the outlook for the real economy and financial variables is set based on the average of forecasts by research institutions and market expectations. It is assumed that Japan's economy and foreign economies continue to grow moderately based on forecasts from the Japan Center for Economic Research's "ESP Forecast Survey" and the IMF's "World Economic Outlook" as of January 2025. Interest rates are assumed to move in line with the forward rate curve derived from the yield curve as of the end of January 2025. It is assumed that other financial variables (stock prices, crude oil prices, exchange rate, and various credit spreads) are unchanged from their levels at the end of January 2025. Figure 3 shows the assumptions of each variable in the various scenarios.

Figure 3: Assumptions for economic and financial variables in each scenario



Note: Economic variables are indexed so that real GDP in 2020/Q1 is set to 100. Long-term interest rates are 10-year yields.

Source: BEA; Cabinet Office; FRB; IMF; Haver Analytics; ICE Data Indices. LLC; Japan Center for Economic Research; Ministry of Finance.

3.2 Financial Stress Scenario

The financial stress scenario, which is used in the FSR regularly, assumes that global financial markets experience a negative shock in the April-June quarter of 2025 comparable to that of the GFC, with prices of risky assets plummeting and domestic and foreign interest rates declining to record low levels (Figure 3).[18] The yen is assumed to appreciate by about 40 yen against the dollar compared to the baseline scenario, reflecting the exchange rate movement during the GFC. In addition, Japan's economy decelerates, reflecting the substantial repricing in financial markets and a slowdown in foreign economies similar to that seen during the GFC.

3.3 Exploratory Analysis considering the Growing Presence of Domestic and Foreign Investment Funds

We incorporate the amplification mechanism of shocks by the NBFI sector into the financial stress scenario. Given the recent expansion in the size of investment funds, this scenario assumes that a shock similar to the GFC, as outlined in the financial stress scenario, would be amplified by domestic and foreign investment funds. This analysis incorporates the following three additional mechanisms, as shown in Figure 4.

I. Negative shocks in the financial markets or real economy (such as a significant decline in asset prices or a sharp increase in corporate bankruptcies) trigger large-scale redemptions in domestic and foreign open-end funds. These redemptions force investment funds to sell their holdings of securities. In particular, the sale of illiquid assets leads to sharp price declines, creating a negative feedback loop of deteriorating performance of the funds, increased redemptions, and asset sales driven by liquidity depletion. As a result, the scale of asset sales becomes larger, causing asset prices to decline more sharply than during the GFC.

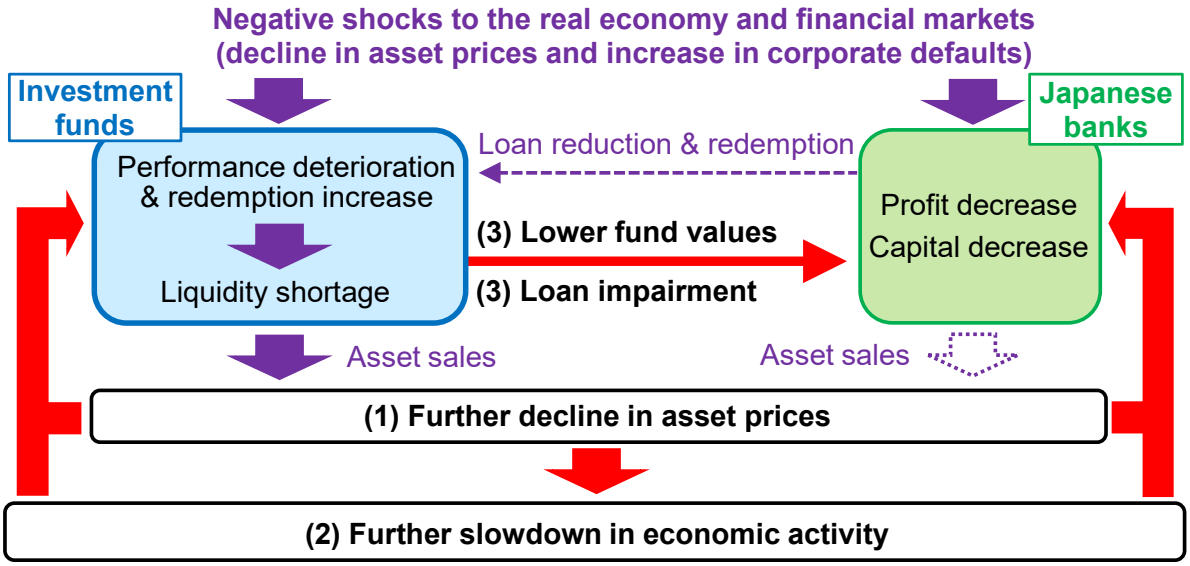
II. The additional adjustment in the financial markets lead to further deterioration of the real economy.

III. As asset prices fall and the real economy weakens, the performance of investment funds deteriorates, leading to a higher probability of default for foreign funds, particularly private

[18] Considering the possibility of long-term government bond sales during periods such as the GFC and the pandemic, the financial stress scenario assumes that long-term interest rates will remain at the same level as the previous quarter, from April to June 2025, with a decline in rates expected from July to September 2025 onward. Furthermore, the scenario assumes that long-term interest rates will reach the following levels: 0.7% in the U.S., which corresponds to the lowest level historically, and 0% for domestic long-term interest rates.

funds, that are financed by Japanese banks. This results in higher credit costs due to downgrades. Also, Japanese banks incur losses in the investment funds in which they invest.

Figure 4: Amplification mechanism of shocks by investment funds



Note: The mechanism represented by the dashed arrow is excluded from this analysis.

Impact of asset sales by investment funds on asset prices

We consider an additional decline in asset prices resulting from the sale of securities held during a stress event similar to the GFC. Given the recent expansion in the size of NBFI sector, this scenario assumes a more significant impact than the GFC. Since the GFC, the size of open-end bond funds has grown, as illustrated in Figure 5.[19] With the increased presence of open-end funds, there is a heightened risk that substantial redemptions could trigger the forced sale of assets (Oishi et al., 2025).[20] During the "Dash for Cash" in March 2020, for example, bond funds were particularly impacted, as growing concerns over the spread of the pandemic led to large-scale sales of securities. This, in turn, caused a rise in long-term interest rates, both in Japan and abroad, as well as an increase in U.S. corporate bond spreads, surpassing levels observed during the GFC.[21] From the perspective of implications for Japanese financial institutions, Koide, Hogen,

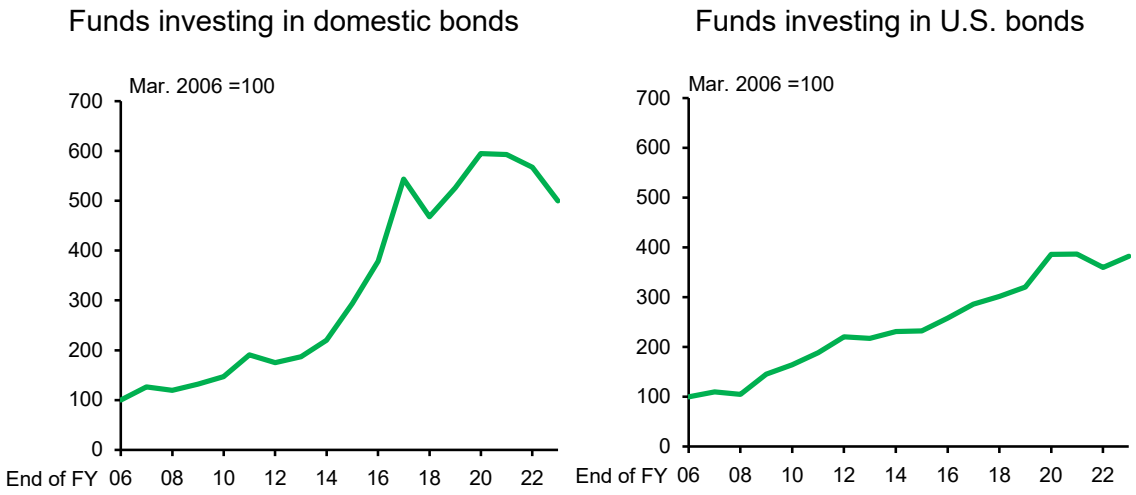
[19] Open-end funds face liquidity mismatches due to the possibility of capital outflows from investor redemption requests on the liability side, while on the asset side, some entities hold illiquid assets. In fact, during past periods of market stress, significant capital outflows, particularly from bond funds, have been observed (Claessens and Lewrick, 2021; FSB, 2022; IMF, 2022).

[20] The expanding presence of investment funds has also been attributed to the increased demand from investors due to changes in the financial environment. Kaufmann (2020) suggests that the pursuit of higher yields by investors, driven by accommodative monetary policies in the United States, has expanded the demand for investment in investment funds.

[21] The impact of liquidity depletion in the NBFI sector during the pandemic on financial markets has been

and Sudo (2022) point out that the correlation between the market value fluctuations of securities portfolios held by Japanese financial institutions and investment funds, especially bond funds, had been steadily increasing from the GFC to the period just before the market turmoil in March 2020. Furthermore, they highlight that financial institutions with a higher correlation prior to the market turmoil faced larger securities valuation losses during the market shock.

Figure 5: Trends in bond fund investments



Note: NAV as of March 2006 is set to 100. For investment trusts that invest in more than one country, the index is calculated by multiplying the percentage of investment in Japan and the United States by the total assets in the fund.
Source: LSEG Lipper.

The change in asset prices is estimated by multiplying the amount of asset sales by the price decline per unit of sales of similar bonds, assuming a shock similar to the GFC. In estimating the amount of assets sold, we incorporate the significant increase in the size of global bond funds since the GFC. This estimation is carried out in two stages: (i) the estimation of the amount of sales and (ii) the estimation of the price change.

The total amount of asset sales by investment funds is calculated by multiplying the average fund outflow rate during the GFC by the increase in total assets of investment funds from the GFC to September 2024. In other words, we subtract the actual sales amount during the GFC from the total asset sales calculated for a shock assumed in this analysis.[22] The amount of asset sales for

discussed in studies such as Eren et al. (2020), Czech et al. (2021), Huang and Takats (2020), and Huser et al. (2024).

[22] More specifically, the increase in interest rates is estimated by subtracting the asset size and price impact (maximum value) during the GFC from the product of the current asset size of investment funds and the price impact (maximum value). For example, for U.S. investment-grade corporate bonds, the price impact during the pandemic is higher than during the GFC. By using the above method, this approach not only takes into

each asset is estimated using the weights of long-term government bonds from Japan and the U.S., as well as U.S. corporate bonds, in the portfolio as of September 2024.[23]

The price change for each asset is estimated by multiplying the sales amount by the price impact, which is the price change rate per unit of transaction. Following Fricke and Fricke (2021) and Aikman et al. (2019), we use the illiquidity measure proposed by Amihud (2002) to estimate the price impact for each asset. The Amihud illiquidity measure is defined as the absolute value of the asset price change rate divided by the asset's trading volume. A higher value of the measure indicates greater illiquidity in the market. During periods of financial market stress, this measure tends to increase, meaning that the price change per unit of trading volume becomes larger. We calculate weekly illiquidity measures for long-term Japanese and U.S. government bonds, as well as U.S. corporate bonds. For the price impact for each asset, we use the maximum values observed in the financial markets so that we can consider the higher asset price volatility observed during financial crises.[24]

There is another approach to estimate price impact, based on past exogenous securities sales. Ellul et al. (2011) estimate the price impact of investment-grade bonds based on asset sales by U.S. insurance companies when their equity capital approaches regulatory levels. Based on such estimates, Greenwood et al. (2015) analyze the impact of securities sales by financial institutions on asset prices and their leverage. The method used in studies like Ellul et al. (2011) has the advantage of minimizing endogenous relationships between price and transaction volume. However, this study aims to estimate the non-linear increase in price impact during periods of financial market stress across various assets in Japan and the U.S. from a macro perspective. Therefore, the Amihud illiquidity measure, which is relatively easy to obtain, is used, following Aikman et al. (2019).

For the estimation of bond fund sales amounts, we use the LSEG Lipper database. This database provides data on fund flows and asset sizes for each investment fund. We use data of bond funds, which experienced capital outflows during the "Dash for Cash." Figure 5 shows the trends in asset

account the recent expansion in asset size, but also incorporates the fact that, for certain bonds, the price impact exceeds the level seen during the GFC, thus estimating an additional increase in interest rates.

[23] Following Fricke and Fricke (2021), in these estimates it is assumed that each investment fund will sell assets in proportion to the composition of its portfolio (vertical slicing) in response to outflows due to redemptions.

[24] In this analysis, following prior studies such as Cetorelli et al. (2016) and Fricke and Fricke (2021), we consider the so-called "second-round effects" to estimate the decline in price.

sizes of bond funds targeting Japanese bonds and U.S. bonds.[25] Bond funds targeting Japanese bonds have expanded their asset size by approximately five times, and those targeting U.S. bonds have expanded by approximately four times since the GFC. Reflecting this increase in asset size, in this analysis we assume that the total amount of asset sales by investment funds during a shock also increases.[26]

To estimate the Amihud illiquidity measure, the price of the 10-year Japanese government bond is used for the price of Japanese long-term government bonds. The trading volume is based on the general trading volume of coupon-bearing long-term government bonds from the trading volume of over-the-counter bonds data provided by the Japan Securities Dealers Association. Similarly, for U.S. long-term government bonds, the price of the 10-year U.S. Treasury bond is used, and the trading volume is based on the trading volume of coupon-bearing long-term U.S. Treasury bonds from the Primary Dealer Statistics provided by the Federal Reserve Bank of New York.

As for U.S. corporate bonds,[27] the price of investment-grade bonds is calculated based on the ICE BofA US Corporate Index, while the price of high-yield bonds is based on the ICE BofA US High Yield Index. The trading volume is based on the trading volume of investment-grade and high-yield bonds from the Primary Dealer Statistics provided by the Federal Reserve Bank of New York.

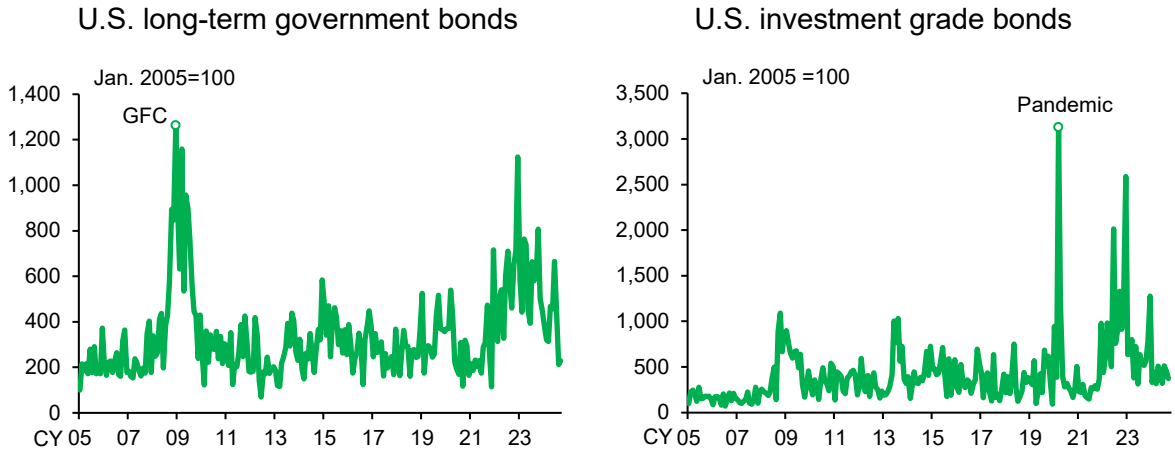
Figure 6 shows the illiquidity measures for U.S. long-term government bonds and U.S. investment-grade corporate bonds. A sharp increase is observed during crises such as the GFC and the pandemic, suggesting a decline in liquidity.

[25] The bonds targeted by investments in both Japan and the U.S. include government bonds such as municipal bonds and treasury bonds, corporate bonds including high-yield bonds, asset-backed securities, and mortgage-backed securities.

[26] The outflow rate during the GFC period is calculated by dividing the total amount of capital outflows during the GFC by the total assets of the investment funds. The total amount of capital outflows from each investment fund between September and November 2008 is divided by the total assets of the investment funds as of August 2008. The outflow rate of bond funds targeting Japanese bonds is calculated to be approximately 7%. The rate of bond funds targeting U.S. bonds is approximately 4%.

[27] For the price impact of corporate bonds (BBB or higher), the illiquidity measure for investment-grade bonds is used. For the price impact of corporate bonds (BB or lower), the illiquidity measure for high-yield bonds is used.

Figure 6: Trends in the price change rate per unit of transaction volume



Note: Shows the absolute value of weekly price change rate divided by trading volume, with the maximum value displayed for each month. Latest data as of September 2024.
Source: Bloomberg; FRBNY; ICE data Indices.

Based on the sales amounts and price impacts, calculated as outlined above, we estimate the increase in the 10-year interest rate in Japan and U.S. corporate bond spreads for U.S. BBB-rated bonds. We also assume that asset sales are carried out in April-June 2025. Figure 3 shows the assumptions of the 10-year interest rates in Japan and the U.S., and the BBB-rated corporate bond spreads for the U.S. in each scenario. In comparison to the financial stress scenario, the 10-year interest rate in Japan rises by 40 basis points and the 10-year interest rate in the U.S. rises by 60 basis points. The corporate bond spreads for U.S. BBB-rated bonds increase by 600 basis points compared to the financial stress scenario.[28] The path following these increases is based on past market movements. The 10-year interest rates are assumed to rise in April-June 2025 and then decline to their lowest levels historically, similar to the financial stress scenario. The U.S. corporate bond spreads for all ratings are assumed to converge to the levels of the financial stress scenario over a period of approximately three years.[29]

As for other financial variables, stock prices decline further in response to the deterioration of the real economy, with the rate of decline exceeding that of the financial stress scenario. The increase in spreads for commercial mortgage-backed securities (CMBS) and asset-backed

[28] The corporate bond spreads are estimated separately for the price impacts on investment-grade bonds and high-yield bonds.
[29] In past instances of stress, corporate bond spreads have remained more volatile than government bond yields, with high volatility tending to persist for a period of years. As a conservative assumption for the stress test, we assume that U.S. corporate bond spreads remain at a high level for about three years. Gilchrist et al. (2009) estimate the impact of shocks using macroeconomic and financial variable factors on corporate bond spreads, and report that it takes 3 to 4 years for corporate bond spreads to return to their initial levels.

securities (ABS) is calculated based on the total amount of asset sales derived from the LSEG Lipper database and the weight of those assets in the portfolios of bond funds.[30] The cost of dollar funding rises endogenously within the model, reflecting the decline in asset prices and the increase in corporate bond spreads in the international financial capital markets. Figure 7 summarizes the changes in the main financial variables. A discussion of foreign funds and alternative investments will be provided later.

Figure 7: Scenario in exploratory analysis

Main variables			Estimation method of additional impacts in the scenario	Additional impacts
Financial variables	10-year U.S. Treasury yield 10-year JGB yield Credit spreads on U.S. corporate bonds (BBB)		Estimated based on "1. Increase in the outstanding amount of bonds since the global financial crisis (GFC) "× "2. Share of the amount of assets sold during the GFC" × "3. Estimated price impact per unit"	+ 0.6%pts + 0.4%pts + 600bps
	U.S. stock prices Japanese stock prices		Based on the estimated real GDP (see below) and the relationship of real GDP and stock prices	About -14% About -12%
	Fund prices			
		Fixed income Credit products Real estate funds	Based on the additional impact of yield related to each fund price (fixed income: long-term yields, credit products: credit spread on U.S. corporate bonds, real estate funds: credit spread on CMBS)	About -13% (on average)
		Multi-asset Private equity Hedge funds	Based on the estimated stock prices and the relationship of fund prices and stock prices during the GFC	About -7% (on average)
Economic variables	U.S. real GDP Japanese real GDP		Based on the simulation results of macro-econometric models: FRB/US model for the U.S. and FMM model for Japan	About -1% About -1%
Impairment rate of loans	Loans to foreign funds		Based on the default rate of loans to low-rated borrowers during the GFC	About -10%

Note: 1. "Additional impact" for each variable is the maximum difference between the values under the financial stress scenario and the exploratory analysis.
2. Additional impacts on other financial variables, including credit spreads on RMBS, CMBS, ABS, and CLO, are also estimated based on the amount sold by investment funds.

The additional impacts on various financial assets look similar to the price fluctuations and levels observed during the pandemic. Looking at the movements of each variable during the pandemic, from early January to March 2020, the long-term interest rates in Japan and the U.S. initially declined, before rising by approximately 10bps and 60bps, respectively. Additionally, the U.S. corporate bond spreads (BBB-rated) increased by about 300bps and the TOPIX and S&P 500 declined by approximately 30%.[31]

[30] We use the values of the price impact in Cetorelli et al. (2021).
[31] The increase in corporate bond spreads during the pandemic was less than assumed in this scenario. It is possible that the expansion of corporate bond spreads was restrained due to policies such as bond purchases by the Federal Reserve and repayment support from the government.

Further slowdown of the real economy

The further decline in asset prices due to asset sales by bond funds could further deteriorate the real economy through worsened funding conditions for companies and a negative wealth effect on households.[32] In the FRB/US model used to estimate the extent of the deterioration in the U.S. economy, the rise in corporate bond spreads contributes to the deterioration of the real economy by reducing corporate investment and decreasing consumption due to the decline in asset prices.[33] Therefore, we assume that, along with the deterioration of the financial environment, the real economy also deteriorates compared to the financial stress scenario.

The deterioration of the U.S. economy is estimated using the FRB/US model, which is the FRB's large-scale macro model. We consider the shocks of increases in the U.S. 10-year Treasury bond yield and the spreads of corporate bonds (BBB-rated) compared to the financial stress scenario. The resulting decline in real GDP is used as the measure of the deterioration of the U.S. economy compared to the financial stress scenario. The decline in the Japanese economy is estimated using the FMM, given assumed values of financial and foreign economic variables. As a result, the U.S. economy slows down by approximately 1.1% and the Japanese economy by approximately 1.2% compared to the financial stress scenario, as shown in Figure 3. This deterioration in the real economy could reduce capital adequacy ratios through decreased lending, increased credit costs, and an increase in risk assets due to higher default probabilities.

Loans and investments in foreign funds

For foreign funds, we consider the losses associated with investment fund holdings due to the decline in fund prices and we also consider the increase in credit costs of certain loans to investment funds.

As for loans to foreign funds, given the leverage expansion of investment funds borrowing these loans, we assume that an unexpected negative shock to the economy leads to defaults in some high-credit-risk loans, causing an increase in credit costs for banks. We assume that, for the five major banks with significant outstanding loans to investment funds, as shown in Figure 8, the

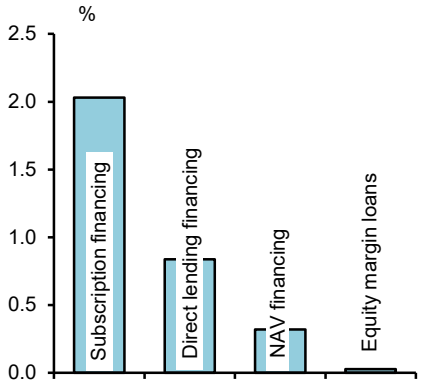
[32] For example, Gilchrist and Zakrajšek (2012) empirically show that, controlling for the rise in expected default rates, an increase in corporate bond spreads significantly lowers GDP growth.

[33] In the FRB/US model, where monetary policy follows the Taylor rule, we consider shocks to long-term interest rates and corporate bond spreads (BBB-rated) and estimate the extent of the deterioration in the real economy. While the increase in corporate bond spreads is significant, the rise in long-term interest rates is relatively small. In addition, the increase in long-term interest rates is temporary. As a result, the impact of the shock to long-term interest rates on the real economy is minimal.

default probabilities of direct lending financing (to private debt) and NAV financing (to private equity) increase.[34] In addition, for the default probability, reference was made to the default rates of leveraged loans, which are considered to have experienced similar effects during the GFC.[35]

As for investments in funds, we assume that in the period of April-June 2025, when a negative shock hits, fund prices decline, resulting in losses as financial market volatility expands and the real economy slows down. Figure 7 describes the estimation methods of the decline in each fund's price. For fixed income products, their prices decline by the same percentage as the price change of the U.S. 10-year Treasury bond from the previous period during April-June 2025. The decline in credit product prices is determined by considering the ratio of the price change of the products during the GFC to the increase in the spreads of U.S. corporate bonds (BBB-rated), along with the increase in the spreads of U.S. corporate bonds (BBB-rated). The decline in real estate fund prices is calculated by considering the ratio of the price change of the funds during the GFC to the price declines of mortgage-backed securities, along with the price decline of mortgage-backed securities. The prices of hedge funds, multi-asset funds, and private equity funds are estimated by considering the ratio of the price change of funds during the GFC to the decline in stock prices.

Figure 8: Loans outstanding to investment funds in the Americas



Note: Shows the ratio of loans outstanding to risk-weighted assets for the five banks with the largest loans outstanding to investment funds. Latest data as of September 2024.
Source: BOJ.

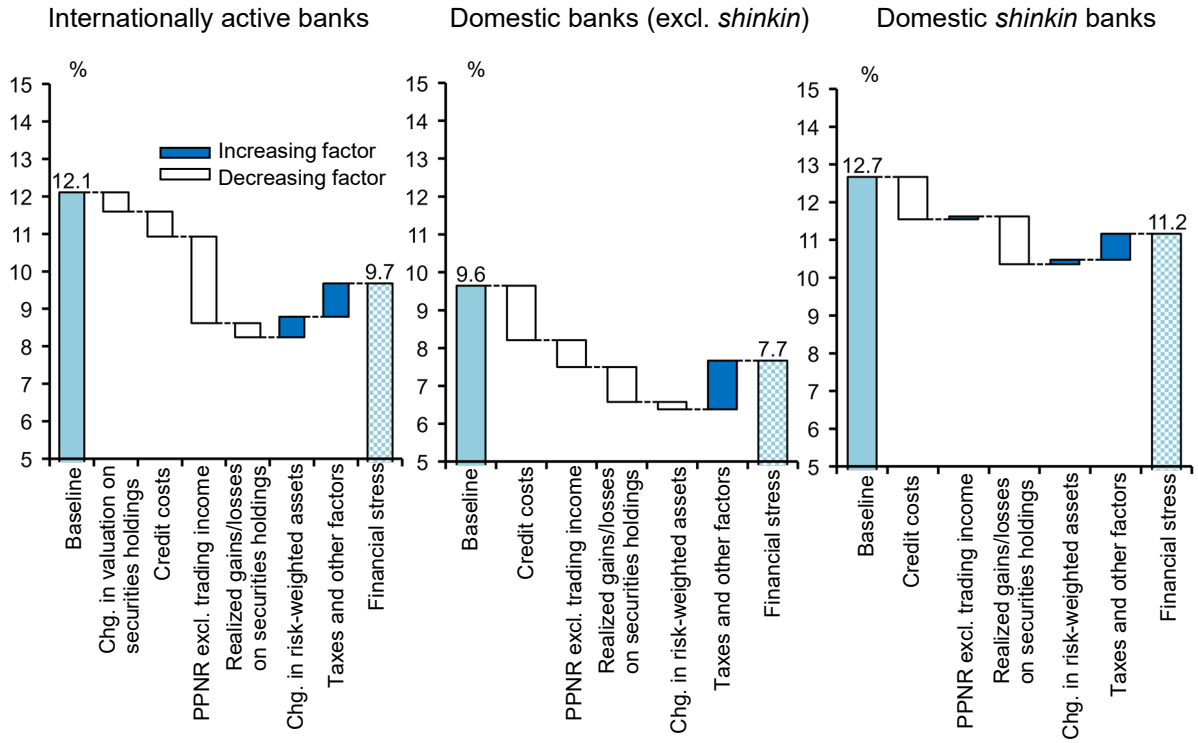
[34] For direct lending financing, the collateral provided typically consists of loans with lower ratings or liquidity, and NAV financing also uses the value of the investment assets of funds as collateral. Therefore, when the economic or financial environment deteriorates rapidly, credit costs could increase. This is in contrast to subscription financing, where the collateral is the fulfillment rights of contributions by high-credit-quality major LP investors and defaults observed in previous periods have been relatively rare. However, it should be noted that lending risks are potentially increasing, for example through the lengthening of loan terms (Kanaguchi et al., 2023).

[35] The credit costs are estimated by assuming that the debt classifications before default are categorized as normal and considering the unsecured ratio based on the reporting data of each bank.

4. Findings

This section explains the simulation results. We first show the results of the financial stress scenario,[36] followed by the results of the exploratory analysis. Figure 9 shows the capital adequacy ratio as of the end of fiscal 2027 under the financial stress scenario. The ratio declines significantly compared to the baseline scenario. The margin compression following the decline in interest rates decreases pre-provision net revenue (PPNR) excluding trading income. The deterioration of the real economy results in an increase in credit costs. The declines in the prices of risk assets worsen both valuation and realized gains/losses on securities holdings. These factors all contribute to the decline in the capital adequacy ratio.

Figure 9: Decomposition of capital adequacy ratio: financial stress scenario



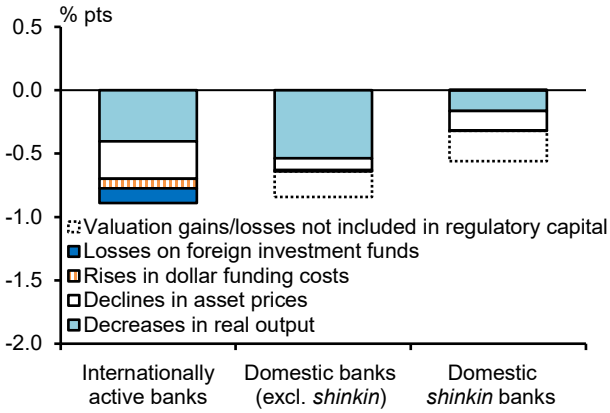
Note: Indicates the contribution of each factor to the difference between the capital adequacy ratios at the end of the simulation period (as of end of fiscal 2027) under the baseline scenario and the financial stress scenario.

The amplified mechanisms assumed in the exploratory analysis further push down the capital adequacy ratio. Figure 10 shows the decline in the ratios as of the end of fiscal 2027 under the exploratory analysis compared to the financial stress scenario. The capital adequacy ratio of IABs declines by approximately 0.8 percentage points. The primary factor is the further slowdown of the real economy, contributing approximately 0.4 percentage points, as the deterioration of the

[36] For the simulation results under the baseline scenario, see BOJ (2025).

financial conditions of borrowing companies causes an increase in both credit costs and holdings of risky assets. The sale of assets by investment funds worsens the valuation and realized gains/losses on securities holdings. The increase in dollar funding costs further reduces the capital adequacy ratio through a deterioration in the PPNR. Losses related to loans and investments in foreign funds push the ratio down by approximately 0.1 percentage points.

Figure 10: Decrease in capital adequacy ratio compared to the financial stress scenario (as of end of fiscal 2027)



Note: 1. Indicates the contribution of each factor to the difference between the capital adequacy ratios as of the end of fiscal 2027 under the financial stress scenario and the exploratory analysis.
2. "Decline in asset prices" represents the change when only financial variables take values assumed for the exploratory analysis. "Rise in dollar funding costs" and "Losses on foreign investment funds" are excluded from "Decline in asset prices."

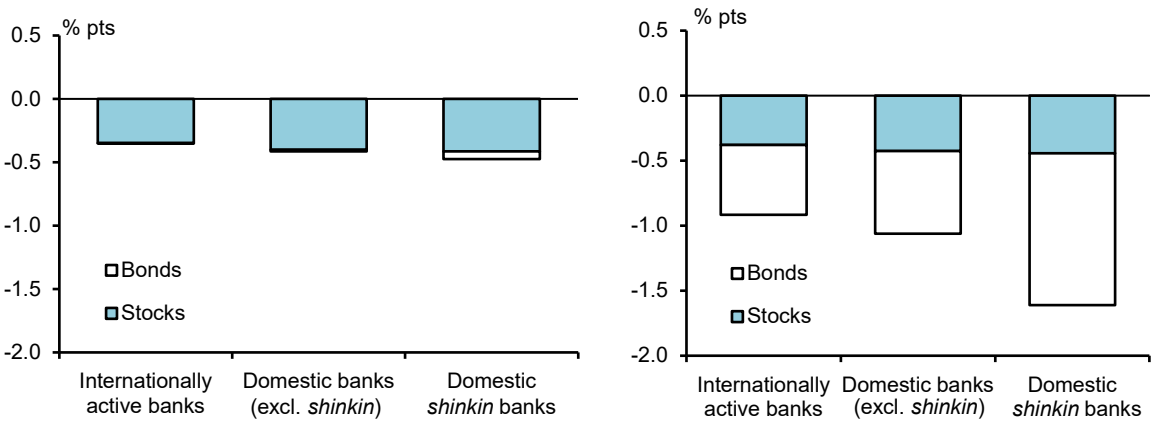
For domestic banks (excluding *shinkin* banks), the capital adequacy ratio decreases by approximately 0.6 percentage points. The further slowdown of the real economy contributes to this decline by approximately 0.5 percentage points through an increase in credit costs and risky asset holdings. The contribution is larger than for domestic *shinkin* banks. This is because some domestic banks (excluding *shinkin* banks) apply the internal ratings-based approach, and the rise in default probability increases risk-weighted assets through higher risk weights.

Financial market volatility is highest immediately after the shock and there is a decline in valuation and realized gains/losses on securities holdings in the short term. Figure 11 shows that when long-term interest rates and corporate bond spreads rise in April-June 2025, the deterioration in valuation and realized gains/losses on securities holdings relative to risk assets is larger than in January-March 2028, when the simulation ends. This is mainly because of the valuation losses on bonds. While we can see the deterioration in all sectors, the losses on bonds for domestic *shinkin* banks is significant. This reflects the higher proportion of bonds in the portfolios of domestic *shinkin* banks.

Figure 11: Valuation and realized gains/losses on securities holdings

At the end of simulation period (as of the January-March quarter of 2028)

At the time of the shock (as of the April-June quarter of 2025)



Note: 1. Shows the contribution to the difference between the gains/losses under the financial stress scenario and the exploratory analysis.

2. Gains/losses are valuation and realized gains/losses on bond and stock holdings relative to risk-weighted assets as of September 2024. Bonds include held-to-maturity bonds and stocks include investment funds.

However, the data for the risk profiles of Japanese banks' exposure to foreign funds are significantly limited and this analysis is based on several assumptions. When estimating the default probability of loans to foreign funds, we assume a uniform default probability across products except for subscription financing because of limited information about the details of the funds and risk characteristics such as Loan-to-Value (LTV) ratios. Additionally, the assumed default probability of the products is based on the default probability of similar loans, such as leveraged loans. However, since private debt and private equity funds typically invest in small and medium-sized enterprises (Cai and Haque, 2024), their vulnerabilities could exceed those of leveraged loans. No additional defaults are assumed for subscription financing in this exploratory analysis since the collateral is typically the fulfillment rights of contributions from high-credit-quality major LP investors, with sufficiently high LTV ratios. However, a significant negative shock in the real economy or financial markets could lead to substantial stress on the investors who are the capital call recipients, and unexpected losses could arise given the large outstanding loan balances of Japanese banks, as shown in Figure 8.

5. Conclusion

Since the GFC, the amount of securities held by investment funds has steadily increased globally and standard-setting bodies, such as the FSB and national authorities, have pointed out that the economic activities of the NBFI sector could amplify stress on the financial system. Under these circumstances, central banks, mainly in Europe and the U.S., have been conducting stress tests and related analyses that explicitly consider the amplification of shocks by the NBFI sector.

This paper explains the approach used to set the scenario in the exploratory analysis in the April FSR (BOJ, 2025) and the details of its simulation results. We design a scenario that captures the amplification effects of foreign-originated shocks and their transmission mechanisms to the domestic banking sector by considering the growing interconnectedness of the domestic banking sector and the foreign NBFI sector. We assume that domestic and foreign investment funds engage in large-scale sales of securities when a negative shock hits. We estimate the additional decline in asset prices caused by such sales, while also considering the losses related to Japanese banks' loans and investments in foreign funds. Furthermore, we estimate an additional decline in both domestic and foreign real economies caused by the asset price declines, which is our main contribution compared to previous research.

However, our results call for careful interpretation. The NBFI sector includes various industries and has complex interconnectedness with other financial institutions.[37] There is no consensus in the existing literature regarding the mechanisms through which the NBFI sector amplifies shocks. Therefore, the NBFI sector could amplify negative shocks to financial institutions through mechanisms not considered in this paper. For example, in addition to open-end funds investing in bonds,[38] open-end funds investing in stocks or real estate, hedge funds, and financial dealers and brokers could also engage in fire sales (BOE, 2024). For some loans to foreign funds, such as subscription financing, losses are not assumed in this analysis, reflecting the fact that there have not been many cases where Japanese banks have incurred significant losses in the past. However, if a significant negative shock hits the real economy or financial markets in the future, unexpected losses could arise. Furthermore, we estimate the asset price declines based on the scale of assets

[37] IMF (2023) summarizes the vulnerabilities of the NBFI sector (such as leverage, liquidity risk, interconnectedness, and currency mismatches) based on characteristics by sector.

[38] As pointed out by Goldstein et al. (2017), redemptions during periods of market stress are generally associated with bond-type assets (such as corporate bonds), but during the pandemic the impact also spread to safe assets. In our analysis, it is assumed that bond sales are uniform (vertical slicing). However, the size of outflows for each asset could differ depending on the asset composition of the investment fund (Yamamoto et al., 2025).

sold by open-end funds during the GFC, and this analysis does not quantitatively assess the amplification mechanism of the NBFI sector in a theoretical model that considers transaction relationships among individual financial institutions, such as in Sydow et al. (2024).[39]

Moreover, the interconnectedness of NBFIs, which is not considered here, could negatively affect the financial system. Beyond the banking sector focused on in this analysis, life insurance companies and pension funds have also been expanding their exposure through loans and investments in private funds. Globally, some life insurance companies have been transferring insurance contracts to reinsurance companies under private equity ownership. This could result in unexpected impacts through unforeseen channels when a shock is realized (Cortes et al., 2023; Garavito et al., 2024). In addition, during a crisis, the NBFI sector could borrow from the banking sector due to increased collateral demand or redemption needs, and if the banking sector does not respond, fire sales could occur. The BOE's SWES suggested that the NBFIs' expectations of the available amount of borrowing from banks when stress arises, especially regarding liquidity supply from banks, could be optimistic (BOE, 2024). This paper does not explicitly consider such liquidity shocks.[40] It remains a topic for future research to explicitly consider these mechanisms by clarifying their responses to shocks with detailed financial information of investment funds.

[39] Aikman et al. (2019) consider the transmission of stress based on the transaction relationships of individual financial institutions, as well as the interactions among different types of financial sectors. By taking liquidity constraints into account, they incorporate the effects of non-linear declines in asset prices once a certain threshold is exceeded. In contrast, this analysis sets the decline in asset prices based on linear regression using historical data, and we do not incorporate such non-linear declines.

[40] The mechanism of fire sales in response to liquidity shocks is discussed in detail in BOE (2024) and Sydow et al. (2024).

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