Chapter 5
Financial Stability and Systemic Risk

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Abstract Recent episodes of financial crises have provided empirical evidence that financial stability is a necessary condition to support sustainable macroeconomic growth. Likewise, systemic risk has become an important measure in macroeconomic risks, especially in light of the increased concern about its ability to distress the economy. The economic authorities thus need to have an understanding of systemic risk given that it may become elevated through the exacerbation of vulnerabilities triggered by shocks arising from different elements of the financial system, including the macroeconomic environment.

Keywords Financial stability · Systemic risk · Macroprudential supervision

Introduction

Financial stability has become an integral part of the macroeconomic stability framework. Recent episodes of financial crises have provided empirical evidence that financial stability is a necessary condition to support sustainable macroeconomic growth. Financial system distress will disrupt the flow of funds to the economy in the form of lower economic liquidity, the deterioration of intermediation, payment system disturbances, and diminished market confidence (Warjiyo and Juhro 2019).

The Global Financial Crisis (GFC) in 2008 was caused by the materialization of systemic risk triggered by a subprime mortgage problem in the financial sector. Not only did it have a negative impact on the performance of the financial sector, but it also significantly derailed global economic growth. Interconnectedness and feedback loops between the financial sector and the real sector inflicted a high cost of crisis, scarred the economy and induced an economic recovery that lasted for many years. This event increased the importance of taking into account macro-financial linkages in the macroeconomic policy formulation.

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These conditions prompted the leaders of the G20 during their meeting in Seoul in 2010 to ask the Financial Stability Board (FSB), International Monetary Fund (IMF), and Bank for International Settlements (BIS) to develop a macroprudential policy framework in order to mitigate systemic risks in the financial sector (FSB et al. 2011). As the next step, the central banks and financial authorities of many countries participated in developing a macroprudential approach in order to limit systemic risk and sustain financial system stability.

Systemic risk is at the core of financial stability and macroprudential policy. This policy is defined as a policy that limits risk and the cost of systemic crises (Galati and Richhild 2011). Meanwhile, the European Systemic Risk Board (ESRB), an institution whose missions include supervising the European financial system and avoiding as well as limiting the occurrence of systemic risk in the Euro Zone, define macroprudential policy as a policy to maintain financial system stability as a whole, including strengthening financial system resilience and reducing the accumulation of systemic risk, resulting in guaranteed continuity of economic growth in the financial sector (ESRB 2013). A similar definition comes from the IMF, stating that macroprudential policy is a policy aimed at sustaining financial stability as a whole through the limitation of systemic risk (IMF 2011).

Systemic risk has become an important measure in macroeconomic risks, especially in light of the increased concern about its ability to distress the economy. The economic authorities thus need to have an understanding of systemic risk given that it may become elevated through the exacerbation of vulnerabilities triggered by shocks arising from different elements of the financial system, including the macroeconomic environment. As such, an understanding of the financial system and its elements is as important as understanding the anatomy of systemic risk. Bearing this in mind, the following section will describe the scope of the financial system.

Understanding the Financial System

The financial system consists of various institutions/entities and markets that interact for the objective of mobilizing funds from surplus units (Lenders-Savers) to deficit units (Borrowers-Spenders) using financial instruments. In this case, surplus and deficit units could be households, business firms or corporations, or governments and foreign entities. Figure 5.1 shows how they can interact (Mishkin 2016). In direct finance, lenders channel investment by buying financial instruments or securities issued in the financial markets by borrowers. The role of the financial markets in this case is to match the need for investment and borrowing by allowing the issuance of a variety of financial instruments. The market eliminates the need to have an intermediary institution to mobilize funds. However, not all financing needs can be fulfilled by market-based transactions.

In indirect financing, there is an intermediary institution between lenders and borrowers. One of the functions of banks, as intermediary institutions, is to channel funds from lenders (depositors) to borrowers. The intermediation function of banks includes maturity transformation from short-term deposits to longer term lending.

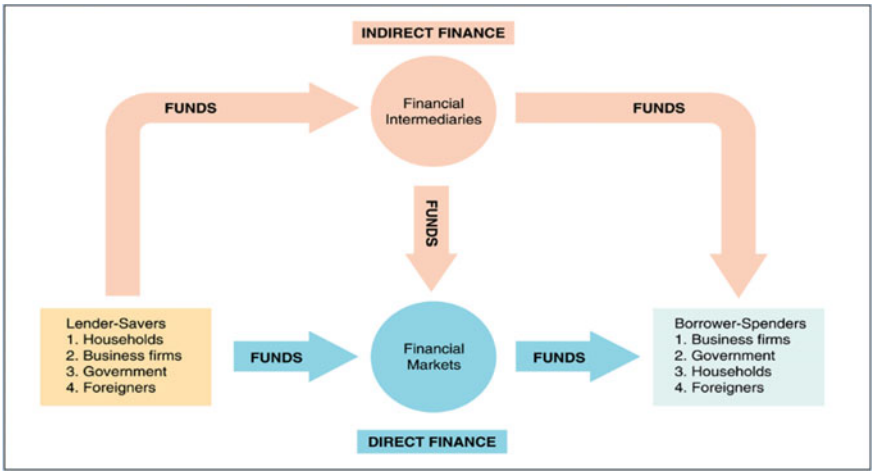

Fig. 5.1 Inter-element interaction in the financial system. *Source* Mishkin (2016)

Therefore, banks need to ensure the creditworthiness of borrowers to ensure they are able to honor their agreement to provide liquidity management for depositors. Nowadays, depositors should be able to withdraw funds from their balance from the bank whenever they need to. The function of banks is thus unique given they require the expertise to match maturities and assess loan projects. Because of this, banks are very highly regulated and required to maintain a capital buffer (capital adequacy ratio) to absorb liquidity and credit risks.

In general, the financial system consists of the following four main components; financial services providers, financial services users, markets and infrastructure. Financial services providers are financial institutions in the form of banks and non-banks. These include pension funds, insurance companies, finance companies, securities firms and others. Meanwhile, financial services users include the corporate sector and household sector, collectively known as the real sector. Figure 5.2 illustrates these elements of the financial system.

Some countries have a financial system dominated by the banking sector, a characteristic known as a bank-based economy, while some more advanced economies tend to have a financial system more dominated by the capital market and larger non-bank financial institutions. The share of non-bank financial institutions in the financial system tends to increase in line with: (i) domestic economic conditions that are conducive to financial services and product development; (ii) a population better educated about the variety of financial sector products and services available; (iii) broader public access to financial services; and (iv) robust domestic economic growth that ameliorates the level of public prosperity and welfare. Nevertheless, market structure and regulatory regimes also shape the financial system, so we can still find bank-dominated financial systems in advanced economies.

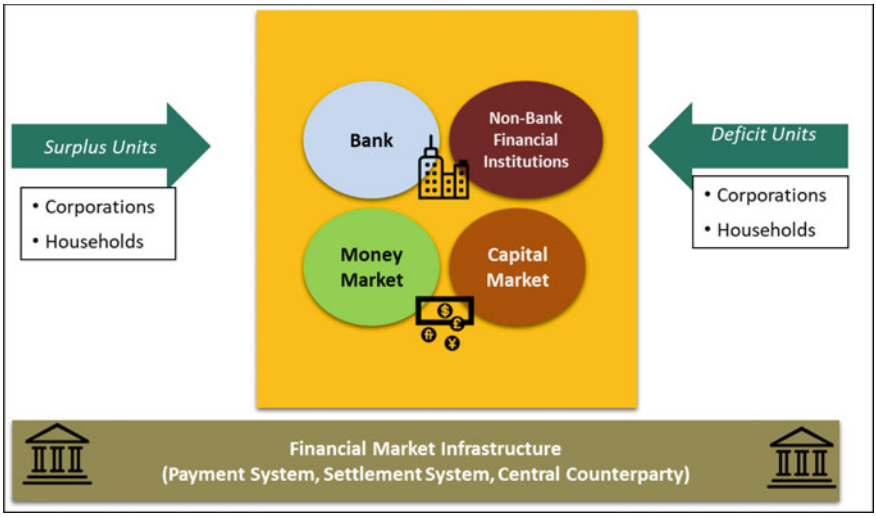

Fig. 5.2 The financial system

The financial system consists of financial institutions, financial markets, financial infrastructure, and non-financial corporations and households which interact in funding and/or financing the supply of the economy. The financial system is also characterized by inter-element interactions—among financial institutions, and between financial institutions and the real sector—otherwise known as interconnectedness. A fraction of the total deposits of the banking industry is owned by non-bank financial institutions, like insurance companies, pension funds and mutual funds. Another fraction is owned by the corporate sector and households/individuals. Banks extend credit to corporations, households and non-bank financial institutions. Therefore, problems among corporations, households and non-bank financial institutions have the potential to affect the banking sector specifically, and the financial system in general, and vice versa. Another example of interconnectedness is how activities on the interbank money market affect banks. A bank defaulting on an interbank market transaction has the potential to trigger a default at another bank, or even disrupt the interbank money market as a whole.

Moreover, in addition to the inter-element interactions of the financial system, interactions between the financial system and macroeconomic variables are of equal importance. As the effects of the global financial crisis spread in 2008, the presence of a feedback loop was evidenced between financial markets and the macro-economy. Meanwhile, exchange rate pressures that flared up during the East Asian financial crisis in 1997/98 had a far-reaching impact on the financial system in Indonesia. Losses were not only incurred by the banking sector, but also by the corporate sector and household sector—due to disruptions of liquidity and credit flow. Given the aforementioned characteristics and structures, monitoring the financial system to maintain stability is a challenge on its own. The dynamics that need to be captured

are not only about the performance of each element of the system, but also the inter-element interconnectedness, along with the impact of the macroeconomic conditions on each of the elements as well as on the financial system as a whole.

Given the scope of the financial system and its dynamics, maintaining financial system stability requires the concerted efforts of a number of authorities. Put differently, there is more than 1 (one) authority accountable for achieving financial system stability. What distinguishes the different authorities is the method used by each institution to attain its main objective; such as the Central Bank—through monetary, macroprudential, and payment system policy; the Government—through fiscal policy; the Financial Services Authority—through microprudential policy; and the Deposit Insurance Corporation—through resolution policy.[1] The implementation of all these policies requires consideration as to how they interact, especially those that have an impact on the financial system. Generally, the interactions are complementary, thereby making the elements of the financial system more prudent. Through the interactions of each policy, problems occurring in the financial system should be managed and limited to maintain sound macroeconomic and real sector conditions.

A Bank Indonesia regulation[2] stipulates that financial system stability is a condition that enables the national financial system to work effectively and efficiently, while also being able to withstand internal and external vulnerabilities, thus resulting in funding allocations or financing that can contribute to national economic growth and stability. Meanwhile, the financial system is defined as a system consisting of financial institutions, financial markets, financial infrastructure, and non-financial corporations and households which interact in funding and/or financing the economy.

Having established this, we can now move on to discuss systemic risk.

The Anatomy of Systemic Risk

Some research defines systemic risk as risk that can cause loss of public trust and greater uncertainty within a financial system, thereby causing the financial system concerned to function improperly and disrupting the flow of the economy. Systemic risk can arise suddenly and unexpectedly or, conversely, build up slowly without some of the relevant parties realizing or detecting it—which may result in late implementation of the appropriate mitigation policy. The negative effects of systemic risk in the economy can be detected by increases in disruptions to the payment system and credit flows, as well as the depreciation of asset values (Group of Ten 2001). Systemic risk is otherwise defined as any set of circumstances that threatens the stability of, or public confidence in, the financial system (Billio et al. 2010). The ECB defines

[1] Resolution policy refers to the policy decided in the practice of the resolution of banks (or financial institutions in general). Resolution, in this case, is the restructuring of a bank by a resolution authority through the use of resolution tools in order to safeguard public interests, including the continuity of the bank's critical functions and financial stability, as well as ensuring minimal costs to taxpayers.

[2] Bank Indonesia Regulation (PBI) Number 16/11/PBI/2014 of 1st of July 2014, regarding Macroprudential Regulation and Supervision.

systemic risk as a risk of financial instability, so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially (ECB 2010). Bank Indonesia defines systemic risk as the potential instability caused by contagion to some part, or the whole, of the financial system due to interactions from the factors of size, complexity, and interconnectedness between institutions and/or financial markets, as well as the behavioral tendency of financial players or institutions to excessively follow the economic cycle (procyclicality).

Building upon the definitions of systemic risk mentioned above, as well as the previous description of the financial system, the following 3 (three) observations can be made. First, systemic risk does not have to stem from a financial institution, but can also come from the other elements of the financial system, such as corporate failure or problems within the payment system. It may also arise from shocks outside the financial system. Second, interconnectedness among the elements of the financial system means there is the potential for risk contagion, with the risk spreading from a certain element to the rest of the financial system (contagion effect). Third, the potential impact from systemic risk is broad; it is not confined to the financial sector, but can also disrupt the economy as a whole. Therefore, efforts to minimize systemic risk in order to maintain the stability of the financial system involve monitoring all elements of the financial system, while also keeping track of the macroeconomic conditions.

The three aforementioned observations demonstrate that the performance and soundness of financial institutions are not sufficient to indicate systemic risk and enhance financial system stability. Systemic risk can occur if financial institutions are exposed to the same risks (common risk factor), one of which is the impact of a concentration of risk within a particular portfolio (concentration risk). Meanwhile, the soundness of a financial institution is no longer important if there is a potential failure of, or risk to, one, or some, other financial institutions that could create significant (systemic) impact in the financial system.

Building upon this concept, in order to analyze systemic risk further, there are 2 (two) dimensions identified as a guide for systemic risk analysis and the formulation of policies. These are the cross-sectional dimension—which focuses on behavioral differences across elements and financial agents, and the time series dimension—which focuses on the behavior of the dynamics of financial elements/agents over time. These dimensions also become the focus of macroprudential policy, contrasting with the focus of microprudential policy which tends to lean on assessments of individual institutions at one point in time or cross-sectional dimension only. It is interesting to observe that monetary policy also tends to focus only on the time dimension aspect of macroeconomic indicators. In detail, in the context of systemic risk, the cross-sectional dimension places an emphasis on how risk is distributed within a financial system during a certain period, which is caused by the concentration within a portfolio of a certain risk (concentration risk), or if exposure to risk is the same (common risk factor), resulting in greater potential for spillover risk between individuals/sectors (contagion risk). As a result, problems in an institution may negatively impact other institutions, either directly or indirectly. Meanwhile, the time series dimension places an emphasis on how risk within a financial system evolves over time, including the

behavior of financial agents that follow the economic cycle (procyclicality). A focus on the time series dimension causes macroprudential policy to become time-varying (varied according to time), implying that the calibration of policy is dynamic in accordance with the evolution of the economic cycle. Problems or risk that contain dimensions of time series will be responded to with policies that go against the economic cycle (countercyclical).

Although more and more financial authorities are implementing macroprudential policy, there is no economic theory that serves as a guide in mitigating systemic risk. Unlike monetary policy which targets inflation using clear policy instruments, such as the interest rate, exchange rate and liquidity, systemic risk cannot be measured with one indicator. To date, no quantitative methodology/model has emerged that is able to comprehensively measure systemic risk within a financial system, except for models and methodologies which rate one or more aspects of systemic risk separately (BCBS 2012). There is plenty of literature describing systemic risk as a certain mechanism, such as imbalances (Caballero 2009), correlated exposures (Acharya et al. 2010), spillover to the real economy (Group of Ten 2001), feedback behavior (Kapadia et al. 2012), asset bubbles (Rosengren 2010) and contagion (Moussa 2011). However, the lack of a common theoretical background has become the foundation on which central banks and financial authorities establish a macroprudential policy framework to mitigate systemic risk, or at least for formulating a framework with the right procedures, based upon accurate data and information, and targeted for implementation at the right moment. Efforts to formulate a policy framework are carried out continuously along with efforts to mitigate systemic risk through the development of risk identification and monitoring, as well as comprehensive risk assessment.

Interconnectedness, Too Big to Fail *and Common Risk Factor*

As explained in the previous section, efforts to maintain financial system stability are insufficient if only focused on individual soundness and the performance of individual banks or other financial institutions. This is because, within a financial system, institutions are tied to one and another in the form of financial transactions. The assets of one bank are the liabilities of another. For example, an interbank market transaction may involve two banks, one of which is lending and the other borrowing funds. A default by one bank can have a profound impact on another bank, or maybe even on numerous banks that have placement in the defaulting bank. Due to the nature of interconnectedness within a financial system, problems of one institution can quickly spread to another, thereby becoming an aggregated problem of the financial system which may potentially affect the real sector.

As explained above, the spillover potential from one institution to another increases if the problem lies with a dominant or substantially large institution. For example, the failure of a big bank with a fairly substantial market share within a financial system will create a more significant impact in comparison to the failure of

a smaller bank. This concept is known as *too big to fail*. Apart from their scale of business, big banks tend to have more interconnectivity with other banks or institutions which have a high business complexity. This means that trouble in a large bank can disrupt the wider coverage of the financial system, ultimately causing systemic risk. The concept of *too big to fail* is unacceptable for the current regime of financial regulation. Therefore, there is a supervisory process that has determines lists of Systemically Important Financial Institutions (SIFI) in general, or Systemically Important Banks (SIB) in particular. These lists can be in the context of the global financial system—G-SIFI and G-SIB—or in the context of a jurisdiction—Domestic SIFIs and SIBs (D-SIFI/D-SIB). The determination of the lists depends on the indicators of size, interconnectedness, complexity and substitutability (BCBS 2012). The financial institutions that fall into these lists have to maintain a higher capital buffer, and sometimes a higher liquidity buffer as well.

Moreover, risk can potentially materialize if a number of healthy financial institutions coincidentally have the same risk exposure (common risk factor). Risk can occur even when each financial institution manages an equally healthy risk profile. As an example, when the property sector grows rapidly, the majority of banks will focus their credit disbursement on the property and construction sectors. As a result, bank concentration on the property sector becomes high. If a slowdown or shock subsequently occurs in the property sector, many banks will face the same risk and will experience asset value deterioration. Such a situation may create instability within the financial system.

Given the aforementioned characteristics of the financial system (interconnectedness, *too big to fail*, and common risk factor), a conclusion can be drawn that in order to maintain financial system stability, a regulation and supervision approach with aggregated characteristics, which is system oriented and takes into account all the elements within the financial system as a unit intertwined with each other, while also understanding and being cautious about the potential transmission of systemic risk, is needed. Such an approach can be accommodated with macroprudential policy. Macroprudential policy is necessary to handle a number of problems arising from the characteristics of the financial system. Macroprudential policy which focuses on the system as a whole will be better able to capture sources of risk in aggregate. In other words, financial system stability can be achieved through supervision—as long as it is not limited merely to the soundness of individual financial institutions.

Procyclicality and Countercyclical Policy

The tendency of financial agents to follow the economic dynamics defines the time dimension of systemic risk. With the profit maximizing objective, financial agents always assess economic upturn as an opportunity to push their business. Banks will extend credit with lower lending standards, because they believe that real sector risk is low during good times. This is true across financial institutions as they also see that liquidity in the economy is quite ample and therefore they can afford to maintain

less of a liquidity buffer (and concentrate more on riskier portfolios) since they think liquidity will be available to borrow quite cheaply as interest rates are also low. However, when the economy faces takes a downturn, financial agents immediately switch to risk aversion mode. Liquidity in the market becomes thinner since the economy is slower. Combined with the uncertainties in their counterparty risks, they prefer to hoard liquidity and reduce their lending appetite significantly, thereby exacerbating the liquidity squeeze.

Basically, financial agents will exaggerate upturns in the economy because of their excessive risk taking during such periods, and then exacerbate downturns by becoming risk averse during such economic slowdowns. The risk of a switch at the peak of the cycle is that the real sector is suddenly left without the flexibility of credit line and liquidity access, thereby causing disruptions to the supply of production and a reduction of the repayment capacity of corporations and households. This, in turn, will provide a negative feedback to the financial system that will push the cycle further down. Because of this, the authorities will devise a countercyclical policy to encourage financial agents to maintain higher capital and/or liquidity buffers during an upturn when funding is relatively cheap. The requirement to maintain such a buffer will also suppress risk appetite that could otherwise potentially push the upward cycle too high, risking an even worse fall after the turning point is reached. This buffer can also then be used to absorb the risks that the financial agents will have to face during the downturn. The policy to require such a buffer is called countercyclical policy.

Materialization and Analysis of Systemic Risk

Materialization of Systemic Risk

The identification of systemic risk refers to the identification of events and potential which may have systemic impact. According to Bernanke (2013), risk will materialize when shock events (*shocks*) interact with vulnerability in a financial system. An analogy for this interaction is that of a homeowner who usually locks his doors at night for security. One night he forgets to do so, thereby leaving himself vulnerable. If there are no shocks, such as the appearance of a thief who comes with the intention of robbing the house, there will be no risk of burglary or theft. The risk of theft arises if a thief arrives at the house to find its doors unlocked, so enters and robs the home. Subsequently, risk will become systemic if it is not balanced with adequate resilience. To extend the analogy, resilience could be likened to taking the preventative action of placing valuable goods inside a secure box. As such, even in the event of theft, no valuable goods will be stolen and any losses will be insignificant. Therefore, the identification of systemic risk is divided into 2 (two) main activities; identification of shocks and identification of vulnerability. A shock is an event which triggers a crisis (proximate cause), while vulnerability is associated with the pre-existing features of a financial system that can amplify and accelerate shock contagion (Bernanke

2013). Systemic risk materializes as a result of an interaction between shock and vulnerabilities embedded in the financial system. The vulnerabilities in the system can be discerned by looking at the systemic risk's cross-sectional and time series dimensions. These are concentration risk, contagion risk and procyclicality. They can also be discerned by looking at the market risk, credit risk, liquidity risk, and operational risk of financial institutions and markets. The resilience of financial institutions involves their ability to absorb risks, such as their capital (solvency) and liquidity buffer. If systemic risk materializes and financial agents actually have the resilience to absorb the risk, then the financial system will only experience temporary turbulence to none at all. However, if systemic risk materialize and financial agents do not have enough buffer to absorb the risk, then the financial system will experience instability that could have a temporary or structural (longer term) impact. Figure 5.3 illustrates the concept of the materialization of systemic risk.

Shocks to the financial system can come from both endogenous and exogenous sources. They are endogenous when they come from the structure and behavior within the financial system, e.g. fraud committed by a financial institution within the system, depreciation of the local currency, a breach of cyber security, failure of a systemically important bank. They are exogenous when they come from outside the financial system, e.g. a shock from the global market (GFC), increase of the policy rate in an advanced country (taper tantrum), currency depreciation in a peer country

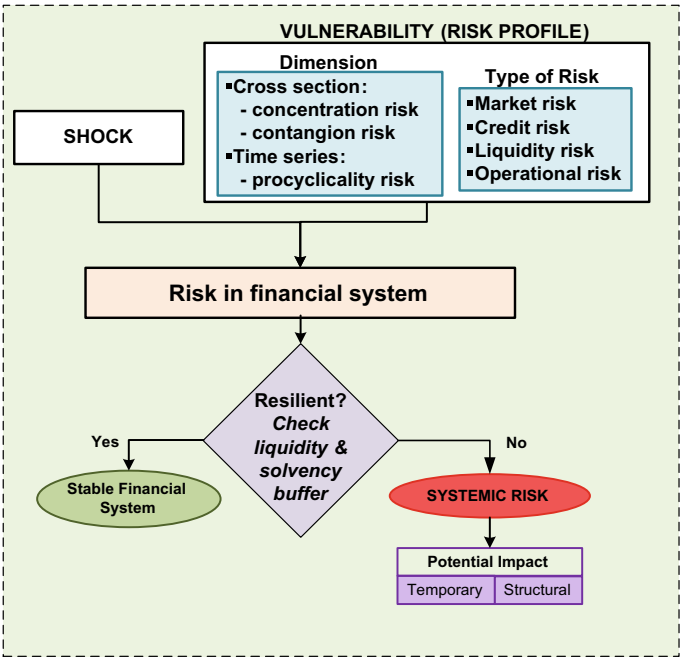

Fig. 5.3 Systemic risk materialization

(Asian Financial Crisis). Shocks can also be idiosyncratic, meaning they stem from a failure of a financial institution, or systematic, meaning they stem from a common exposure, e.g. exchange rate or interest rate shocks.

The transmission of shocks can follow different mechanisms. They can be transmitted through direct financial transactions. For example, a default by a primary client could incur a large loss for the bank that provided the loans to the company concerned. Shocks can also be transmitted through a systematic process in which financial agents are exposed to the same financial risks. For example, a decrease in commodity prices may trigger an increase in non-performing loans within the commodity sector. The other channel of transmission is through the effects of information. In this case, asymmetric information in the financial system could lead to a lot of assumptions of risks and herding behavior, especially when the financial system is in distress. Uncertainties related to information spread within the financial market and may induce irrational behavior on the part of financial agents to the point that they suspend lines of credit altogether. Another example are bank runs, where trouble in a bank may diminish trust in the banking system as a whole, thereby leading not only to massive withdrawals from the bank in distress, but also from other banks deemed to have similar problems based, for example, on similarities in their size and business exposures (domino effect).

Systemic risk also materializes in phases, namely build-up, shock materialization, and amplification and propagation. The build-up phase refers to a slow increase of systemic risk that may possibly go undetected without active risk monitoring, identification and assessment. It is a result of the heating-up of the financial system during an upturn cycle. This is indicated by a boom in financial asset prices, high credit growth, and accelerated financial innovation. The next phase is shock materialization. This begins with the emergence of a shock to the financial system. This can be in the form of a GDP or fiscal shock, an exchange rate depreciation due to external imbalances, or the failure of a systemically important financial institution. The last phase is amplification and propagation, in which systemic risk is further transmitted across financial institutions, markets, sectors and sometimes economies/jurisdictions. It is crucial to manage this phase properly in order to ensure that the systemic risk does not create a structural impact and turn into a prolonged crisis.

Monitoring and Analysis of Systemic Risk

The monitoring and analysis of systemic risk refer to the following 3 (three) off-site macroprudential supervision activities—monitoring, stress identification, and risk assessment.

(i) **Monitoring**

Monitoring of the financial system is conducted by monitoring the indicators which represent the performance of the elements of the financial system, as well as macroeconomic indicators that can affect financial system performance. Ideally, monitoring

should cover all the elements of the financial system, namely financial institutions (banks and non-banks), especially those that are potentially systemic, including parent companies, affiliates, and subsidiary units of banks that may potentially induce systemic risk. Moreover, monitoring should also cover financial markets and infrastructure, as well as the household and corporation sectors. Monitoring of households and corporations is required considering the direct interconnectedness of both these sectors with financial institutions, such that a problem in either of these sectors could have an impact on financial institutions. The broad scope of monitoring is meant to capture previously unidentified *unknown risk*.

(ii) **Stress Identification**

Stress Identification is conducted in order to see when performance indicators show negative signals which represent increasing risks to the financial system. The issue can be examined by comparing the indicators and the corresponding thresholds which have been pre-determined through empirical research results with observations in past crises. It can also be examined by following the indicator's financial cycle. Financial cycle refers to the self-reinforcing interactions between perceptions of value and risk, risk-taking, and financing constraints, which are translated as booms and busts (Borio 2012). Stress in the financial system can also be represented by a composite index which reflects the combined performances of financial institutions and financial markets, as well as by other indicators that can represent the vulnerabilities of the financial system that may turn into systemic risk when triggered by shocks.

(iii) **Risk Assessment**

Risk assessment is conducted with the objective of measuring the extent of the potential impact of previously-identified risk on the financial system or real sector. One methodology used by many financial authorities in measuring risk is a stress test (see Box 1). A stress test is a methodology used to measure the resilience level in regard to certain shock scenarios. Currently, the implementation of stress tests is still focused on banks, considering that banks dominate a lot of financial systems in different jurisdictions. Stress test methodology is also used to test the resilience of other elements of the financial system, such as NBFIs and corporations.

Box 1. Stress Test

In the financial sector, the realization of the importance of understanding and diving further into the vulnerability measurement methodology of the financial sector grew during the 1990s. In the context of the financial sector, stress testing is defined as a methodology to test financial system stability for adverse conditions (Borio et al. 2012). In other literature, a stress test is defined as a methodology created by researchers or decision-makers to calculate risk during abnormal conditions (Kalirai and Scheicher 2002). It is important to remember that stress scenarios do not reflect projections of the economy in the future.

For a financial system which is dominated by banks, the financial system resilience measurement calculated by means of a bank stress test is decisive. In this context, capital adequacy serves as the main indicator of banking resilience. Capital becomes a bearing for financial institutions to absorb loss that may occur because of risks taken, such as credit, liquidity, market, or operational risk. In credit risk for example, loss materializes because of a degraded repayment capacity of debtors due to various reasons, such as reduced income due to economic shocks, which in turn can push up the non-performing loan (NPL) ratio. When facing worsening NPLs, banks must set aside a loan loss reserve (LLR). The building-up of the LLR erodes bank profits and therefore the capability of banks to put aside profit for capital decreases. This issue will degrade the bank's resilience level, as reflected by a reduced Capital Adequacy Ratio (CAR) of banks.

Generally, there are 2 (two) approaches in conducting stress testing; top-down stress tests (industry-wide) conducted by the central bank/bank supervisory institution, and bottom-up stress tests conducted by individual banks with models adjusted to risk management by banks. Both approaches are implemented using a common set of macroeconomic scenarios for all banks. In general, top-down stress testing is developed to measure banking industry resilience against potential risk that may arise. The methodology consists of 7 (seven) main elements needed for calculating a banking stress test, as follows:

1. Stress Scenario: including macroeconomic scenarios and other scenarios. In the practice of stress testing in many countries, there are at least 2 (two) macroeconomic scenarios, namely the baseline scenario and stress scenario. Usually, the baseline scenario is a projection of variables within the macroeconomy, while the stress scenario can consist of many levels, ranging from mild to moderate, adverse and severe. A bespoke scenario can also be developed specifically for each bank according to its specific business process. This bespoke scenario can be developed by the authorities for special concerns, or by the bank itself for the comprehensiveness of the assessment. The most severe stress test scenario should follow a case of extreme but plausible events. The idea is that the authorities should know the level of resilience of the financial system when it faces a worst-case scenario.
2. Macro Stress Testing: broadly used to examine the impact of various macroeconomic factors with regard to bank credit risk. Changes in macroeconomic factors, such as GDP, currency depreciations, inflation or policy rate increases, will have an impact on bank credit quality, as reflected by NPLs.
3. Credit Risk Stress Testing: used to measure the impact of deteriorating credit quality in regard to bank capital, as reflected by the Capital Adequacy Ratio (CAR).

4. Market Risk Stress Testing: used to measure bank losses due to changes in interest, changes in Government bond prices, and depreciating currency, which have to be covered by bank capital and therefore reduce the CAR.
5. Liquidity Stress Testing: used to measure the capability of bank liquidity tools in fulfilling the short-term (daily) liabilities of banks.
6. Integrated Stress Testing (a mixture of credit risk and market risk): used to measure the simultaneous impact of credit risk and market risk on bank capital.
7. Interbank Stress Testing: used to measure the impact of bank failure on fulfilling interbank liabilities in regard to other banks (contagion effect). Interbank stress testing is used to recognize if a bank is systemic to others.

The above setup stops after the calculation of the CAR after incurring all the losses caused by the macroeconomic scenario. The previous modeling—the microprudential stress test—usually only relied on transmitting the macroeconomic scenario on the balance sheets of banks. Nowadays, macroprudential stress tests are developed to further enhance the results of stress tests. In this setup, the amplification and propagation mechanism due to interconnectedness and common risk factors is incorporated. The second round impact in the form of feedback from the real sector to the financial system is also applied. The final measurement is also in the form of systemic risk measurement (instead of distressed CAR in the microprudential stress test). The results of a macroprudential stress test should be more appropriate in determining the resilience of the overall financial system in facing stress, and therefore such a stress test is suitable for macroprudential authorities.

(iv) **Risk Signaling**

Monitoring, stress identification, and risk assessment will be less than optimum if the results are not delivered to related parties within a short span of time and in a proper manner. Proper signaling will determine the success of the policy response that is taken. Other than related parties and time span, another factor that determines the effectiveness of risk signaling is the signal communication strategy. Generally, risk signaling as the result of macroprudential supervision is given to:

(a) Internal Parties

Internal parties include all financial authorities that participate in maintaining financial system stability. Signaling to internal parties is conducted to deliver the current financial system conditions and as an alert for financial authorities regarding a financial system condition that requires more intensive attention. Signaling is in the form of a monitoring report, the identification and assessment of systemic risk delivered at the Board of Governors Meeting, and in coordination meetings with other financial authorities, namely the Ministry of Finance, Financial Services Authority, and

Deposit Insurance Corporation. In order to ensure signaling can be communicated effectively, the thresholds "normal" and "crisis" should be established according to past experiences, and this should be understood and agreed to by all parties. This is to ensure decision-making can be done faster to solve problems if necessary. In normal conditions, the reporting frequency of systemic risk assessments can adhere to the regular procedures of all the financial authorities as well as the schedule of the financial stability committee. However, in a "crisis" condition, the frequency and scope of the reports have to increase as needed, and this will require a set of crisis management protocols (CMP).

(b) Market Participants, Financial Institutions, and the Public (*Stakeholders*)

Signaling to market participants and the public refers to communication from the authorities to provide the latest condition of the financial system. Meanwhile, signaling to stakeholders is about providing guidance for prudent financial portfolio management, as well as increasing awareness to reduce exposure towards portfolios which contain growing risk. The term *stakeholders* here refers to all parties that benefit from the financial system. To provide greater detail, signaling to external parties is conducted with the following objectives:

(i) Providing explanations regarding policies in the financial sector to ensure business certainty in the financial system;
(ii) Providing financial education to the public to minimize asymmetric information, as commonly occurs in financial businesses;
(iii) Ensuring market participants and the public follow the development of the financial system and contribute to implementing market discipline[3] to minimize excessive risk taking; and
(iv) In a crisis condition, providing guidance for market participants and the public to contribute to minimizing the propagation and/or contagion of risk, as well as to prevent the crisis from getting worse.

In particular to improve the effectiveness of communication for external parties, the signaling process needs a proper communication strategy to manage the reactions of market participants as well as changes in their behavior, while also enhancing public confidence in the information they receive. Financial system stability can be managed better when the market and public feel confident about the integrity and performance of the financial system.

Closing

It can be concluded that financial stability policy and efforts to limit systemic risk should be integrated into an overall macroeconomic stabilization policy. Past

[3] Market Discipline is the contribution and active participation of users/participants in the financial market to avoid or punish participants who do not abide by prudential principles.

evidence has shown that the materialization of systemic risk—such as the subprime mortgage crisis—can trigger turbulence that is transmitted to the global financial market (Global Financial Crisis). Financial stability has become a prerequisite for the effective transmission of monetary policy and sustainable economic growth. A financial crisis also has the potential to cause large fiscal costs from crisis resolution and financial system recovery. Therefore, preventing the materialization of systemic risk by minimizing vulnerabilities, detecting shocks as early as possible, safeguarding resilience through adequate financial buffers, and ensuring prudential behavior among market players through sound policy dissemination, is a vital part of the macroeconomic stabilization policy.

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