August 2020

Evaluation of Differential Premium Systems for Deposit Insurance

Research Paper

PREPARED BY
THE DIFFERENTIAL PREMIUM SYSTEMS TECHNICAL COMMITTEE
OF THE CORE PRINCIPLES AND RESEARCH COUNCIL COMMITTEE

International Association of Deposit Insurers
C/O BANK FOR INTERNATIONAL SETTLEMENTS
CENTRALBAHNPLATZ 2, CH-4002 BASEL, SWITZERLAND
TEL: +41 61 280 9933 FAX: + 41 61 280 9554
WWW.IADI.ORG

TABLE OF CONTENTS

ABBREVIATIONS

BPS	basis points
CAMELS	capital adequacy, asset quality, management capability, earnings, liquidity, sensitivity to market risk
CAP	cumulative accuracy profile
CAR	capital adequacy ratio
CDIC (Canada)	Canada Deposit Insurance Corporation
CDIC (Chinese Taipei)	Central Deposit Insurance Corporation
DI	deposit insurer
DIF	deposit insurance fund
DIS	deposit insurance system
Dodd-Frank Act	Dodd-Frank Wall Street Reform and Consumer Protection Act
DPB	Differential Premiums By-Law (Canada)
DPS	differential premium system
D-SIB	domestic systemically important bank
EBA	European Banking Authority
EL	expected losses
EU	European Union
FDIC	Federal Deposit Insurance Corporation
G-SIB	global systemically important bank
IADI	International Association of Deposit Insurers
IDI	insured depository institution (member bank)
IPS	integrated protection scheme
KDIC	Korea Deposit Insurance Corporation
LCR	liquidity coverage ratio
LDR	loans to deposits ratio
LGD	loss given default
NDC	National Development Council (Chinese Taipei)
NPL	non-performing loan
OSFI	Office of the Superintendent of Financial Institutions (Canada)
PIDM	Perbadanan Insurans Deposit Malaysia
RBC	risk-based contributions
SREP	Supervisory Review and Examination Process
TC	technical committee

KEY TERMS

Actuarially fair premiums – Deposit insurance premiums are actuarially fair if the premiums paid are equal to the expected losses to the deposit insurance fund posed by each institution's risk profile, which is the probability of failure multiplied by estimated insurance losses given failure.

Back-testing – Testing of a predictive model using historical data.

Bank – Any entity which accepts deposits or repayable funds from the public and is classified under the jurisdiction's legal framework as a deposit-taking institution.

Bank run – A rapid and significant withdrawal of deposits from a bank by depositors following a loss of confidence, precipitated by the fear that the bank may fail and that depositors may therefore suffer losses or lose access to funds.

Basel Framework – Standards set by the Basel Committee on Banking Supervision for the prudential regulation of banks.

CAMELS – A system used to rate banks according to six factors represented by the acronym for Capital adequacy, Asset quality, Management capability, Earnings, Liquidity and Sensitivity to market risk.

Capital adequacy ratio – A measure of the amount of a bank's capital, typically expressed as a percentage of its risk-weighted assets.

Corporate governance – The systems, strategies, policies, processes, and controls by which an organisation is directed, administered or controlled, including the relationships among stakeholders and the goals for which the organisation is governed.

Cumulative accuracy profile curve – A visual aid used in discriminant analysis to assess the predictive power of a model such as a bank failure prediction model.

Deposit insurance – A system established to protect depositors against the loss of their insured deposits in the event that a bank is unable to meet its obligations to the depositors.

Differential premium system – A premium assessment system which seeks to differentiate premiums on the basis of criteria such as individual bank risk profiles.

Expected loss – The average losses that a deposit insurance fund may incur as part of normal deposit insurer business, mathematically defined as the mean of the deposit insurance fund's loss distribution.

Funding – Financing mechanisms necessary to cover the operating expenses and obligations of a deposit insurer.

Global systemically important bank – A bank designated by the Financial Stability Board as global systemically important because of its size, complexity, and interconnectedness.

Insolvency – A situation in which a bank can no longer meet its financial obligations when due, or the value of its assets is less than the total of its liabilities.

Insured depository institution – A bank or savings association, the deposits of which are insured.

Insured deposits – Eligible deposits that do not exceed the maximum coverage level of a deposit insurance system.

Integrated protection scheme – A system in which a single agency, usually a pre-existing deposit insurer, provides a guarantee or protection to investors in securities firms, or policyholders of insurance companies, in addition to depositors in banks, for the loss of insured funds or unsatisfied claims in the event of a member institution's failure.

Legal framework – The comprehensive legal system for a jurisdiction, established by a constitution; primary legislation enacted by a legislative body that has authority in that jurisdiction; subsidiary legislation (including legally binding regulations or rules) adopted under the primary legislation of that jurisdiction; or legal precedent and legal procedures of that jurisdiction.

Legal protection – The set of legal mechanisms by which the deposit insurer and persons participating in the resolution of a failed bank, including current and former employees, directors, officers, and lawfully delegated agents of an organisation, are covered from the effects of claims and procedures initiated against them for alleged acts and omissions executed in good faith, which occur within the scope of their mandate.

Liquidity coverage ratio – The high-quality liquid assets of a bank divided by its total net cash flows, over a 30-day stress period.

Loss given default – The amount lost after the disposition of a failed member institution. Typically expressed as a percentage of the total exposure.

Market discipline – The effect that depositors, creditors, or investors who assess the risk characteristics of a bank have in influencing bank risk-taking behaviour by threatening to withdraw funds from the institution.

Moral hazard – Arises when parties have incentives to accept more risk because the costs from such risk are borne, in whole or in part, by others.

Premium – The amount that a member institution pays to the deposit insurer in the manner and time frames prescribed by legislation.

Probability of default – The probability that a bank will not be able to meet its obligations over a particular time horizon.

Put option – A contract for the right to sell a specified amount of an underlying security at a pre-determined price within a specified time frame.

Resolution – A plan and process to dispose of a non-viable bank. Resolution may include liquidation and depositor reimbursement, transfer or sale of assets and liabilities, establishment of a temporary bridge institution, and write-down or conversion of debt to equity. Resolution may also include the application of procedures under insolvency law to parts of an entity in resolution, in conjunction with the exercise of resolution powers.

Resolution authority – A public authority that, alone or with other authorities, is responsible for the resolution of financial institutions established in its jurisdiction (including resolution planning functions).

Resolution regime – The elements of the legal framework and the policies for planning, preparing for, carrying out and coordinating a resolution, including the application of resolution powers.

Systematic risk – Overall market risk.

Systemic risk – A risk of disruption to financial services that occurs when an event at one institution triggers disruption at other institutions.

EXECUTIVE SUMMARY

A. Purpose

Deposit insurance significantly reduces the risk of bank runs. However, the existence of a deposit insurance system (DIS) designed to prevent bank runs can create a moral hazard problem by altering the behaviour of depositors and bank management, which can affect the risk-taking behaviour of banks. Differential deposit insurance pricing is one of several methods to mitigate moral hazard. It alters the incentive for bank management to take on excessive risk by explicitly pricing risk into the premiums paid for deposit insurance. Differential deposit insurance pricing can also increase fairness by charging higher premiums to institutions posing higher risk to the deposit insurance fund (DIF).

The International Association of Deposit Insurers (IADI) formed a technical committee (TC) to investigate whether differential pricing systems (DPSs) as implemented are effective in meeting their objective(s). The TC considered both the general conditions favourable for an effective DPS and the best techniques for quantitatively evaluating a DPS. The four principal objectives of the study are to:

1. determine reasonable goals and expectations in implementing a DPS;
2. identify basic considerations in evaluating a DPS, including factors in the operating environment and design features that promote DPS effectiveness;
3. examine how different jurisdictions measure, or evaluate, the effectiveness of a DPS; and
4. describe quantitative methodologies used to evaluate the effectiveness of a DPS.

The TC used contributions from committee members, IADI guidance on DPSs, data from recent IADI annual surveys, and the European Banking Authority (EBA) report on implementing EBA guidelines for calculating DIS premiums to identify common DPS goals, designs, and performance evaluations. The TC also reviewed academic literature to identify the conceptual approaches for evaluating and pricing risk. Based on this research, this paper examines how to determine whether DPSs as implemented have been effective in achieving the goals of decreasing moral hazard and increasing fairness.

B. Literature Review

Banking scholars identify differential pricing as one of several policy tools available for mitigating the moral hazard associated with deposit insurance, including prudential bank supervision, financial regulation, and limits on the scope and level of insurance coverage. The literature review identifies four methodologies for pricing risk under a DPS: structural models, expected loss models, bucketing, and fund-size calculations. The extent to which a DPS influences risk-taking independently is an empirical question, but it is challenging to disentangle the marginal effects of DPSs from other country- and time-specific effects. This is especially the case as DPSs tend to be adopted or enhanced with other financial reforms and at similar points in the business cycle across jurisdictions.

Despite expectations, the academic literature has not established a compelling causal link between the adoption of differential pricing and a reduction in moral hazard, although there is evidence of reduced risk-taking by insured institutions. The literature review describes findings based on the crisis experience of flat-rate versus differential pricing systems and on *ex post* bank risk characteristics following DPS adoption.

C. Goals and Expectations for a DPS

IADI survey results and input from TC members reflect broad agreement among IADI Members that the primary goals of establishing a DPS are to reduce moral hazard by discouraging excessive risk-taking and to increase fairness by reducing the cross-subsidisation of high-risk insured depository institutions (IDIs) by low-risk IDIs.

Despite the challenges in measuring the effect of a DPS on risk-taking, if institutions that can be identified as generally riskier pay higher premiums, a DPS could be argued to contribute to mitigating moral hazard as institutions would then have a positive incentive to reduce their risk-taking. Common indicators of risk include failure rates, examination ratings, and market information.

DPS may not fully reflect the risk exposure of the highest-risk institutions because of political and pragmatic limitations, such as limits on the deposit insurer's (DI) ability to set premiums. In such cases it is reasonable to expect that some cross-subsidisation will remain.

D. Basic Considerations in Evaluating DPSs

The TC views several factors as necessary for an effective DPS and therefore as a starting point in an evaluation. By necessity, a DPS expands the range of DI decisions that rely on having effective legal, institutional, accounting, and supervisory regimes. Other features of the operating environment such as the availability and quality of data and financial structure will also influence the effectiveness of a DPS. The DI needs to have the authority to modify the DPS as conditions change. In the absence of sufficient data to conduct a more rigorous quantitative analysis, verifying that all the necessary factors are met can be an indicator of DPS effectiveness.

A DPS evaluation must recognise the trade-offs involved in designing a system. Core Principle 9 of the IADI Core Principles for Effective Deposit Insurance Systems (Core Principles) states that if a DI uses a DPS, the system for calculating premiums should be transparent to all participating banks, the scoring/premium categories should be significantly differentiated, and the ratings and rankings resulting from the system pertaining to individual banks should be kept confidential.[1] Consistent with this Principle, an evaluation should determine whether the DI considered how to improve transparency as the system becomes more complex, set premiums considering the financial impact on IDIs, including de novo institutions, and balance the frequency of data collection against the burden imposed on IDIs and DIs.

E. Evidence from Case Studies

Case studies from four TC members – Canada, Chinese Taipei, South Korea, and the United States – as well as Malaysia and the EBA illustrate different methods used for evaluation, and inform the identification of best practices and lessons learned.[2] The Canada, Chinese Taipei, Malaysia, and South Korea case studies discuss the possibility that their DPS contributed to a decrease in moral hazard, as their systems saw a decline in the number of institutions in the higher risk premium categories after their systems were implemented.

The selected jurisdictions evaluate their systems with a range of frequencies. South Korea evaluates its

[1] *See* the Core Principles in Appendix D. For in-depth explanations, *see* International Association of Deposit Insurers, "A Handbook for the Assessment of Compliance With the Core Principles for Effective Deposit Insurance Systems". 14 March 2016.

[2] The four TC members provided their case studies in 2019. Subsequently, the TC reached out to the six members who had contributed to the 2011 IADI paper ("General Guidance for Developing Differential Premium Systems"), but were not on this TC, to see if they had evaluated their DPS; Malaysia contributed a case study. The TC also wrote a case study on the EBA's "Report on the Implementation of the EBA Guidelines on Methods for Calculating Contributions to DGS".

system annually. Canada evaluates its system annually and performs a comprehensive examination every five years. Malaysia evaluates its system every three years. Chinese Taipei, the EBA, and the United States evaluate their systems as needed. Chinese Taipei evaluates its DPS as certain events occur, such as a change in the economic cycle or the development of new international standards. The United States has typically conducted its evaluations following crises and changes in legal requirements.

Malaysia surveys member banks and their central bank, and develops consultation papers on their proposed changes for public comment. South Korea and Canada solicit public input and conduct academic studies, and Chinese Taipei analyses the changes in the percentage of institutions for each premium category. The EBA reviews its Guidelines on methods for calculating premiums to DISs by providing a statistical tool to its Members to assess whether the risk-based method ensures adequate differentiation based on risk profiles and historical data. The United States has evaluated its DPS by calculating the distribution of failures in each premium category. Canada and the United States utilise back-testing to compare the performance of current and proposed models. Canada uses supervisory ratings in its back-testing while the United States has sufficient failure data to utilise in its back-testing.

F. Quantitative Evaluation Methodologies

Experience during a financial crisis or stress event can generate important information with which the DI can evaluate its DPS. However, the DI needs to recognise the idiosyncratic nature of the event when determining the usefulness of the information for that evaluation. Data on the underlying characteristics of failed banks and the scope of their losses can provide an empirical basis with which to measure the accuracy of a proposed or existing DPS in identifying riskier banks.

Jurisdictions have used a range of approaches to indicate whether the DPS is effective in differentiating risk among IDIs. Regardless of the approach used, there is strong statistical support for including capital ratios and supervisory ratings among the risk indicators for DPSs. Other commonly identified reliable risk indicators are rapid asset growth, high asset concentrations, growth in non-performing loans, and heavy reliance on unstable funding sources.

The simplest approach to evaluating the effectiveness of a DPS involves periodic comparisons between premiums paid and risk indicators such as historical failure rates or higher insurance losses. For example, a jurisdiction that uses the bucketing approach would expect that banks assigned to the higher-risk buckets would be charged higher premiums and fail at higher rates.

More complex approaches rely on sophisticated statistical analysis that can identify the risk indicators most highly correlated with failure or loss and the relative importance of the factors for accurate pricing. For example, back-testing can be used to evaluate the effectiveness of a DPS and to compare alternatives. This statistical method measures how well a pricing system differentiates between IDIs that failed and those that did not over a given period. It quantifies performance through the calculation of accuracy ratios, which are derived from Cumulative Accuracy Profile curves.

G. Conclusion

DPS can be used by DIs to incentivise banks to internalise their risk-taking behaviour and to ensure fairness in the premiums IDIs pay. To determine whether a DPS remains effective in meeting these goals, periodic evaluation and recalibration of the DPS is necessary as circumstances evolve. Statistical analysis is valuable only if current and future relationships among variables in the pricing model resemble past relationships. Frequent updating is essential to incorporate new information and maintain reliable scientific grounding for DPS design features.

Directly measuring the effectiveness of a DPS in reducing moral hazard is difficult. However, methods from

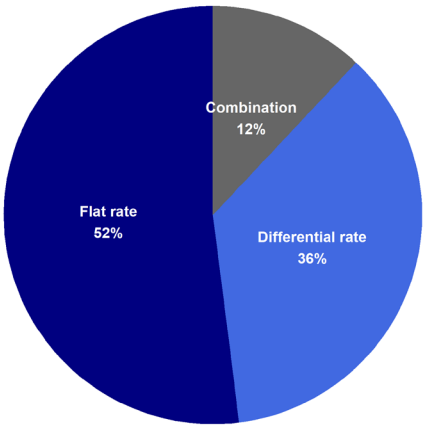
simple to complex can evaluate the impact of a DPS on fairness. Under a fair system, those institutions taking on greater risk are charged a higher premium and have an incentive to reduce risk. To the extent the DPS is effective in increasing fairness, riskier institutions will either pay for their risk-taking or will reduce their risk-taking to reduce the premium they pay. Therefore, by using methods that evaluate fairness, DIs can approximate their ability to reduce moral hazard in the system. Through periodic evaluation based on the considerations and methods identified in this study, DIs can make reasonable determinations regarding DPS effectiveness in meeting the goals of reducing moral hazard and increasing fairness.

I. INTRODUCTION

A well-designed deposit insurance system (DIS), built on the International Association of Deposit Insurers (IADI) Core Principles for Effective Deposit Insurance (Core Principles), can deter bank runs and contribute to financial stability. One of the most important design features is the system for charging premiums. Premium structures can range from flat-rate systems to complex systems that differentiate fees based on the risk profiles of the individual entities participating in the system.

According to the 2019 IADI Annual Survey, more than half of IADI Members use flat-rate premium systems, while fewer than half of the IADI Membership use a differential premium system (DPS) or a combination of both, as shown in Figure 1 below.[3] Previous IADI papers provided guidance for establishing a DPS; this paper focuses on evaluating the effectiveness of DPSs, or combination systems, in place.

Figure 1: IADI Members' Premium Assessment Methods as of Year-End 2018[4]



Source: IADI 2019 Annual Survey

Differential deposit insurance pricing – generally synonymous with risk-based deposit insurance in the literature – arises as a mechanism to mitigate the incentive to take on excessive risk created by the deposit insurance guarantee, referred to as moral hazard. A DPS mitigates moral hazard by creating incentives that internalise the cost of risk-taking to the financial institution. Another benefit of a DPS is that it can increase fairness in deposit insurance pricing resulting in a reduction in cross-subsidisation. Under such a system, riskier institutions pay higher premiums, reflecting their greater relative risk, and safer institutions pay relatively less than they would under a flat-rate system. An effective DPS requires that the deposit insurer (DI) has access to information about the risks undertaken by the insured institutions.

The effectiveness of a DPS is heavily influenced by its design and operating environment; therefore, DPSs may not be feasible or suitable for all jurisdictions, regardless of their mandates. The IADI DPS Technical Committee (TC) sought to determine the general conditions favourable for an effective DPS and techniques

[3] Generally, a 'combination' system applies a flat-rate premium to all insured institutions and supplements it with an additional risk-based premium.

[4] The 'Combination' category includes Members who selected both differential and flat rate in their survey response.

to evaluate whether a DPS is effective in mitigating moral hazard and increasing fairness. After much deliberation, the TC agreed that the principal objectives for this study are to:

1. determine reasonable goals and expectations from implementing a DPS;
2. identify basic considerations in evaluating a DPS, including factors in the operating environment and design features that promote DPS effectiveness;
3. examine how different jurisdictions measure, or evaluate, the effectiveness of a DPS; and
4. describe quantitative methodologies used to evaluate the effectiveness of a DPS.

With these objectives in mind, the TC reviewed contributions from members of the TC, case studies from a 2011 IADI paper ("General Guidance for Developing Differential Premium Systems"), and the EBA report on implementing EBA guidelines for calculating DIS premiums to identify common DPS goals, methodologies, and performance evaluations.[5] The TC also reviewed academic literature to identify conceptual approaches to evaluate and price risk. Section II, the literature review, discusses these approaches, which provide a foundation for understanding how a DPS achieves its goals.

The rest of this paper is structured to parallel the principal objectives. Section III discusses goals and expectations. Section IV describes the basic considerations for evaluation. Section V presents six case studies of jurisdictions that have evaluated their DPSs. Section VI discusses quantitative methodologies for evaluation.

[5] The TC members are Belgium, Brazil, Canada, Chinese Taipei, Ecuador, France, Germany, Indonesia, Kenya, Korea, Turkey, United States, and Zimbabwe. EBA guidelines for assessing deposit insurance premiums apply to Belgium, France, and Germany.

II. LITERATURE REVIEW

The literature review examines the theoretical motivations for differential pricing of deposit insurance, methodologies for pricing, and the nature of differences that may be priced. It highlights what is potentially achievable in a DPS, the data requirements for implementing different DPS designs, and some of the trade-offs that should inform the choice of DPS design.[6] While the literature generally favours DPS over a flat-rate premium system, most papers ignore the practical challenges of implementation. Hoelscher, Taylor, and Klueh[7] argue that certain preconditions should be met prior to DPS adoption, including existence of a robust supervisory framework and an adequate framework for risk measurement. This review focuses primarily on issues a jurisdiction should consider conditional on DPS adoption, rather than the adoption decision itself.

The existence of a DIS can create moral hazard by altering the behaviour of depositors and banks. Kane and Grossman argue that deposit insurance can effectively stop or decrease the severity of bank runs, but can also undermine depositors' incentives to monitor their banks (termed 'depositor discipline'), reducing bank incentives to invest carefully.[8] Demirgüç-Kunt and Kane, and Anginer, Demirgüç-Kunt, and Zhu state that given a lack of depositor discipline, banks have an incentive to make riskier loans.[9] DeLong and Saunders find evidence that introducing fixed-rate deposit insurance in the United States was associated with an increase in bank risk.[10] Ngalawa, Tchana, and Viegi compare 118 countries and find that the negative moral hazard effect of deposit insurance on banking system stability may be large enough to outweigh the positive effect of deposit insurance.[11]

These costs are weighed against the benefits of DISs. Anginer, Demirgüç-Kunt, and Zhu examine deposit insurance from a cost-benefit perspective and find that moral hazard concerns dominate during normal times, while the stabilising effect of decreased runs dominates during crises. International organisations, such as the International Monetary Fund and the World Bank, and individual jurisdictions around the world tend to find that the benefits of DISs outweigh the costs.[12]

Four methods are identified to mitigate moral hazard. The first is regulatory supervision to prevent excessive risk-taking.[13] The second is the use of financial regulation. The third is a reduction in coverage scope and level, and the fourth is risk-based differential deposit insurance pricing.

Anginer, Demirgüç-Kunt, and Zhu show that supervisory mechanisms can offset the moral hazard problems that arise in normal times, as discussed in Section IV.[14] The same is true for financial regulation, such as risk-based capital requirements, minimum leverage ratios, liquidity requirements, unsecured subordinated debt requirements, and extended liability.[15] Anginer and Demirgüç-Kunt argue that establishment of a formal DIS

[6] This literature review focuses on the academic literature surrounding the theory and methodologies associated with differential DISs. For a review of best practices, implementation, and policies adopted by jurisdictions internationally, *see* IADI (2011), Nolte and Khan (2017), and EBA (2015). For an academic review of deposit insurance schemes more broadly, *see* Anginer and Demirgüç-Kunt (2018).

[7] Hoelscher, Taylor, and Klueh (2006).

[8] Kane (1989), Grossman (1992).

[9] Demirgüç-Kunt and Kane (2002); Anginer, Demirgüç-Kunt, and Zhu (2014).

[10] DeLong and Saundes (2011).

[11] Ngalawa, Tchana, and Viegi (2016).

[12] IADI (2014).

[13] Kahn and Santos (2005).

[14] Anginer, Demirgüç-Kunt, and Zhu (2014).

[15] Avery and Berger (1991).

can provide an opportunity to establish rules and regulation to quickly close and resolve problem banks.[16]

Anginer and Demirgüç-Kunt recommend several important design features in a well-functioning DIS, such as coverage limits and risk-based pricing.[17] Bliss and Flannery argue that reducing the extent of coverage would create a larger group of creditors (including depositors) to bear the costs of a bank failure and should increase the incentive to monitor and perhaps influence bank risk decisions.[18] Several researchers argue that unprotected creditors should then have incentives to demand prudent risk management from the bank or impose market discipline on the bank by demanding high returns as the price of risk.[19] Anginer, Demirgüç-Kunt, and Zhu, however, find that limited deposit insurance coverage can expose financial systems to instability during financial crises, conditional on a robust DIS.[20]

Differential pricing is also cited as a mitigant to moral hazard. Whether it can achieve this is central to a jurisdiction's motivations for DPS adoption. However, it is a challenge to disentangle the effects of a DPS from other country- and time-specific effects. This is especially the case if adoption of or changes to DPSs are undertaken alongside other financial reforms or systematically occur at specific points in the macroeconomic cycle across jurisdictions. Empirical identification challenges make it particularly difficult to make definitive conclusions about the effectiveness of DPSs on risk-taking in a jurisdiction.

Notwithstanding the empirical challenges, a few papers provide evidence that differential pricing is associated with reduced risk-taking. For example, Demirgüç-Kunt and Detragiache find that the probability that a country would experience a banking crisis is lower for the six countries in their sample with risk-based premiums than for the countries with flat-rate premiums.[21] Similarly, Hovakimian, Kane and Laeven find that risk-based deposit insurance premiums are associated with less bank risk-taking, which is identified by the relationship of bank-level book debt to market asset value ratios.[22]

Common across each approach for mitigating moral hazard under deposit insurance is the difficulty of precisely measuring the risk in bank portfolios. Flannery finds that errors in the measurement of bank risk can cause deposit insurance to be mispriced.[23] However, he also finds that combining risk-based capital standards with risk-based deposit insurance pricing can decrease the negative effects of measurement error. As a result, risk-based deposit insurance pricing may be viewed as a complement to other supervisory tools.

A. Methodological Approaches

To price risks and deter moral hazard, four methodologies are identified in the literature – structural, expected loss, bucketing, and fund size calculations – each with implications for differential pricing. As Section V demonstrates, jurisdictions tend to use bucketing approaches when pricing risks.[24]

---

[16] Anginer and Demirgüç-Kunt (2018).

[17] Ibid.

[18] Bliss and Flannery (2002); Flannery (2001).

[19] Bliss and Flannery (2002); Maechler and McDill (2006); Forssbaeck (2011); Bennett, Hwa, and Kwast (2015).

[20] Anginer, Demirgüç-Kunt, and Zhu (2014).

[21] Demirgüç-Kunt and Detragiache (2002).

[22] Hovakimian, Kane, and Laeven (2003).

[23] Flannery (1991).

[24] Arguments for differential pricing systems need not be risk-based. For example, Chan, Greenbaum, and Thakor (1992) show that because of asymmetric information, risk-based fairly priced deposit insurance is incompatible with perfect competition in the banking industry. While the finding suggests that differential pricing might be designed alongside policy objectives that are not risk-based (e.g., competitiveness), the literature provides little guidance on how differential pricing should be set to achieve these objectives. This review focuses on risk-based differential pricing.

1. Structural Option Pricing Models

Among the earliest papers that examine differential pricing across banks is Merton.[25] The Merton framework views deposit insurance as a put option. When the value of a bank's assets falls below its liabilities, it 'puts' the shortfall on the deposit insurance fund (DIF). The value of this option can be priced with standard option pricing models given the market return and standard volatility of the underlying assets and treating the strike price as bank liabilities. In addition, the option pricing model requires a time horizon over which the option can be exercised. In the first generation of models, this is taken to be a finite period corresponding to the time between examinations. One additional challenge to using the option pricing model for deposit insurance is that the underlying asset is not bank equity but bank assets whose returns and volatility are not readily observable.[26] Merton shows how returns and volatility of bank assets can be computed given bank equity returns and the bank's capital structure.[27]

Under the Merton framework, banks with high levels of market capitalisation are further away from the strike price and the put option is less likely to be exercised, decreasing the value of the option and the price of deposit insurance. Banks with more volatile assets are more likely to breach the strike price, raising the value of the put option and the price of deposit insurance. Marcus and Shaked use the Merton framework to estimate differential pricing for U.S. banks.[28] They find that even if the Federal Deposit Insurance Corporation (FDIC) had set pricing at the right average level from 1979 to 1980, a flat-rate pricing system would have forced the majority of relatively safe banks to subsidise the few high-risk banks.

Later papers in the literature build upon Merton by relaxing various assumptions of the model. For example, Ronn and Verma explicitly model bank value as a function of the DIS and also account for discrepancies between the bank closure rule and insolvency.[29] The latter modification addresses a concern raised by Brickley and James, who find that the Merton model understated the option value during the savings and loan crisis in the early 1980s in the United States because of regulatory forbearance.[30]

A common limitation identified by early contributions to the option pricing deposit insurance literature is that pricing can only be estimated for banks with observable net worth, implying that the framework cannot be used for banks not listed on a stock exchange. To relax this requirement, Cooperstein, Pennacchi, and Redburn estimate bank net worth from regulatory reports filed by private banks, and demonstrate how the Merton framework can be applied across a banking system that includes both public and private banks.[31]

Several papers evaluate the predictive ability of the options-based modelling approach to capture bank risk. Carlson, King, and Lewis construct an index of financial sector health using the Merton pricing model to show predictive power at the aggregate level more than a year before stress.[32] Gropp, Vesala, and Vulpes find that Merton-based measures predict credit rating downgrades from 6 to 18 months in advance, though the result is weaker in the presence of implicit guarantees.[33] Hasan, Liu, and Zhang examine the ability of Merton-based measures to capture risk in 161 global banks in 23 countries, using credit default swap

[25] Merton (1977).

[26] This is a general challenge in using option-based pricing methods to calculate credit risk. *See* Flood (1990) for a more in-depth and accessible description for how these models work.

[27] Merton (1977).

[28] Marcus and Shaked (1984).

[29] Ronn and Verma (1986).

[30] Brickley and James (1986).

[31] Cooperstein, Pennacchi, and Redburn (1995).

[32] Carlson, King, and Lewis (2011).

[33] Gropp, Vesala, and Vulpes (2006).

spreads as a benchmark.[34] They show that the Merton variables are significantly correlated to credit default swap spreads, but that they have only slightly more explanatory power than standard balance sheet variables. Harada, Ito, and Takahashi argue that Merton-based measures are a useful indicator of the deterioration of a failed bank's health in eight case studies.[35] Milne finds that Merton-based measures do not effectively differentiate bank risk for the 41 largest global banking organisations in the crisis until after the middle of 2008.[36]

Kane provides a critique of the option pricing approach to deposit insurance.[37] He disputes the assumption that bank risk can be taken as exogenous rather than as a function of the regulatory environment and the existence of deposit insurance. He also argues that ex-ante risk cannot be measured accurately. Finally, Kane posits that the relationship between the DI and the bank includes a complex set of agency conflicts that cannot be modelled in an options contracting framework.

2. Empirical Expected Loss Models

Laeven advances an expected loss framework as an alternative approach to the option pricing framework.[38] This framework is governed by a simple and widespread principle used in credit loss modelling, described by:

$$Expected\ Loss = Probabilty\ of\ Default * Exposure\ at\ Default * Loss\ Given\ Default$$

In this framework, the DI breaks even if it charges deposit insurance premiums equal to the expected loss per insured deposit. To calculate the components of expected loss, the DI can apply the appropriate method commensurate with the available data. For example, probability of default can be estimated using regulatory ratings, balance sheet data, market data, external ratings data, macroeconomic data, structural bank data (e.g., holding company structure), or some combination. Ultimately, the relationship of the risk factor to outcomes, rather than the source of the data, determines whether it is included in the calculation. Exposure is often assumed to be equal to insured deposits, but could also be estimated or simulated to include broader obligations of the DI at the time of failure (as in the case of 'too big to fail', for example). Loss given default (LGD) represents the loss, net of recoveries, to the DI conditional on failure as a fraction of defaulted exposure and might include the structure of bank liabilities (an unsecured debt cushion that limits insurer obligations, for example), the nature of bank assets, and loan concentration. Like probability of default, this could be calculated using historical experience or using forward-looking market data.[39] Blair and Fissel note that the components of the expected loss framework are often measured on a historical rather than a forward-looking basis.[40] They argue that a forward-looking basis is conceptually preferable, but acknowledge the difficulty in obtaining accurate forward-looking measures. As demonstrated in Balla, Mazur, Prescott, and Walter,[41] the factors driving probability of default and LGD are not necessarily the same. Furthermore, their analysis shows that the factors driving the various elements of expected loss are not consistent across crises. DIs should exercise caution that predictive models are not causal in nature: structural changes to the banking industry (such as regulation or industry structure) can cause future

[34] Hasan, Liu, and Zhang (2016).

[35] Harada, Ito, and Takahashi (2010).

[36] Milne (2014).

[37] Kane (1995).

[38] Laeven (2002).

[39] Forward-looking measures could include information obtained through examination ratings or market-based measures (stock prices, option prices, and credit default swaps).

[40] Blair and Fissel (1991).

[41] Balla, Mazur, Prescott, and Walter (2019).

relationships between factors and outcomes to deviate from historical experience.

In the expected loss framework, the probability of default is the most commonly modelled component. Hirschhorn, and Pantalone and Platt use regression analysis to estimate the determinants of bank failures.[42] Hirschhorn quantifies bank risk using 1983 regulatory bank financial reports. He shows that 90 percent of all failures in 1984 were among the riskiest 20 percent of banks under this measure. However, model performance deteriorates significantly in predicting failures in 1985; only 60 percent of failures that year were among the riskiest 20 percent of banks. Blair and Fissel claim that the decrease in model performance observed by Hirschhorn is a common feature of failure prediction models, limiting their efficacy in pricing risk promptly.[43] Laeven uses credit ratings and historical cumulative default rates to estimate default probabilities.[44] A disadvantage of this approach is that it requires bank credit ratings. Default probabilities can also be estimated by the DI itself, though this may result in loss of transparency. Another possibility is to obtain default probabilities from public external credit ratings, but this precludes regulatory judgement.[45]

Estimates of LGD are also frequently obtained through regression analysis of historical data. For example, James finds that losses on bank assets average 30 percent, though losses to the DI will depend on the liability structure of the bank.[46] Importantly for differential pricing, James also finds that the determinants of losses reveal significant differences in the value of assets retained by the FDIC. Bennett and Unal extend an empirical LGD regression framework to account for resolution types.[47] They find that failure to account for the selection of the resolution method by the resolution authority can bias loss estimates. Using an extension to models of fixed-income securities, Duffie, Jarrow, Purnanandam, and Yang show how to transform reduced-form models of credit risk into fair market pricing of deposit insurance by incorporating risk premiums (*see* the discussion below on systematic risks).[48]

3. Bucketing Approaches

Despite the prevalence in the literature of option pricing and empirical expected loss models, most jurisdictions use a bucketing approach when establishing a DPS. Blair and Fissel discuss bucketing approaches based on asset and examiner classifications.[49] An advantage of this approach is that it can price risk ex-ante based on future expected-risk drivers, rather than reflecting the ex-post historical relationships of risk and outcomes. For example, they argue that DIs could follow a risk-weighting approach of assets similar to Avery and Berger as the basis for setting premiums.[50] However, they caution that such an approach ignores the quality of assets in a risk category and may induce banks to maximise risk within each bucket. Blair and Fissel promote the use of examiner risk buckets as a metric for deposit insurance pricing, as examiners have the flexibility to incorporate information not obtainable from bank financial statements, while also being forward-looking. They caution, however, that using examiner ratings for pricing could have a negative impact on the examination process.

The literature provides some evidence that, despite their relative simplicity, bucketing approaches can be effective substitutes for more complicated modelling methodologies. Kendall and Levonian advocate

[42] Hirschhorn 1986 and Pantalone and Platt (1987).

[43] Blair and Fissel (1991).

[44] Laeven (2002).

[45] White (2010).

[46] James (1991). Bovenzi and Murton (1988) and Brown and Epstein (1992) obtain losses of similar magnitudes.

[47] Bennett and Unal (2014).

[48] Duffie, Jarrow, Purnanandam, and Yang (2003).

[49] Blair and Fissel (1991).

[50] Avery and Berger (1991).

bucketing by comparing a two-tiered pricing system against a flat-rate system and a more complicated option-based pricing model similar to Ronn and Verma.[51] They show that a two-tiered pricing system that charges a flat rate for banks above a fixed capital threshold and adds a fixed surcharge for banks below the threshold overcomes 80 percent of the mispricing of a flat-rate system. They show that if the surcharge for a bank below the threshold is proportional to its capital shortfall, then the system captures 86 percent of mispricing. The two-tiered nature of the Ronn and Verma pricing system is consistent with Marcus and Shaked, who find that a large mass of healthy banks subsidises a small fraction of risky banks under a flat-rate system.[52]

While some of the literature supports using a bucketing approach, Bloecher, Seale, and Vilim discuss the limits of bucketing and discrete risk-based pricing.[53] With discrete pricing formats, small changes near the thresholds of the range can have large 'cliff effects' on the insurance premium. The cliff effect, or threshold effect, creates a substantial incentive for a bank to improve above the threshold of the next lower-priced bucket. More graduated or continuous pricing can mitigate the cliff effect, but continuous pricing requires granular data. Under the bucketing system used in the United States in 2000, 92 percent of banks, and an even greater proportion of deposits, were in the lowest premium bucket.[54] Pennacchi states this was a *de facto* flat-rate pricing system for the vast majority of banks.[55]

4. Fund Size Calculations

There are two components to pricing within a DPS. The first is the average price. The second is the difference around that average price. While this review focuses on differences around an average price, there is a sizable existing literature about the average price in which differential pricing follows as a natural corollary. The size of the DIF will be determined by the premiums collected net of the expenses incurred.

A common approach to analyses for calculating the size of the DIF is to construct a portfolio of the fund's credit risks (the banks) and estimate a loss distribution for the fund. This approach may first estimate bank-specific expected losses (EL) for a period, usually one year, and then aggregate across the portfolio of banks.[56] Estimates are obtained for bank-specific EL and conditional EL that can then be placed in an expected loss framework. For example, Kuritzkes, Schuermann, and Weiner estimate the loss distribution for the FDIC, but allow for differential pricing.[57] They group banks by asset size, and sort them into buckets by probability of default and LGD. For the largest 20 banks, the probability of default is measured individually. Bennett also demonstrates how fund analysis can be used for differential pricing by allowing parameters of the model (loss severity, for example) to vary with bank characteristics such as size.[58] Bennett, Nuxoll, Fu, and Zhang extend this model to combine credit risk, interest rate risk, deposit growth, and loss rate into a multi-dimensional system to estimate risks to the insurer's entire portfolio.[59] They first calculate a bank-specific probability of default and LGD based on bank characteristics that could be used for differential deposit insurance pricing. Using a credit risk model similar to KMV's CreditMonitor on 15 large Italian banks, Maccario, Sironi, and Zazzara estimate both the loss distribution to the DI and individual

[51] Kendall and Levonian (1991) and Ronn and Verma (1986).

[52] Marcus and Shaked (1984).

[53] Bloecher, Seale, and Vilim (2003).

[54] FDIC (2001).

[55] Pennacchi (2010).

[56] A key parameter in these models is the correlation of defaults across banks, as higher correlation implies that tail losses for the fund are larger.

[57] Kuritzkes, Schuermann, and Weiner (2005).

[58] Bennett (2001).

[59] Bennett, Nuxoll, Fu, and Zhang (2005).

bank marginal contributions to the portfolio risk.[60] Differential deposit insurance pricing arises by allowing for bank-specific loss parameters. If data are available, differential pricing can be calculated alongside fund size.

B. Pricing for Systematic and Systemic Risk

The literature considers at least three types of risk that can be priced: idiosyncratic, systematic, and systemic. The jurisdictional practices discussed in Section V predominantly rely upon idiosyncratic risk as the basis for differential pricing within their DPS. But systematic and systemic risk concerns are also considered. For example, in considering systematic risk, jurisdictions explicitly included limiting pro-cyclicality as a DPS objective (Appendix B) and as an operational concern in IADI's 2011 paper. In addition, Canada and the United States allow for differential pricing based on size or systemic importance.

Actuarially fair premiums – mostly associated with empirical expected loss pricing – are calculated as the losses the DI would incur upon bank failure multiplied by the likelihood of failure. While actuarial pricing is intuitively appealing, Pennacchi argues this method can cause under-pricing because it ignores the timing of bank failures.[61] He argues that unlike property and casualty insurance companies, where loss events are generally independent from one another and the business cycle, deposit insurance is subject to systematic risk. Bank failures are typically clustered in time, with the bulk of bank failures happening over a few years in financial crises and during economic downturns. The risks faced by DIs are not diversifiable and insurance funds and governments are subject to losses at precisely the times at which resources are scarcest and market risk premiums are highest.

The timing of bank failures causes concerns that DISs are pro-cyclical, with aggregate premiums falling during booms and rising during recessions and banking crises. Blinder and Wescott suggest that raising premiums during recessions may exacerbate downturns, undermining efforts of the DI to maintain stability.[62] Pennacchi demonstrates how to calculate a fair market value for deposit insurance by accounting for the market risk premiums associated with bank failures.[63]

While the concepts of pro-cyclicality and systematic risk are often discussed in deposit insurance pricing generally – more consistent with how jurisdictions consider pro-cyclicality in Appendix B – systematic risk also gives rise to *differential* pricing in the literature. Pricing systematic risk suggests that banks whose returns are more highly correlated with those of other banks and the economic cycle should be charged higher premiums, because of the scarcity of resources that the DI and the economy would face when a bank fails. Just as deposit insurance might encourage risk-taking behaviour, Pennacchi suggests that the interaction between risk-based capital standards and actuarially fair deposit insurance pricing may encourage banks to choose portfolios with higher systematic risk.[64] Similarly, Acharya and Yorulmazer argue that a 'too-many-to-fail' problem exists, in that the government is more likely to bail out banks that fail *en masse*.[65] This leads to incentives for banks to herd into highly correlated portfolios, which increases systematic risk. Acharya and Yorulmazer argue that deposit insurance premiums should rise with a bank's correlation of returns with those of the banking industry to deter such behaviour.

Systematic risk can be incorporated into any deposit insurance pricing methodology. Duffie, Jarrow,

[60] Maccario, Sironi, and Zazzara (2003).

[61] Pennacchi (2006).

[62] Blinder and Wescott (2001).

[63] Pennacchi (1999).

[64] Pennacchi (2006).

[65] Acharya, and Yorulmazer (2007).

Purnanandam, and Yang incorporate a measure of market risk based on the correlation of losses in an expected loss framework.[66] Similar to Pennacchi, they find that the fair market prices of insurance, after including market risk, are considerably higher than prices estimated without it.[67] In addition, Duffie, Jarrow, Purnanandam, and Yang discuss how bank-specific credit default swap spreads or risk adjustments to an expected loss model can be applied to a DPS.

Most options-based pricing models implicitly capture systematic risk by using market prices. Because market prices incorporate market premiums, so too does the value of the put option on which they are based. However, Lee, Lin, and Tsai extend the Merton model further to account for the DI's inability to diversify against its specific exposure to the banking industry.[68] To do this, they adopt an options-based approach and include a term for the correlation of a bank's assets with the industry, which induces an additional penalty for pro-cyclicality.

Beyond systematic risk, some papers consider the role that systemic risk plays in deposit insurance pricing. Unlike pricing systematic risk, which is intended to capture a bank's correlation with the cycle, pricing systemic risk is designed to capture the risk that a bank poses to a system-wide failure.[69] Acharya, Santos, and Yorulmazer consider the theoretical implications of systemic risk on actuarially fair deposit insurance pricing.[70] They introduce the effect of asset fire sales during the resolution process into the herding framework of Acharya and Yorulmazer.[71] Acharya, Santos, and Yorulmazer show that banks that are more likely to trigger fire sales are charged a higher actuarially fair deposit insurance premium because of their effect on other banks' EL. Staum suggests a method for attributing systemic risk across a portfolio of banks and incorporates a component of counterparty contagion as a systemic risk interaction in the model and estimation.[72] Although less complex than the systemic risk measures described in the literature, adopting a DPS across institution types (such as the systemically important financial institution designation) as articulated in Appendix B could serve as a basis for differential risk pricing due to systemic risk.

C. Literature Review Conclusion

Consistent with TC member views and the IADI survey, and to the extent that the right conditions are in place, the literature considers differential deposit insurance pricing as one policy capable of mitigating moral hazard risks among the tools available for a DIS. However, a compelling causal link has not been established either in the academic literature or in the jurisdictional experiences discussed in the next section. In response, scholars and practitioners have studied what risks can or should be priced in a DPS and have developed several methodologies that may be used to establish a DPS. The method of pricing risks and the nature of the risks selected for pricing are likely to be a function of the legal, regulatory, and data environment. For example, the option pricing methodology has limited utility for countries that are not market-oriented.[73] Similarly, jurisdictions with limited historical data, few historical bank failures, or few banks may find empirical loss estimation impractical. These considerations help explain the predominance of the bucketing approach (*see* Section V).

[66] Duffie, Jarrow, Purnanandam, and Yang (2003).

[67] Pennacchi (1999).

[68] Lee, Lin, and Tsai (2015).

[69] Acharya, Engle, and Richardson, (2012).

[70] Acharya, Santos, and Yorulmazer (2010).

[71] Acharya and Yorulmazer (2007).

[72] Staum (2012).

[73] Laeven, (2002).

III. GOALS AND EXPECTATIONS FOR A DPS

Typically, flat-rate premium systems are adopted by DIs for their simplicity in design, implementation, and administration. Flat-rate premium systems, however, do not reflect the varying levels of risk that individual banks may pose to the DIS. Such systems can be seen as unfair since all banks pay the same premiums regardless of the level of risk they pose to the DIF.[74] A DPS may overcome these deficiencies.

IADI survey results and input from TC members reflect broad agreement among IADI Members that the primary goals of establishing a DPS are to reduce moral hazard by discouraging excessive risk-taking and to increase fairness by reducing the cross-subsidisation of high-risk insured depository institutions (IDIs) by low-risk IDIs. By assessing relatively higher premiums on those banks that take on greater risk, a DPS may moderate excessive risk-taking and reduce cross-subsidisation.

The literature review points to empirical evidence that a DPS is associated with reduced risk-taking by IDIs, but the magnitude of the effect remains unclear.[75] Measuring the precise effect of a DPS on risk-taking is challenging because it is difficult to disentangle its marginal impact from other possible influences over risk exposure. Nonetheless, if institutions paying higher premiums can be identified as generally riskier by common indicators such as failure rates, examination ratings, or market information, a DPS could reasonably be expected to contribute to mitigating moral hazard to the extent that when IDIs are charged for the risk they undertake, they may have an incentive to undertake less risk in order to reduce their premiums.[76] This is discussed in the case studies of Canada, Chinese Taipei, Malaysia, and South Korea, which note a decrease in the number of IDIs in the higher-risk premium categories after implementing a DPS.

If the DPS accurately identifies and prices risk characteristics, it can enhance fairness by reducing the cross-subsidisation of riskier firms by safer ones. However, a pricing system may not fully reflect the risk exposure of the highest-risk institutions because of political and practical limitations, such as limitations on the DI's ability to set premiums. In such cases it is reasonable to expect that some cross-subsidisation will remain.

The rest of this paper examines ways to evaluate whether the DPS achieves these primary goals: reducing moral hazard and increasing fairness.

[74] "General Guidance for Developing Differential Premium Systems", prepared by the Research and Guidance Committee of IADI, October 2011.

[75] *See* Blair and Fissel (1991) and Hovakimian, Kane, and Laeven (2003).

[76] In May 2013, IADI's Research and Guidance Committee identified DPSs as one of several important factors for mitigating moral hazard, including strong corporate governance and market and regulatory discipline. *See* "Enhanced Guidance for Effective Deposit Insurance Systems: Mitigating Moral Hazard" (IADI, 2013).

IV. BASIC CONSIDERATIONS IN EVALUATING A DPS

IADI's 2011 paper "General Guidance for Developing Differential Premium Systems" addresses several factors to be considered before designing and adopting a DPS. The TC views these factors, among others, as key conditions and circumstances for an effective DPS and therefore as a starting point in an evaluation. In the absence of sufficient data to conduct a more rigorous quantitative analysis, these factors can also be indicators of DPS effectiveness.

Certain design features should also be considered in an evaluation. These features follow Core Principle 9, which states that if a DI uses a DPS, the system for calculating premiums should be transparent to all participating banks, the scoring/premium categories should be significantly differentiated, and the ratings and rankings resulting from the system pertaining to individual banks should be kept confidential.[77]

A. Conditions and Circumstances for an Effective DPS

Each jurisdiction exhibits unique attributes that make some DPS design features work better than others. But IADI experience suggests common elements determine the likely effectiveness of a DPS across jurisdictions. Foremost among these elements are the legal framework, accounting and disclosure regimes, availability and quality of data, supervisory regime, and financial industry structure and performance. While these elements are important for determining the effectiveness of all DISs regardless of how premiums are set, there are aspects of these elements that are especially important to support and sustain a system of differential pricing because the adoption of a DPS extends the range of DI decisions that affect IDIs. These elements represent the starting point in evaluating a DPS.

1. Legal Framework

DISs need relevant and comprehensive laws and a legal regime that can be adapted over time to an evolving risk environment. The Core Principles detail several features of a robust legal and institutional setting that provide for an effective DIS regardless of how premiums are assessed.[78] Moreover, a DPS opens the DI up to legal challenges that are unlikely to occur under a flat-rate system. Given that an institution is charged a higher premium if it is perceived as riskier than other institutions, there is a higher probability that the DI will be challenged regarding the basis of the calculation. Therefore, it is important that the DI establish an appeals process that is perceived as fair and open and that allows insured institutions to challenge their risk classification and assessment without undermining the effectiveness of the DPS itself.

2. Accounting and Disclosure Regimes

A sound accounting regime includes comprehensive and well-defined accounting principles and rules that command wide international acceptance. Sound accounting and disclosure regimes that provide a true and fair view of the financial system are crucial under a DPS and require more granular information than in a flat-rate system. The DI and market participants will need information beyond what is provided in a basic balance sheet to effectively evaluate a bank's risk profile.

A sound disclosure regime, through the reporting of financial statements, can provide accurate, reliable and timely information to management, depositors, market participants, and authorities. DIs using a DPS rely on this information to more accurately price risk, thereby reducing cross-subsidisation. Although not unique to a DPS, disclosure of such information may help reduce moral hazard by enabling accurate decision-making regarding the risk profile of an institution, and improve market, regulatory, depositor, and supervisory

[77] *See* Core Principle 9.

[78] *See* Core Principles 2, 3, and 11.

discipline.

Disclosure of information must be balanced against the need for confidentiality. Often confidential information, such as supervisory reports and regulatory reporting, provides the DI with higher-quality, risk-oriented data than is publicly available.[79] DIs using a DPS must be careful that a bank's rating or premium category is not disclosed to the public or there could be negative consequences, including the withdrawal of funds by uninsured depositors and other creditors. Conversely, the disclosure of ratings of safer institutions could give those institutions a competitive advantage. If the DIS does not have direct access to confidential information, IADI guidance states that formal agreements with the supervisor should be in place.[80]

Among IADI Member jurisdictions, the United States requires all regulated financial institutions to file periodic financial and other information with their regulators and other parties. For U.S. banks, one of the key reports is the quarterly Consolidated Report of Condition and Income, generally termed the Call Report. The FDIC also has access to confidential supervisory data and uses these data in its risk-based premium system. In Chinese Taipei, the Central Deposit Insurance Corporation (CDIC) has statutory inspection powers to verify the accuracy of data and files related to the risk indicators reported by insured institutions.

3. Availability and Quality of Data

The availability and quality of financial data vary widely across IADI jurisdictions, and DPS design will reflect the data environment in each jurisdiction. Evaluation of the DPS will need to consider whether the available data and the quality of the chosen data are sufficient to meet DPS goals. Quality and quantity of the data are often related to the size and complexity of the reporting institutions. Typically, increased amounts and more detailed information are associated with larger firms.

In evaluating a DPS, it should be considered whether the system incorporates high-quality data for pricing risk, such as failure statistics, supervisory ratings, liquidity indicators, asset quality, and capital adequacy. Resolution activities generate additional data, such as asset loss rates, which can enhance premium calculations and provide opportunities for back-testing new models.

An evaluation may also consider the use of market data such as stock prices, credit ratings, or interest rate spreads above the risk-free rate on bank debt. These may supplement supervisory and other financial data for more detailed risk-based pricing calculations. Sometimes the availability of such data may allow for separate pricing systems in the industry. For example, in the United States, the FDIC initially changed its basic DPS using long-term debt issuer ratings, which tended to be available only for larger banks. Over time, the FDIC found these ratings did not change quickly enough to fully reflect the risk of the institution.[81]

4. Supervisory Regime

A strong supervisory regime is critical for the success of a DPS.[82] Effective bank regulation and supervision

[79] Bretschneider and Benna: "Risk-Based Premium Models for Deposit Insurance Systems", in Nolte, Jan P., and Isfandyar Z. Khan, Editors, "Deposit Insurance Systems: Addressing Emerging Challenges in Funding, Investment, Risk-Based Contributions and Stress Testing", World Bank Group, November 2017.

[80] IADI, "General Guidance for Developing Differential Premium Systems", updated in October 2011.

[81] In adopting the scorecard approach, the FDIC eliminated the use of debt issuer ratings in determining deposit insurance assessments. The FDIC first proposed removing debt issuer ratings from the risk-based pricing model in April 2010. The later enactment of the Dodd-Frank Act, which required federal agencies to review and modify regulations to remove reliance upon credit ratings (Public Law 111–203, § 939A, 124 Stat. 1376, 1886), ensured the adoption of this proposal. See Garnett, Edward, LaVaughn Henry, Daniel Hoople, and Ashley Mihalik, "A History of Risk-Based Premiums at the FDIC", FDIC CFR Staff Studies Report No. 2020-01: 19.

[82] *See* Core Principle 13: Early Detection and Timely Intervention.

ensure that an institution's risk profile is measured, monitored, and managed promptly, and where appropriate, supervisory intervention is swift. A supervisory process that results in prompt and accurate risk assessments, reflected through supervisory ratings, will provide for more precise and better informed pricing and will complement the role of DPSs in reducing moral hazard and promoting fairness. The more confidence the DI has in the quality of supervisory ratings and the better the ratings reflect significant risk factors, the greater reliance the DI can have in using the ratings as criteria in the DPS. Accordingly, an evaluation should consider whether the DI has supervisory powers or can influence the factors reviewed in the supervisory process. To evaluate effectiveness, the greater the influence, the more confidence that important factors affecting risk to the DIF are captured.

The supervisory framework should include a regular and robust onsite examination programme coupled with an offsite surveillance system. Without such a framework, the supervisory process may not identify all financial sector risks that are important inputs to the DI's pricing calculations, making DPS less effective.

5. Financial Industry Structure and Performance

An evaluation should consider the extent to which a DPS reflects the evolution of the financial industry. As a jurisdiction's financial industry evolves, DIs should examine whether there are changes in the number, types, and characteristics of banks (such as size, business models, complexity, systemic and systematic influences, and the degree of cross-border banking); types of deposits and depositors covered; and heterogeneity among banks. When IDIs are more complex and heterogeneous, the risk-based premium model must reflect those conditions.[83]

Financial industry structure and performance also have implications for alteration of a DPS. Any changes to the premium structure should consider the condition of the financial sector, including the health and risk profiles of insured institutions based on capital adequacy, earnings, liquidity, exposure to market risks, and credit quality. For integrated protection schemes (IPSs), consistent treatment across the various types of institutions is important.

B. Evaluation of Design Features

An effective DPS achieves its goals by striking the right balance among competing considerations. An evaluation should determine whether the DI considered how to improve transparency as the system becomes more complex, set premiums considering the effect on IDIs, including de novo institutions, and balance the frequency of data collection against the burden imposed on IDIs and DIs. Other considerations for DPS design, such as limiting the pro-cyclicality of the pricing system and the ability to differentiate between institutions for pricing, are discussed in IADI's 2011 paper "General Guidance for Developing Differential Premium Systems".[84]

1. Transparency

Complexity of a DPS can make reducing moral hazard more difficult if a pricing model is so complicated that IDIs cannot determine how their riskiness affects their assessment. In such a case an IDI will not know precisely how to alter its behaviour to reduce its perceived risk. In these circumstances, differential

[83] Bretschneider and Benna, p 60.

[84] Readers may also consider the relative risk approach to mitigating pro-cyclicality cited in Jean Roy's 2019 paper, where banks are not charged for macroeconomic risks beyond their control. Banks are charged a relative risk, which Roy defines as the difference between the risk measure of a bank and the weighted risk measure of the banking sector.

See Roy, Jean. "Optimal Pricing of Deposit Insurance: Aiming at Fairness and Stability". Athens Journal of Business & Economics 5, no. 1 (2019): 37-52.

premiums may not have the desired effect on risk-taking behaviour.[85] An evaluation should, therefore, determine if the DPS is sufficiently transparent to allow an insured institution to understand how its risk was factored into the premium calculation. Making the premium calculation public and enabling institutions to estimate future premium rates can enhance the transparency of the pricing system. To prevent institutions from using this information to 'game the system', average numbers over the premium assessment period can be used to place the institution into a risk category. A fair and balanced premium appeals process can also enhance transparency of a DPS by establishing a system of checks and balances in setting the risk categories. However, DPSs should not compromise confidentiality for additional transparency.

Another element in evaluating transparency concerns how the DI communicates changes to its premium system and solicits feedback from the public. A DI can notify the affected institutions through press releases, industry letters, and its public website. An effective means to solicit feedback is a formal and standardised method for requesting public comments. A DI should consider all comments received and have a follow-up mechanism to ensure that concerns have been addressed in the most appropriate manner. Several IADI Members periodically solicit input from insured institutions on their DPS model. For example, before adding an indicator to their model in 2016, Chinese Taipei held a public consultation workshop to solicit feedback from insured institutions. The Korea Deposit Insurance Corporation (KDIC) annually surveys insured institutions to gauge the level of satisfaction with the DPS. In the United States, changes to the assessment system are implemented through a formal rulemaking process, which typically includes a 30- or 60-day public comment period. Shortly after instituting its Guidelines for calculating Deposit Guarantee Schemes contributions, the EBA surveyed Member States about their implementation.

2. Pricing Constraints

A properly designed DPS can improve fairness in the assessments levied on insured institutions. 'Actuarially fair' premiums represent one straightforward basis for a fair DPS. However, if the premium spread is wide, the DPS might impose prohibitively high costs on riskier institutions and threaten their viability. In practice, therefore, a DPS often charges riskier institutions less than an actuarially fair premium system would charge, but more than under a revenue-equivalent flat-rate system. Less risky IDIs should be charged lower premiums, but every bank benefits from a DIS and poses some risk to the DIF. Therefore, an evaluation should consider whether every bank is charged a premium, even if it is low for the least risky institutions.[86]

Subject to the limits imposed by the funding target, an effective DPS should have a premium spread that is as wide as possible, without threatening the viability of riskier institutions, to incentivise banks to improve their risk management practices.[87] Caps on premiums because of practical or legal considerations, or floors to meet revenue targets, may limit the pricing system's influence on risk-taking behaviour.

When changes to a DPS are made, DIs may also consider a transition period to allow market participants to adjust. This may initially involve limited differences in premiums that evolve over a reasonable time period to a wider premium spread. Simulations that demonstrate how changes in rate spreads affect assessment revenues can help determine a reasonable distribution of the burden across risk categories.[88] Similarly, a DI could estimate how changes to the assessment system would affect individual banks and quantify the burden of a premium or a change in a premium at an individual institution.

Some jurisdictions must also comply with the goals and mandates of other authorities. For example, in

[85] Core Principle 9 emphasises the need for transparency in the calculation of premiums.

[86] "General Guidance for Developing Differential Premium Systems" (IADI 2011).

[87] Ibid.

[88] Ibid.

Europe, the EBA prescribes guidelines for determining premiums: "…these guidelines set out principles on the risk component of the calculation method. In addition, they capture various aspects of the institutions' risk profile by specifying a number of core risk indicators pertaining to capital, liquidity and funding, asset quality, business model and management, and potential losses for the DGS [DIS]."[89] The guidelines were drafted with reference to IADI General Guidance for developing DPSs. The EBA guidelines aim to harmonise practices of national deposit guarantee schemes, ensure a level playing field, and contribute to greater comparability of risk-based contributions to deposit guarantee schemes.

(1) De Novo or Newer Institutions

De novo or newer institutions pose unique challenges to a DPS. For instance, evidence from past crises shows that new institutions tend to be more vulnerable than their established counterparts, and have a higher incidence of failure and problem status.[90] This trend suggests that new entrants should pay higher premiums in a DPS, but higher premiums for new institutions may create a barrier to entry to the banking industry. An evaluation of the DPS should consider whether it strikes the right balance between deterring excessive risk-taking by de novos and discouraging de novo formation. To reduce this potential barrier to entry, some jurisdictions create 'grace periods' for new firms or take a graduated approach to risk-based pricing, assessing a low premium initially and raising it in small increments until it reflects the institution's risk.

Another challenge concerns the limited information available on which to base an assessment of the institution's risk. Until an IDI establishes some business history, its risk profile is often unclear. Therefore, close supervisory attention is required to ensure that the new entrant follows an approved business plan until its management is acclimatised to the business environment. Incorporating this factor in the supervisory regime needs to be considered in evaluating a DPS.

3. Frequency of Data Collection

The evaluation should measure how often pricing data are collected. More frequent data observations and repricing can improve accuracy in models, regardless of when premiums are paid. This makes it more feasible to base premiums on observed trends rather than single data points. With infrequent data observations and repricing, premiums cannot keep pace with changes in risk exposure for the DIF, resulting in extended periods over which the premiums in place do not accurately reflect the current risks posed by IDIs. Frequency of data collection among TC members ranges from monthly to annually.

The benefits of more frequent data collection must be balanced against the cost of the reporting burden on IDIs. The levying of assessments and the corresponding data reporting must be frequent enough for the pricing system to capture changes in risk-taking behaviour, but not so frequent that it imposes an excessive burden on the reporting institutions.

[89] "EBA Guidelines on Methods for Calculating Contributions to Deposit Guarantee Schemes" (EBA 2015).

[90] FDIC, "History of the Eighties: Lessons for the Future. Vol. 1, An Examination of the Banking Crises of the 1980s and Early 1990s" (p 21, 33, and 37).

V. EVIDENCE FROM CASE STUDIES

While many jurisdictions value rigorous, empirically based metrics that might measure success in achieving DPS goals, universal metrics have yet to be established, and may not be suitable to all jurisdictions given the diversity in their banking and other financial sectors. Establishing such metrics would require consistent data collection. In jurisdictions where it is possible to use robust back-testing and advanced statistical techniques to measure how well pricing aligns with actual institution risk (reflected through failure experience and insurance losses, supervisory downgrades, or other risk characteristics), the evaluation of DPS performance can be based on stronger evidence.

The four TC member jurisdictions that have assessed their DPS – Canada, Chinese Taipei, South Korea, and the United States – as well as Malaysia and the EBA, used a variety of evaluation methods.[91] These case studies inform the best practices and lessons learned that are described in Section VI – Quantitative Evaluation. Additionally, the Canada, Chinese Taipei, Malaysia, and South Korea case studies discuss the possibility of their DPS contributing to a decrease in moral hazard, as their systems saw a decline in the number of institutions in the higher risk premium categories.

A. Canada

The Canada Deposit Insurance Corporation (CDIC) reports to the Parliament through the Ministry of Finance and is the DI and resolution authority for 86 member institutions. The Office of the Superintendent of Financial Institutions (OSFI) is the primary regulator and supervisor for most of the CDIC's member institutions. Six member institutions have been designated by OSFI as domestic systemically important banks (D-SIBs) and one of these is also a global systemically important bank (G-SIB). The six D-SIBs account for more than 90 percent of total membership assets and more than 80 percent of insured deposits.

Following several financial institution failures in the 1990s, the CDIC introduced a DPS in 1999 and provided a two-year transitional scoring mechanism to facilitate adaptation to the new premium system. With the DPS, the CDIC sought to provide the board and senior management of each member institution with a signal of the CDIC's evaluation of its risk. The DPS places member institutions into one of four risk-based premium categories (Category 1 is the lowest risk and Category 4 is the highest risk), which are designed to incentivise member institutions to pursue a better classification. The CDIC's statutes prevent it from charging more than 33.33 bps of the volume of insured deposits. This limits the ability of the premiums to reflect the actuarially fair pricing of risk.

As of October 2019, three member institutions were in Category 3 and the remainder were in Categories 1 or 2. The scoring methodology underpinning the DPS in Canada employs both quantitative and qualitative criteria. Categorisation is based on quantitative factors, which account for 60 percent of the total weight, and qualitative factors, which account for 40 percent of the total weight (35 percent examiner rating, and 5 percent CDIC-determined considerations). Quantitative metrics fall within the broad areas of capital adequacy, profitability, efficiency, liquidity (applying only to D-SIBs), and asset quality and concentration. Institutions can appeal their score and categorisation directly to the DI. Scores and scoring information are considered confidential. The CDIC's ex-ante fund target is 1 percent of insured deposits.

The Differential Premiums By-Law (DPB) which underpins the regime is issued by the CDIC Board and must be approved by the Minister of Finance. The DPS is reviewed annually for technical accuracy relative to data

[91] The TC reached out to the six members who had contributed to the 2011 IADI paper ("General Guidance for Developing Differential Premium Systems"), but were not on this TC, to see if they had evaluated their DPS; Malaysia contributed a case study. The TC also wrote a case study on the EBA's "Report on the Implementation of the EBA Guidelines on Methods for Calculating Contributions to DGS".

points contained in OSFI supervisory forms. Technical amendments to the By-Law are made annually.

Most of the technical amendments to the DPB involve revisions to enhance clarity and to promote efficiency by ensuring that language in the By-Law aligns with that in other prudential and supervisory correspondence received by member institutions (for example, when updated technical language or definitions are introduced via amendments to the Basel framework). As the DPS relies heavily on inputs to members' regulatory filings, technical amendments must ensure that the DPS continues to rely on the correct data points and that any changes to data points in the regulatory return requirements are accurately reflected in the DPS Reporting Manual and align with language in the DPB.

The CDIC also comprehensively evaluates the DPS (which includes input solicited from the industry and regulators) on average once every five years. There have been two comprehensive reviews of the DPS since its inception in 1999. The first review occurred during 2004–05 and the second during 2013–14. A third review is under way for 2019–20. Comprehensive reviews typically focus on evaluating the effectiveness of the current scoring regime against one or more alternative scoring regimes in the context of the objectives of the DPS. Scoring regimes considered during a review have generally differed in terms of quantitative metrics employed, where alternative regimes might comprise a subset of the metrics in place (sensitivity and robustness testing), and may also involve modifications to existing metrics and/or introduction of new metrics. Comprehensive reviews are underpinned by empirical back-testing to support model comparison.

The most recent comprehensive evaluation in 2014 was both quantitative and qualitative. The evaluation considered performance of the system, the relative risk between member institutions, and each of the quantitative criteria. The CDIC reviewed how each criterion performed through the history of the DPS, what it was intended to measure, whether that was achieved, how it performed based on perceived risk, and whether it should be applied equally to all members (to improve fairness of the system).

Because of the review, the CDIC implemented amendments to the DPB in 2015 to make key changes to the quantitative criteria. The CDIC reduced the number of tests used to calculate the capital adequacy ratio (CAR) from three to two: the leverage ratio (percentage of authorised assets to capital multiple) and the Tier 1 capital ratio (including capital conservation buffer). Further, changes were introduced to the calculation methods and scopes of certain quantitative criteria: mean adjusted net income volatility, stress-tested net income, net impaired assets to total capital, three-year moving average growth ratio, real estate asset concentration ratio, and aggregate commercial loan concentration ratio. Because of the size, complexity, and diversity of business lines of D-SIBs, the real estate asset concentration criterion was removed and a new asset encumbrance criterion was introduced.

In considering new ratios and thresholds individually or as a group, the CDIC performed back-testing to determine how individual members and the membership as a whole would have scored. The CDIC had limited historical member failure events (and none in more than 23 years) to use as the left hand variable in a formal predictive modelling exercise. The back-testing regime focused instead on changes in the allocation of member institutions both individually and collectively across premium categories. Changes in members' scores, given introduction of an alternative scoring regime dating back over some historical period were also considered. Assessment of changes in the allocation of members across premium categories is necessary but not sufficient for conclusive comparison and evaluation of two scoring methodologies. To complement these results, the CDIC therefore relies on the expert judgement of its risk assessment function to validate individual and collective member allocations between two scoring regimes, and to flag suggested misclassifications produced by a scoring regime, e.g., where one or more members known to be an elevated risk to the CDIC end up categorised in a low premium category, or vice versa. This can be carried further to focus on the scoring outcomes of particular 'watch-list' members which have been declared by the CDIC to carry elevated risk.

This back-testing determined if the ratios and thresholds being contemplated would provide a better measure of risk relative to perceived risk (as determined by the CDIC's Risk Assessment Department) and if the distribution of member scores was acceptable relative to the objective of having 80 percent of members within the top two categories during normal times.

Besides the migration by institutions from high-risk categories to lower-risk categories, the CDIC considered the industry input received during the 2014 review as evidence that the established categories and the premiums assigned to those categories were largely and effectively incentivising prudence by member institutions. However, the CDIC notes that to assess effectiveness, the DPS needs to be tested through a full economic cycle that includes an economic downturn. Canada has not experienced a full credit cycle recently and none of the members experienced a failure since the establishment of the CDIC's DPS. Therefore, it is important to note that the full effectiveness of the DPS is yet to be tested.

The CDIC continues to refine its empirical back-testing methodology to support future comprehensive reviews. For instance, while failure data are limited, the CDIC could consider alternative proxies of member failure risk which are historically observable and measurable. For example, watch-list entry and exit, examiner risk ratings, and member risk ratings produced by the CDIC's risk assessment function could serve as effective left-hand-side variables in modelling the forward-looking properties of future DPS scoring regimes.

B. Chinese Taipei

Following a series of bank runs affecting several financial institutions, the Ministry of Finance and the Central Bank organised and funded Chinese Taipei's DIS in 1985. It is administered by the Central Deposit Insurance Corporation (CDIC). The CDIC insures about 400 commercial banks, cooperatives, and credit departments of farmers' and fishermen's associations.

The initial DIS was flat rate and voluntary. After a series of runs on community banks in 1995 that spilled over to other less operationally sound financial institutions, the DIS was amended to include compulsory membership for deposit-taking institutions, effective in 1999. Liberalisation of the financial sector resulted in greater diversity among banks and also sparked debate over issues of fairness and moral hazard, which resulted in the CDIC introducing a DPS in July 1999 after insured institutions, the government, and academia reached a consensus.

The CDIC uses two risk indicators for its DPS. The CAR represents the risk-bearing capacity of insured institutions. The Composite Score of the risk-based premium rating system, a CAMEL-based system, represents the risk of insured institutions calculated by an evaluation model established by the CDIC. Each risk indicator is further divided into three grades, forming a 3 x 3 matrix (nine groups). The premium rates were originally set at three levels, and were changed to five levels in 2007.

Table 1: Risk Premium Matrix

Capital Adequacy Ratio \ Composite Score	Grade A	Grade B	Grade C
Well-Capitalised	Group 1	Group 2	Group 3
Adequately Capitalised	Group 4	Group 5	Group 6
Undercapitalised	Group 7	Group 8	Group 9

Note: Five premium rate levels are assigned in different colours: blue is level 1, green is level 2, yellow is level 3, orange is level 4, and red is level 5.

While the CDIC's basic DPS model has not been changed, the rating system used to generate the Composite Score has been revised several times in consideration of the economic cycle and the indicators used by bank supervisors. The statistical model used for the rating system is based on data collected in a complete economic cycle, including boom and bust periods, to mitigate statistical bias. The National Development Council (NDC) considers indicators related to exports, investments, consumption, economic growth, and other economic variables to judge if a period has covered a complete economic cycle. Statistical data and six economic indicators such as real gross domestic product (GDP), an industrial production index, and non-farm payrolls are used in the NDC's model. The NDC de-trends its data updates quarterly.

All indicators influencing the business conditions of insured institutions within the complete economic cycle are considered while building or revising the CDIC's DPS rating system. Banks are divided into sound and weak groups. The CDIC conducts t-tests to determine which indicators are significantly different between the two groups.[92] A correlation test is performed to determine the correlation coefficient among the variables to select the least correlated variables. Experience and opinions of supervisors and risk management experts are also considered in building the model. The indicators selected may represent loss assumed, such as loss tolerance capacity and the ratio of classified assets to total assets, or may serve as leading or forward-looking indicators such as the loan growth rate.[93] The data used to calculate the Composite Score are updated each quarter.

The CDIC premium collection and risk management units also review the effectiveness of the system when these events occur: adjustment of the indicators used by the supervisory authority, a change in the financial environment at home and abroad, a change in the financial burden or condition of the insured institutions, or developments among peer DIS. The main objectives of such reviews are to ensure the DPS can continue differentiating the risk profile of each insured institution, and to keep providing the incentive to the insured institutions to promote sound operation in line with supervisory measures and the CDIC risk management policies.

Through periodic review, the CDIC can ensure that the rating system properly reflects the risk and the premium level of each insured institution and that the DPS remains effective. Following a comprehensive review of the rating system in 2013, the CDIC revised many indicators and the weights assigned to each.

To provide an incentive for insured institutions to improve their business operations, the CDIC includes in its DPS new indicators adopted by the supervisory authority or selected by its risk management experts. For example, in 2013, the supervisory authority implemented a new standard of bank capital adequacy (Basel III) and began increasing the capital adequacy requirement each year. As a result, the CDIC adjusted the CAR used for pricing premiums. Another example was adding a liquidity coverage ratio (LCR) to its rating system. To ensure that the rating system remained stable without the additional indicator causing a significant change in the Composite Score of each insured institution, the CDIC conducted several simulation tests before revising its system. The new system was run in parallel with the old rating system for several premium terms before the LCR was officially added.

The CDIC enhanced incentives by expanding the number of premium levels and spreads between each rate level. In 2000, the spread between each of the three premium rate levels was increased from 0.25 bps to 0.5 bps. In 2007, the three premium rate levels were expanded to five, with the spread increased to 1 bp. In 2011, the spread was enlarged further to 1, 2, 3 and 4 bps between each successive rate level. [94]

---

[92] A t-test compares the average values of two data sets to determine if they came from the same population.

[93] Loss tolerance capacity is the ratio of potential asset losses to net worth plus valuation reserve.

[94] Three premium rates in 1999 were set at 0.015 percent, 0.0175 percent and 0.02 percent of covered deposits. The premium rates in 2000 were increased to 0.05 percent, 0.055 percent and 0.06 percent of covered deposits. Five premium rates in 2007 for banks were set at 0.03 percent, 0.04 percent, 0.05 percent, 0.06 percent and 0.07 percent of covered deposits. Differential premium rates from 2011 for banks are 0.05 percent, 0.06 percent, 0.08 percent, 0.11 percent and 0.15 percent of covered deposits.

Table 2: Central Deposit Insurance Corporation Premium Rate Increases

Risk Category	1	2	3	4	5
1999	.0150 %	.0175 %	.0200 %		
2000	.0500 %	.0550 %	.0600 %		
2007	.0300 %	.0400 %	.0500 %	.0600 %	.0700 %
2011	.0500 %	.0600 %	.0800 %	.1100 %	.1500 %

Note: Rates are percentages of covered deposits.

The CDIC solicits and considers the views of financial institutions when evaluating its DPS. Before amending the rating system in 2016 to incorporate 'information security items' in the indicator of management ability, the CDIC held a public consultation workshop and invited insured institutions to make recommendations.[95] The CDIC revised the plan according to the recommendations received. This change was to guide the insured institutions to strengthen their cyber security, which is in line with the DPS objective of promoting sound operation of the insured institutions and reducing insured risk.

In the 2013 revision of the DPS rating system, the lowest premium rate applied to 69.3 percent of the CDIC's insured institutions. By September 2019, the lowest premium rate applied to 76.2 percent of institutions, with no institution falling into the highest premium category. This result is the outcome of the synergy of implementing the new supervisory measures and the DPS.[96] While it shows that the DPS has provided insured institutions with the incentive to improve their business operations, the CDIC has started to evaluate and review its DPS again to keep the pricing mechanism effective and incentive-driven.

C. European Banking Authority

Article 13(3) of the Deposit Guarantee Schemes Directive (DGSD) tasked the EBA with issuing Guidelines on methods for calculating Deposit Guarantee Schemes contributions (the Guidelines). These Guidelines, published by the EBA on 28 May 2015, specify methods for calculating contributions to DIS and the objectives and principles governing contribution schemes.[97] The deadline for Member States to implement these risk-based calculation methods for contributions was 31 May 2016. Following implementation and in accordance with the DGSD, the EBA had to review the Guidelines by 3 July 2017. The purpose of the review was to assess whether the Guidelines were implemented correctly and whether they were effective in meeting the objectives.

[95] The evaluation indicators of information security in the DPS rating system include cyber security-related certification, cyber security self-assessment, major breaches in information and communication security, and staff information-related fraud cases.

[96] The major supervisory measures for enhancing the operation of banking institutions include increasing allowance for bad debts and increasing capital adequacy.

[97] *See*: "Guidelines on Methods for Calculating Contributions to Deposit Guarantee Schemes (DGSs)". 2015. *European Banking Authority*. https://eba.europa.eu/regulation-and-policy/recovery-and-resolution/guidelines-on-methods-for-calculating-contributions-to-deposit-guarantee-schemes-dgss-.

The initial conclusions of the review were published on 18 January 2018.[98] As the time period between the deadlines for implementing the Guidelines and reviewing the implementation was only thirteen months, the initial conclusions are based on limited experience of operating the risk-based contribution systems among most DISs and were not designed to propose immediate changes to the Guidelines.

The DGSD requires contributions of DIS member institutions to be based on the amount of covered deposits and the degree of risk incurred by each member institution. Calculation of contributions shall be proportional to the risk of the member institutions and shall take due account of the risk profiles of the various business models. The Guidelines set out eight core indicators (that is, risk variables) and five risk categories to be followed by DISs and other authorities when developing or approving the calculation methodologies. Individual DISs may utilise their own methods for calculating the risk-based premiums from their members, but each method must be approved by the EBA.

The evaluation was based on both quantitative and qualitative measures and, given the brief period between implementation and evaluation, provides limited information on the practical experience of members' DPSs. However, the review does discuss methodologies to assess whether contributions to a DPS adequately differentiate to produce a fair calculation for member institution contributions or whether the contributions provide incentives for member institutions to operate under a less risky business model.[99]

To test whether the DPS results in a difference in contributions based on the institution's riskiness, each DIS compared member contributions calculated per the Guidelines (GL RBC) to a contribution methodology based solely on covered deposits (non-risk-based contributions or nRBC).[100] To assess the differentiation, the EBA provided each DIS with a tool to calculate basic statistical information that could then be used to compare results under GL RBC to results under nRBC. DISs were also asked to respond to a survey to provide information comparing their GL RBC method to previous RBC methods, historical data on institution failures, and the Supervisory Review and Examination Process assessment (SREP assessment).[101] By comparing GL RBC results to available historical data, the EBA gauged whether the assessment of riskiness was in line with real life experience of firms that were riskier and ultimately failed (or would have failed without DIS intervention) within the previous two years. The comparison to SREP assessments tested whether the GL RBC method produced significant differences from other forms of risk assessment. The review found that generally, based on the limited experience, the GL RBC method adequately differentiated between institutions' risk.

As noted, the GL RBC method requires the use of eight core indicators distributed across five risk categories. To test whether the GL RBC method could be simplified and fewer indicators used, a correlation calculation was made for indicators in the same risk category. The expectation was that if the correlation between any two indicators was very strong, then a Member State should consider whether both indicators are necessary.

Testing whether the GL RBC methodology produced differences in member institution contributions as compared to other methodologies, however, could not determine whether the differentiation achieved using GL RBC would be adequate to account for an institution's risk. Relatively low differences between GL

[98] *See*: "Report on the Implementation of the EBA Guidelines on Methods for Calculating Contributions to DGS". 2018. *European Banking Authority*. https://eba.europa.eu/eba-report-shows-that-the-guidelines-on-methods-for-calculating-contributions-to-deposit-guarantee-schemes-have-broadly-met-their-aims-but-they-would-.

[99] Differentiation is defined as a difference in contributions based on institutions' riskiness and whether there is a difference vis-à-vis a contribution methodology based solely on covered deposits.

[100] Results of the various methodologies used to evaluate the GL RBC can be found in the EBA report cited in footnote 2.

[101] According to the ECB, SREP summarises all the supervisor's findings of a given year and sets key objectives for a bank to correct identified issues within a given timeframe. *See* https://www.bankingsupervision.europa.eu/about/ssmexplained/html/srep.en.html

RBC and nRBC, for example, could simply indicate that DIS institutions were relatively homogeneous. To address whether the achievement of differentiation under GL RBC fully accounts for differences in institutions' risks, DIS compared the level of differentiation in institutions' individual risk scores (IRSs), which are calculated for each risk indicator, to the overall level of heterogeneity in each of the core indicators among institutions covered by the DGS.[102]

Expectations were that a DIS with a broad range of results in core indicator values should also have a relatively broad range of results in the IRS for that indicator. Similarly, a DIS with a narrow range of core indicator values – indicating relative homogeneity among institutions for that indicator – should have a relatively narrow range of IRSs. If for a given core indicator, the DIS has a broad range of values but the IRS range is narrow, it could suggest that the DIS decision on the design of the method led to a lowering of the importance of the observed differentiation in that indicator on the amount of contributions. Spearman's rank correlations were also used to assess whether higher indicator values were correlated with higher IRS scores and vice versa.[103]

Finally, the evaluation considers aggregate risk scores (ARSs) and aggregate risk weights (ARWs). An institution's risk is represented by its ARS, which is derived from its IRSs. [104] To calculate contributions, the ARS is translated into an ARW.[105] In general, risk differentiation should increase with the level of heterogeneity within the DIS.

The EBA review also included measures to assess whether the Guidelines methodology is transparent, objective, ensures protection of confidential data, and does not create an excessive reporting burden. To assess each of these, qualitative survey questions were administered, leaving room for open-ended answers. For example, to measure transparency, Member States were asked about the steps they had taken to ensure that institutions understood the criteria for calculating contributions and the purpose of the risk-based method. For confidentiality, respondents were asked what information relating to the contributions was disclosed to the public and to each institution. Lastly, to assess additional reporting burden, Member States were asked what data they requested from institutions and competent authorities, as well as the percentage of data necessary to calculate contributions that the DIS already had.

Based on the limited results of the evaluation, the report included some recommendations on further improvements and amendments of the Guidelines to be considered as part of a wider DGSD review in 2019, when more and better data are available to draw more robust conclusions.[106]

---

[102] To assess whether the institutions affiliated with a DIS were heterogeneous, a comparison was made between the 5th and 95th percentile values for each core indicator for the population of institutions. An average value of the indicators was also calculated across all DISs. Based on the values, each DGS was ranked on each indicator in comparison with the average value. DISs were classified as having a homogeneous set of institutions, a moderately homogeneous set of institutions and a heterogeneous set of institutions for each indicator. An overall average score was then calculated for each DIS and the DIS was categorised.

[103] It was noted that this statistical method should only be interpreted in conjunction with the results of the other analytical methods as it does not account for differences in each DIS membership's distribution.

[104] The ARS is calculated by summing the individual IRSs adjusted for appropriate indicator weights. Its value is between 0 and 100, with higher values indicating greater risk.

[105] The ARW determines the change in an institution's contribution compared with an nRBC method.

[106] In August and October 2019, the EBA published its first and second of three opinions on the implementation of the DGSD.

The first opinion covers the eligibility of deposits, coverage level and cooperation between DISs. *See* https://eba.europa.eu/eba-publishes-the-first-of-three-opinions-on-the-implementation-of-the-deposit-guarantee-schemes-directive.

The second opinion focuses on the payouts by DISs. *See* https://eba.europa.eu/eba-publishes-opinion-proposing-further-strengthen-depositor-protection-eu.

The third and final EBA opinion, on DIS funding and uses of DIS funds, will be published in early 2020.

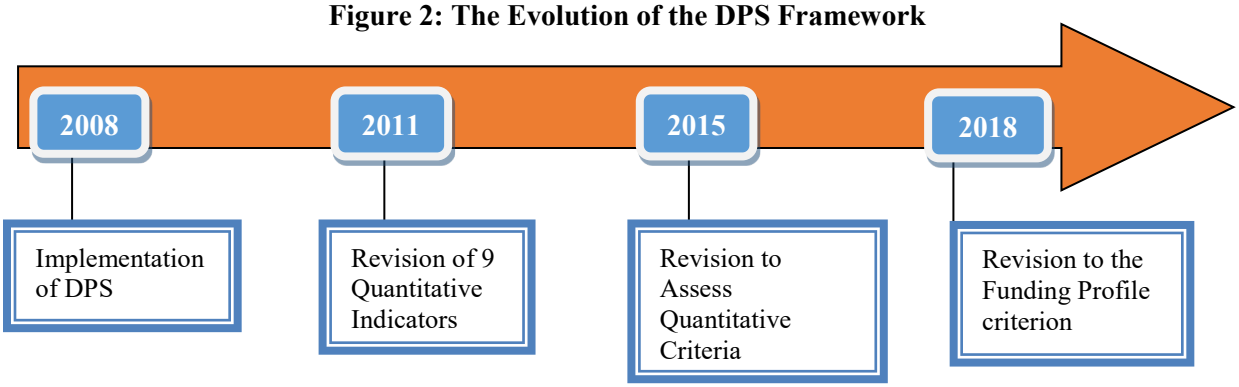
D. Malaysia

1. Introduction

Perbadanan Insurans Deposit Malaysia (PIDM) is a government agency, established in 2005, to administer the DIS aimed at protecting depositors as well as the owners of takaful certificates and insurance policies.[107] In its first two years of operation, PIDM adopted a flat-rate ex-ante premium system with 0.06% charged on the total amount of insured deposits held by a member bank. The flat-rate premium system was intended to be temporary and the plan was to migrate to a risk-based premium system by 2008 to encourage banks to improve their risk profiles and to introduce more fairness into the premium assessment process.[108]

PIDM implemented one DPS framework applicable to both conventional and Islamic banking businesses. However, certain indicators in the framework are adjusted to reflect the unique features of the Islamic banking business.[109] Since its implementation, the DPS framework has been revised three times, reflecting PIDM's continuous commitment to ensure that the DPS framework remains effective.

Figure 2: The Evolution of the DPS Framework



The first revision in 2011 reflected changes and new developments in the regulatory and operating environment. The second revision in 2015 assessed the quantitative criteria to incentivise member banks to maintain strong capital buffers and ensure overall financial soundness. The third revision in 2018 revised two indicators in the funding profile criterion to reflect changes in the member banks' funding structure and recent regulatory developments.

2. Establishment of the DPS

In 2008, PIDM transitioned to a DPS. The system used quantitative criteria such as capital ratios, profitability measures, and asset quality measures (Table 3). To incentivise member banks to improve their overall risk management, the supervisory rating was incorporated as a major component of the qualitative assessment with a maximum score of 35%.

[107] 'Takaful certificates' is the term used for insurance policies under the Islamic insurance concept.

[108] PIDM Corporate Plan (2006–2008).

[109] Premium categories are assigned separately for conventional and Islamic banking businesses. Conventional banks that operate Islamic banking windows are required to submit separate reporting forms for the respective businesses and their annual premium payment is paid separately between the conventional and Islamic banking businesses.

Table 3: Summary of Criteria and Scoring System for the PIDM DPS (2008)

CRITERIA	SCORE	
Capital		**20**
Risk-weighted Capital Ratio	10	
Core Capital Ratio	10	
Profitability		**15**
Return on Risk-weighted Assets	8	
Mean Adjusted Return Volatility	7	
Efficiency		**5**
Efficiency Ratio	5	
Asset Quality		**10**
Net non-performing loans (NPLs) to Capital Base Ratio	5	
Gross NPLs and Loans In Arrears To Gross Loans Ratio	5	
Asset Concentration		**5**
Aggregate Sector Asset Concentration Ratio and Residential Property Asset Concentration Ratio	5	
Asset Growth		**5**
Risk-weighted Assets to Total Assets Ratio; and Total Asset Growth Ratio	5	
Total Quantitative Criteria		**60**
Supervisory Ratio		**35**
Other Information		**5**
Total Qualitative Criteria		**40**
TOTAL		**100**

The framework had, and continues to have, four risk-based premium categories (Table 4). They range from 1 to 4, with 1 being the lowest risk category, and 4 the highest. To provide a strong incentive for riskier member banks to modify their risk behaviour, the premium rates were doubled between categories, starting with a premium rate of 0.03 percent for premium category 1 to 0.24 percent for premium category 4.

Table 4: PIDM Premium Categories

DPS Score	Premium Category	Premium Rate
≥ 85	1	0.03%
≥ 65 to < 85	2	0.06%
≥ 50 to < 65	3	0.12%
< 50	4	0.24%

Overall, PIDM developed a system that was simple to implement yet robust enough to classify members into different risk categories effectively. To ensure acceptance, the assessment process was made transparent and not too complex so that member banks were able to understand and verify their risk categorisation. An appeal process was put in place to allow any member bank to request a review of its final scores.

3. The Revision Process

As part of PIDM's commitment to ensure the effectiveness of the DPS framework, continuous reviews are carried out with major reviews planned every three years. The purpose is to ascertain whether the DPS framework's criteria and indicators continue to be relevant in line with changes and developments in the operating and regulatory environment, prudential requirements, and accounting convention. Reviews may also be necessitated by structural changes in the financial system or experience over time.

Consultation and engagement with member banks and close consultation with Bank Negara (BNM), the primary regulator and supervisor of member banks, are integral to the review process. The review process usually starts with a survey to gather feedback from member banks, and discussions with BNM, focusing on areas for improvement.

As part of the review process, PIDM conducts an impact assessment which simulates the results of the proposed member banks' premium category distribution to determine whether it would be a better reflection of the member institutions' risk profiles. PIDM also utilises a comprehensive risk assessment methodology to assess member banks' risk profiles for internal monitoring and reporting purposes. There are more indicators used in the methodology and it includes more qualitative factors. The member bank's risk profile based on this internal assessment is also used to validate the results of the simulation done.

Guided by the survey results and discussions, a consultation paper is developed and issued for public comments. All comments to the consultation paper, as well as PIDM's response to the comments, are published on PIDM's website.

4. First revision in 2011: Revision to the quantitative criteria

In 2010, PIDM issued a consultation paper for public comments on the DPS framework. Comments were received from member banks, rating agencies, and consulting firms, and the revised framework was implemented in 2011.

The objectives of the review were to:

a) ensure that the existing criteria and indicators used were still current and relevant;

b) address feedback received and issues encountered since the implementation of the DPS framework; and

c) assess the impact of changes and developments in the operating and regulatory environments such as the implementation of Basel II and the adoption of Financial Reporting Standard ('FRS') 139.

The analysis performed included an assessment of the relevancy of the indicators given the developments in the operating environment and regulatory landscape, the adequacy of the threshold and scoring approach in providing incentives for sound risk management practices, and the need for new indicators to account for changes in member banks' risk appetite and growth direction.

For example, the relevance of incorporating the efficiency ratio (cost to income ratio) was reconsidered since a significant number of member banks continued to have low scores. Upon examination, it was determined that the low scores were due to banks making significant investments in technology infrastructures and human capital to comply with Basel II requirements. Based on the analysis and consultation process, revisions were made to the quantitative criteria, including the removal of the efficiency criterion. In addition, the capital, profitability, asset quality and asset concentration criteria were enhanced (Table 5).

Table 5: The First Revision - Comparison of Revised and Current DPS Criteria and Weight/Score

2008		Revised - 2011		Remarks
Criteria	**Weight/ Score**	**Criteria**	**Weight/ Score**	
Quantitative Criteria	**60**	**Quantitative Criteria**	**60**	
Capital	**20**	**Capital**	**20**	
Risk-weighted Capital Ratio	10	Risk-weighted Capital Ratio	10	Refined threshold
Core Capital Ratio	10	Core Capital Ratio	10	Refined threshold
Profitability	**15**	**Profitability**	**15**	
Return on Risk-weighted Assets	8	Return on Risk-weighted Assets	8	Refined threshold
Mean Adjusted Return Volatility	7	Mean Adjusted Return Volatility	7	Unchanged
Efficiency	**5**			
Efficiency Ratio	5			Removed
Asset Quality	**10**	**Asset Quality**	**15**	**Increase score weight**
Net NPLs to Capital Base Ratio	5	Net Impaired Loans to Capital Base Ratio	8	New indicator based on FRS 139
Gross NPLs and Loans in Arrears to Gross Loans Ratio	5	Total Impaired Loans Ratio	7	New indicator
Asset Concentration	**5**	**Asset Concentration**	**5**	
Aggregate Sector Asset Concentration Ratio and Residential Property Asset Concentration Ratio	5	Household Sector Concentration Ratio; and Aggregate Sector Loans Concentration Ratio	5	New indicator
Asset Growth	**5**	**Asset Growth**	**5**	
Risk-weighted Assets to Total Assets Ratio; and Total Assets Growth Ratio	5	Risk-weighted Assets to Total Assets Ratio; and Total Assets Growth Ratio	5	Unchanged; refined formula

Changes were also made to the reference source of information obtained from the regulatory reporting to the financial statements. This was to ensure greater consistency in the computation of various indicators as data would be extracted from a single source. The changes also reduced the operational risk arising from the need to make some adjustments to the data to comply with PIDM's reporting requirements.

5. Second Revision in 2015: Introduction of the Matrix Approach

2015 marked a significant milestone in the enhancement of the DPS framework. Feedback obtained from the survey and discussions with member banks and BNM centred on two main areas. First, the feedback identified the need to monitor changes in the regulatory environment and prudential requirements. Second, the feedback highlighted the need to draw lessons from the recent global financial crisis. The aspiration was for the DPS framework to be more effective in providing the incentives for better overall risk management.

The key structural change to the framework was the revision to the assessment of the quantitative criteria. While the weighting of the quantitative criteria was unchanged at 60 percent, the criteria would be assessed based on a 'matrix approach', replacing the linear method that was in place since 2008. Other revisions to the quantitative criteria included the introduction of a new criterion, the 'funding profile', changes to some of the existing indicators, and the introduction of several other new indicators (Table 7).

(1) Matrix Approach

The introduction of the matrix approach enabled PIDM to better differentiate the risk profile of members based on two dimensions – the level of capital buffer, and overall financial performance and condition. The approach was designed to reflect the linkages between a strong capital buffer and sustainable financial

performance and to incentivise members to have both strong capital buffer levels and financial performance and condition.

(2) Capital Buffer Assessment

The global financial crisis demonstrated the importance of having strong capital to cushion members against unexpected losses. Recent developments on the regulatory front also reinforce the need for strong capital positions. A strong capital level is critical in ensuring that member banks remain solvent as it represents the last line of defence against any unexpected losses. The capital buffer maintained by member banks was differentiated using four thresholds at the horizontal axis of the matrix, as detailed in Table 6.

Table 6: Capital Buffer Assessment

Capital Buffer Assessment				
Position Under the Matrix	4	3	2	1
	< 2.0%	≥ 2.0% to < 3.0%	≥ 3.0% to < 4.0%	≥ 4.0%

(3) Financial Performance and Condition Assessment

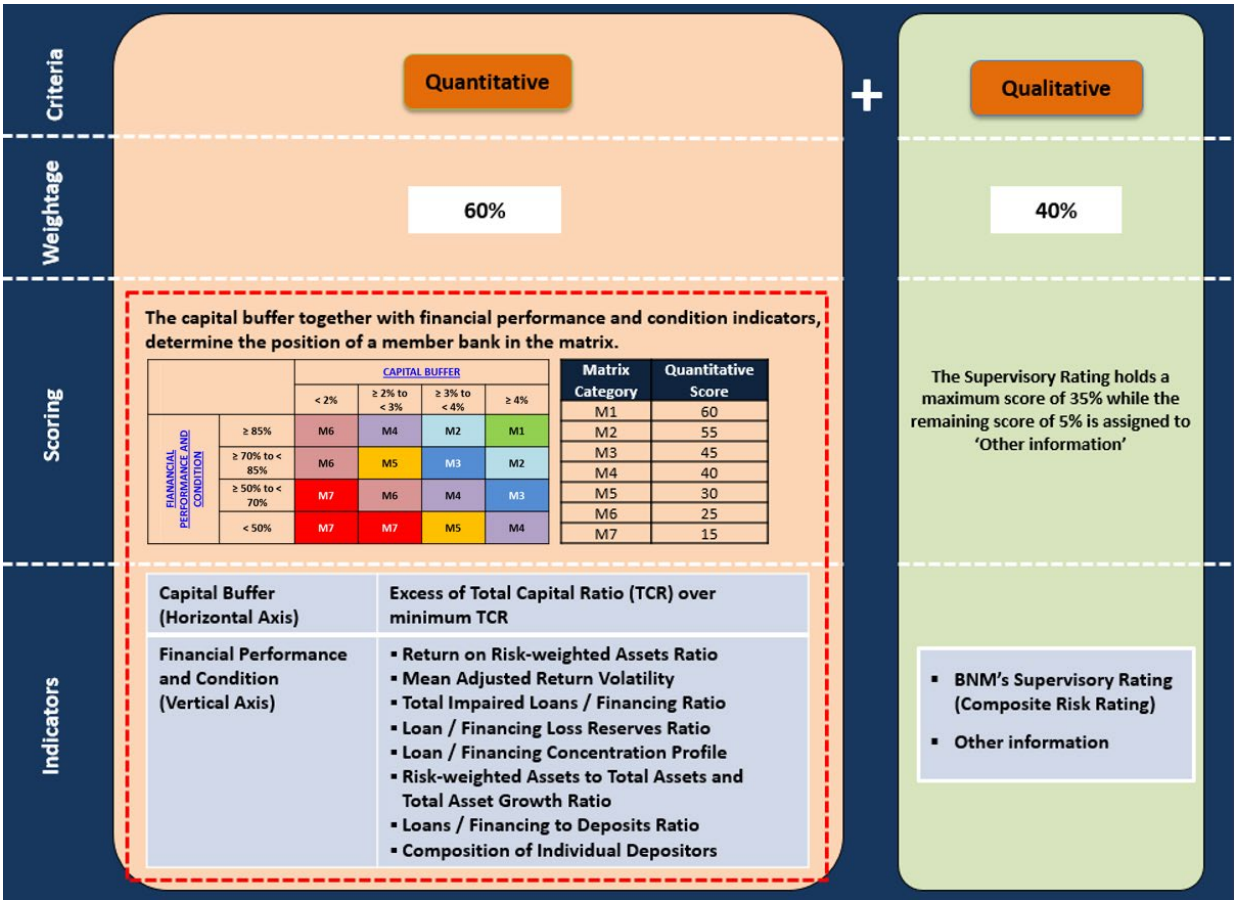
In selecting the criteria and indicators for assessing financial performance and condition, PIDM carried out extensive analysis to ensure the appropriateness and suitability of the indicators. The thresholds determined for each of the indicators were identified and tested based on the current and expected developments in the operating environment. Further reviews and tests were performed on the distribution of the results of the selected indicators to ensure applicability over the business operating environment. PIDM also considered the alignment with the current regulatory and supervisory policies, fairness to all member banks, the average industry performance, as well as peer positioning of member banks. Overall financial performance and condition was assessed based on three major criteria: profitability, asset profile, and funding profile. The proposed indicators for each of the criteria were as follows:

Table 7: The Second Revision - Indicators under Financial Performance and Condition Assessment

Criteria	Indicators	Score	Remarks	Objectives
Profitability (25%)	1. Return on Risk-weighted Assets Ratio	15	Existing indicator	To measure the sufficiency and sustainability of member banks' earnings.
	2. Mean-adjusted Return Volatility	10	Existing indicator	
Asset Profile (50%)	1. Total Impaired Loan/Financing Ratio	15	Existing indicator	To measure the level of impaired loans in a member bank's lending/financing portfolio.
	2. Loan/Financing Loss Reserves Ratio	10	New	To measure the level of loan loss reserves held against a member bank's impaired loans/financing.
	3. Loan/Financing Concentration Profile	10	Revised	To measure the extent of a member bank's lending /financing portfolio concentration to a particular economic sector.
	4. Loan/Financing Growth	15	New	To measure the annual growth rate of a member bank's total asset base vis-à-vis the risk profile.
Funding Profile (25%)	1. Loans/Financing to Deposits Ratio	20	New	To measure the level of loans/financing that was funded by customer deposits.
	2. Composition of Individual Depositors	10	New	To measure the composition of individual depositors against a member bank's deposit base.
Total		**100**		

The revised DPS framework is summarised in Figure 3.

Figure 3: The Revised DPS framework



Overall, with the matrix approach, the risk profiles of members can be better differentiated. The mapping of these two key areas would then place member banks in one of the seven possible categories, with each category carrying a fixed quantitative score. A bank could improve on its position in the matrix, and thus its premium, by improving its risk profile.

6. Third Revision in 2018: Revising the Funding Profile Criterion

PIDM also noted changes in the funding landscape, from the regulatory perspective as well as the operating environment. Based on discussions with BNM representatives it was acknowledged that enhancements to the two indicators under the funding profile criterion would reflect developments in member banks' funding structures.

The loans to deposits ratio (LDR) was introduced in 2015 to measure the level of loans funded by customer deposits. The LDR for the banking system had been rising since mid-2015, as loan growth outpaced deposit growth. This development was partly due to a deepening of Malaysia's financial market as banks were increasingly able to tap into the domestic capital market to broaden their funding base, reduce maturity mismatch, and prepare for the implementation of the new liquidity standards under Basel III. As a result, PIDM replaced the LDR with the loans to available funds ratio (LAFR). The LAFR, which takes into account the varied funding instruments that are available to member banks, provides incentives for member banks to manage their balance sheet prudently.

The 'composition of individual depositors' was another indicator introduced in 2015. It was defined as the amount of deposits placed by individuals as a percentage of total deposits. Deposits from individuals were generally regarded as the most stable source of deposits. The new liquidity standards under Basel III, particularly the net stable funding ratio ('NSFR'), were aimed at promoting long-term resilience of a bank's liquidity risk profile by ensuring that banks funded their activities with sufficiently stable sources on an ongoing basis. Apart from the deposits sourced from individuals, the NSFR recognised funding sourced from small business customers, operational deposits, and long-tenured debt instruments as stable funding. Against this backdrop, the 'composition of individual depositors' was replaced with the composition of core funds, which incorporates the other stable funding sources.

In summary, the enhancements to the indicators under the funding profile criterion were to recognise the other stable funding sources apart from deposits, as well as to provide incentives for member banks to maintain sound funding strategies with a high composition of stable funding sources.

Table 8: The Third Revision - Enhancing the Funding Profile Criterion

No.	Indicators	Revised Indicators	Remarks
1.	Loans/Financing to Deposits Ratio	Loans/Financing to Available Funds Ratio	The Loans/Financing to Available Funds ratio takes into consideration the broader range of funding instruments available to member banks to fund their lending activities. Generally, as financial intermediaries, member banks' lending activities should predominantly be funded by stable funding sources. This ratio was intended to incentivise member banks to manage their balance sheet prudently with an appropriate matching of more diversified and stable funding sources to their lending activities.
2.	Composition of Individual Depositors	Composition of Core Funds	The Composition of the Core Funds indicator was intended to provide incentives for member banks to maintain a strong level of stable funds. Apart from retail deposits, other forms of stable funds such as funds from small business customers, operational deposits and long-tenured debt instruments and borrowings were included.

7. Conclusion - A Continuous Journey

The implementation of the DPS has been instrumental in PIDM's achievement of its mandate of providing incentives for sound risk management practices in member banks by administering an incentive-based system to promote financial stability. Member banks continue to maintain strong fundamentals of sound asset quality, stable funding and adequate liquidity position, and solid capital position.

Since its implementation in 2008, PIDM believes the DPS has met its objective of providing an equitable system, which can effectively differentiate the risk profiles of member banks and incentivise them to manage their risks more prudently. Notable improvements have been observed in member banks' risk profiles, as reflected in the shift to better premium categories over the years. For members whose premium category was unchanged, the shift to a better position in the matrix for the quantitative criteria indicates an improvement in their risk profile. Positioning analysis of the overall industry also reflects a stable risk profile. For some quantitative indicators, member banks' positions were mainly distributed in the top range of the threshold. Annually, PIDM provides benchmarking analysis to member banks that can be used as a reference to determine areas for improvement. PIDM also engages with the senior management and boards of weak member banks to discuss action plans to improve their overall risk profiles.

PIDM will continue to review the DPS framework from time to time to ensure that it remains current and relevant, given the fast-evolving operating environment and regulatory landscape. One possible criterion for inclusion in the assessment could be the resolvability assessment of member banks. The ultimate intention is to ensure that the DPS framework continues to promote sound risk management practices among member banks and, ultimately, to contribute to the stability of the financial system.

E. South Korea

The KDIC is an IPS, making it responsible for insuring commercial and savings banks, securities firms, and insurance firms, totalling 307 institutions (as of FY 2018).[110] The KDIC adopted a DPS in February 2009 with an amendment of the Depositor Protection Act and it was implemented in 2014 with the Act's Enforcement Decree.[111] In designing the DPS, the KDIC considered IADI recommendations and practices in other countries and adapted them to national circumstances.

The KDIC has an assessment model for each of the financial industry sectors. Each institution is rated on an absolute, 100-point scale and then assigned to one of three grades. The KDIC's risk assessment model comprises two areas: the Basic Assessment, which has 80 points, and the Supplementary Assessment, which has 20 points. The Basic Assessment looks at financial indicators related to an institution's capacities for crisis management, prudential management, and resilience to losses. The Supplementary Assessment has two components: Financial Risk Management, which accounts for 15 points, and Non-financial Risk Management, which accounts for 5 points. In Financial Risk Management, the KDIC looks at two financial ratios which can provide a complementary view of an institution's risk profile. These ratios are changed every year in consideration of primary risk concerns and the characteristics of each industry sector. The Non-financial Risk Management category evaluates a firm's risk management as determined by such items as sanctions and penalties imposed by regulatory authorities, occurrence of financial incidents, non-compliance with requirements for explaining deposit insurance coverage and confirming customer understanding, and any failure to implement corrective measures ordered by regulatory authorities after a KDIC examination or inspection.[112] The structures of the risk assessment models are similar across industry sectors, but there are differences in the financial indicators chosen and in their weights to reflect sector characteristics.[113]

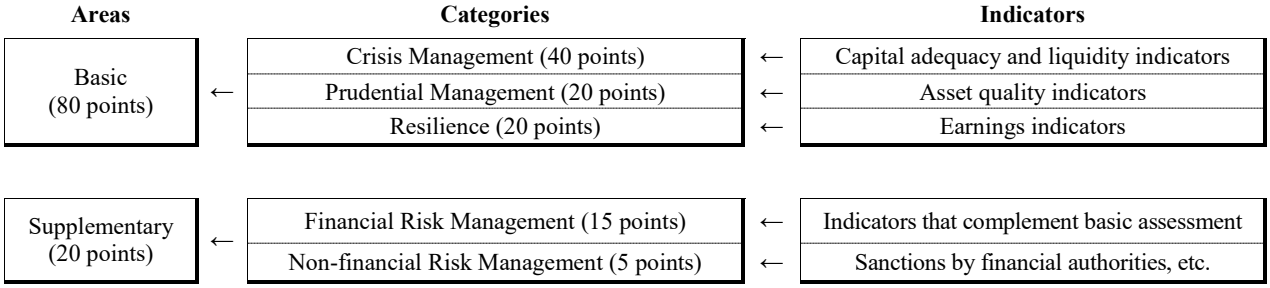
[110] The KDIC conducts three types of assessment: model-based assessment, specifically assigned rate assessment (for firms which pay small DI premiums, such as newer institutions), and non-grade assessment (applied to insolvent firms, etc.). All KDIC-insured financial institutions that do not receive a predetermined premium rate and are not waived from the DPS are assessed for their risk level using the DPS model.

[111] The 1995 version of the Depositor Protection Act had provisions related to the DPS, but implementation was delayed by the lack of provisions in the Act's Enforcement Decree.

[112] In Korea, the Financial Supervisory Service uses the CAMEL-R rating system, which includes the Management Capacity component (M). However, the frequency of that rating is different from the DPS rating, and the Financial Supervisory Service does not share its ratings with the KDIC. The KDIC has developed its own set of indicators to assess non-financial risk management capacity for its risk pricing.

[113] Loans account for most of the assets in the commercial and savings banking sectors, which implies a higher importance of credit risk management, so more weight is given to asset quality. In the insurance sector, where it is critical that firms have sufficient loss-absorbing capacity to cope with interest rate risk and insurance risk, capital adequacy is emphasised.

Figure 4: KDIC Risk Assessment Model Structure



Source: KDIC.

The DPS initially had three grades.[114] Grade 2 represented the standard rate while institutions in Grade 1 receive a discount and institutions in Grade 3 paid higher rates.[115] After consulting the industry, the KDIC set the maximum premium spread at 6 percentage points, ranging from a discount of 5 percent off the standard rate, to 1 percent over the standard rate. For commercial banks, the standard rate was set at 8 bps and for savings banks at 40 bps (as shown in Table 9). In 2016, the KDIC began to increase the maximum rate applicable to Grade 3. By 2017, the KDIC applied the same discount and premium (5 percent) to the standard rate, for a spread of 10 percent. The spread was increased to 14 percent in 2019 and will increase to 20 percent in 2021.

Table 9: Rates for Each Grade (Banks and Savings Banks)

Sector	**Premium Rates** (Rate discount/increase)*	**2014–2015**	**2016**	**2017–2018**	**2019–2020**	**2021–**
Banks	Grade 1 (Discount)	7.6 bps (–5%)	7.6 bps (–5%)	7.6 bps (–5%)	7.44 bps (–7%)	7.2 bps (–10%)
	Grade 2	8.0 bps				
	Grade 3 (Rate increase)	8.08 bps (+1%)	8.2 bps (+2.5%)	8.4 bps (+5%)	8.56 bps (+7%)	8.8 bps (+10%)
Savings Banks	Grade 1 (Discount)	38.0 bps (–5%)	38.0 bps (–5%)	38.0 bps (–5%)	37.2 bps (–7%)	36.0 bps (–10%)
	Grade 2	40.0 bps				
	Grade 3 (Rate increase)	40.4 bps (+1%)	41.0 bps (+2.5%)	42.0 bps (+5%)	42.8 bps (+7%)	44.0 bps (+10%)

* Rate discount or increase from standard premium rates.

The thresholds for dividing grades and cut-off values for each indicator were set through a simulation with a sample of financial institution data so that the distribution of grades would be 30 percent, 40 percent, and 30 percent.[116]

The KDIC reviewed the DPS model in 2016 in cooperation with a national policy research institute. The review found that some sectors experienced a rapid increase in the share of institutions in Grade 1. The review noted that, although the DPS increased incentives for financial institutions to manage their risks, the thresholds for grade separation were set too low because the sample used to determine the thresholds was

[114] Korea's DPS was constructed with three grades in the expectation that it would make it easier for financial institutions to adapt to the new system.

[115] These were the same under the previous fixed rate scheme.

[116] The sample used to set thresholds for grade separation included total scores of all insured institutions from 2007 to 2011. The sample used to set cut-off values included insured institution performance on each indicator from 2000 to 2011.

derived from data during the financial crisis, rather than over an economic cycle. Changes from reforms in the supervisory criteria also needed to be incorporated in the DPS model.

The KDIC held public hearings and seminars to promote receptivity among the industry for changes to the model. Key changes to the model included:

- resetting grade thresholds based on a sample data set of financial institution performance on each indicator of the most recent five years;
- adding new banking sector indicators related to capital regulation (tier 1 capital and common equity capital requirements) and liquidity regulation (LCR) under Basel III; and
- adding indicators of asset concentration in high-risk industries and household loans in light of emerging risk factors.

The modified model was applied to risk assessments for FY 2017.[117] In 2019, the KDIC undertook another review of the model in consideration of the latest changes in the financial market environment in collaboration with an outside research institute. Key improvements will include:

- increasing the number of grades for the maximum amount of rate differentiation;
- identification of new candidate indicators to enhance the model's accuracy;
- a review of the appropriateness of indicator weights; and
- incorporation of industry requests for system improvement in the DPS.

In addition to the reviews conducted with outside research institutes, the KDIC also performs an annual internal review to test the appropriateness of the indicators and verify their statistical significance. When shifts in supervisory policy and other changes necessitate adjustments in cut-off values or other thresholds, the KDIC makes corresponding changes to the DPS model and if necessary, replaces the indicators in the Financial Risk Management category.[118] Each year, the KDIC holds seminars with financial institution officials to support their understanding of the risk assessment process and conducts a survey to get their input on the DPS's operation and areas of improvement. The KDIC also provides analysis reports to insured institutions showing how they performed on each indicator relative to their peers, to encourage voluntary efforts for sound management.

F. United States

The FDIC was established in 1933 and insured 5,177 commercial banks and savings associations as of 31 December 2019. The FDIC's DPS has evolved since it was implemented in 1993 and continuing through changes made during and after the most recent financial crisis.[119] In setting risk-based premiums, the FDIC is required to consider the risks attributable to different categories and concentrations of assets and liabilities, the likely amount of any loss for which the DIF is at risk, and any other factors the FDIC determines to be relevant.[120] The first system assigned institutions to one of nine risk categories based on capital levels and supervisory ratings. In transitioning to a risk-based system, the FDIC implemented a

[117] The KDIC also conducted an empirical study in 2017 to see whether the DPS adoption had resulted in changes in the risk appetite of KDIC-insured financial institutions. The study found that risk appetite decreased significantly across all financial industry sectors.

[118] When supervisory rules for the banking sector changed in 2017 to allow the recognition of additional capital instruments such as common equity, the KDIC adjusted the methodology for calculating institution scores and cut-off values of related indicators.

[119] Additional details on each major change to the FDIC's DPS are available in Garnett, Henry, Hoople, and Mihalik: "A History of Risk-Based Premiums at the FDIC", FDIC CFR Staff Studies Report No. 2020-01.

[120] Section 302(a) of FDICIA (Pub. L. No. 102-242, 105 Stat. 2236). Under Section 302(a), the revenue needs of the deposit insurance fund may also be taken into account when calculating assessments under the statutory system.

narrow range of rates between the lowest and highest risk classifications, balancing the need for generally high assessment rates to recapitalise the DIF with the burden that very high rates could have on institutions already in a weakened condition.

A few years after the system was implemented, risk differentiation became severely constrained by statutory restrictions that prevented the FDIC from charging well-capitalised, highly rated institutions for deposit insurance once the DIF reached a certain level. For nearly ten years, only a small number of institutions were charged premiums and more than 95 percent of insured institutions paid zero assessments. The statutory restrictions were eliminated by Congress in 2006, and in 2007 the FDIC refined its DPS and established separate pricing methodologies for small and large banks. The FDIC added financial ratios to its risk-based premium calculations to determine assessment rates for certain institutions.[121] The financial ratios were shown, in a statistical model, to predict the probability that a bank's supervisory rating would be downgraded within one year. The FDIC chose this model because there had been very few failures in the years leading up to 2007. The financial ratios ultimately selected included the Tier 1 leverage ratio, the non-performing assets to gross assets ratio, and the net loan charge-offs to gross assets ratio. As part of the revisions, the FDIC collapsed the nine risk categories used to determine a bank's assessment rate into four categories and widened the range of assessment rates. In addition, the FDIC changed how it assessed new institutions based on findings that new institutions have a higher failure rate than established institutions.[122] The changes were also intended to limit the moral hazard associated with new entrants to the DIS not paying premiums commensurate with their risk.[123]

In 2009, based on its experience resolving failed banks at the start of the financial crisis, the FDIC made additional adjustments to its pricing system to account for liabilities that could increase or decrease the loss to the DIF. One adjustment increased assessment rates for banks financed with large amounts of secured debt, which has a higher standing than the FDIC as receiver in the priority of claims after a bank fails, which could increase the loss to the DIF.

The banking crisis that began in 2008 led to passage of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) in 2010.[124] The Act required the FDIC to redefine the assessment base by broadening it from domestic deposits to average consolidated total assets minus average tangible equity (an approximation of total liabilities). This change shifted the total burden of assessments to the largest banks, which rely less on deposits for funding than the rest of the industry. The FDIC also revised its pricing methodologies for large banks. The FDIC introduced new scorecards to determine risk-based assessment rates for large banks derived from information on how large banks fared during the crisis.

The most recent changes to the system were in 2016, in response to the FDIC's evaluation of the effectiveness of the system, and were based on its experience during the two financial crises. The agency updated its risk-based pricing for established small banks, using data obtained from the failure of hundreds of small banks during and in the aftermath of the 2008 crisis and failures from the previous crisis. These revisions, as with earlier reforms, aimed to improve the pricing system's accuracy in measuring the relative risks that banks posed to the DIF and to enhance incentives for prudent risk-taking by banks by

[121] Financial ratios were used with supervisory ratings to determine assessment rates for small banks in the lowest risk category and for large banks that did not have available market data.

[122] While new institutions were generally formed with higher levels of capital than their competitors, they had low rates of return on assets and were "financially fragile and more susceptible to failure than established banks". *See* Yom, Chiwon "Recently Chartered Banks' Vulnerability to Real Estate Crisis", *FDIC Banking Review* 17 (2005): 115.

[123] From 1996 to 2006, most new institutions, like other banks in the lowest risk category (1A), paid no premiums at all. *See* Yom, Chiwon and Yan Lee, "The Entry, Performance, and Risk Profile of De Novo Banks", FDIC Center for Financial Research Working Paper 2016-03 for more on new institutions.

[124] Public Law 111-203, 124 Stat. 1376, 1539.

incorporating more forward-looking risk measures.

1. Large Bank Pricing

In 2011, the FDIC revised how it charged deposit insurance premiums for large banks. The revisions had three primary goals: (1) to mitigate pro-cyclicality by pricing for risk as banks incur those risks, rather than when losses are realised; (2) to better differentiate risk during good economic times based on how banks would fare during stressful times; and (3) to explicitly incorporate potential losses to the DIF from a large bank failure.[125]

To accomplish these goals, the FDIC adopted a scorecard method to calculate assessment rates for large banks. One scorecard applies to most large banks, and another applies to banks that are structurally and operationally highly complex, or that could pose unique challenges and risks if they failed. The scorecard method combines information from supervisory ratings with forward-looking financial measures to produce an indicator of an institution's financial performance and ability to withstand stress. A loss severity score is also calculated to represent the level of potential losses if the institution fails. The performance score and loss severity score combine to form a total score converted to an initial assessment rate. The FDIC can also make limited discretionary adjustments to the total score, using quantitative or qualitative measures not captured by the scorecard.

Given the few failures of large institutions that occurred during the 2008 financial crisis, the FDIC chose financial measures using a statistical model that predicted, over a three-year horizon, the relative risk of large institutions as of year-end 2009 based on the FDIC's experience and judgement (the expert judgement ranking).[126] The three-year prediction horizon and several financial measures selected provide a more forward-looking measure of risk by capturing risks when they are assumed, rather than when losses are realised. For example, the scorecards include measures of higher-risk assets, growth-adjusted portfolio concentrations, counterparty exposures, and balance sheet liquidity. These measures were shown to predict a large institution's long-term performance, including the ability to withstand unexpected market events.

Forward-looking risk measures are intended to help mitigate the pro-cyclicality of risk-based assessments because banks that pose higher long-term risk will pay higher assessments when they assume those risks. This feature should also provide incentives for banks to avoid excessive risk-taking during economic expansions.

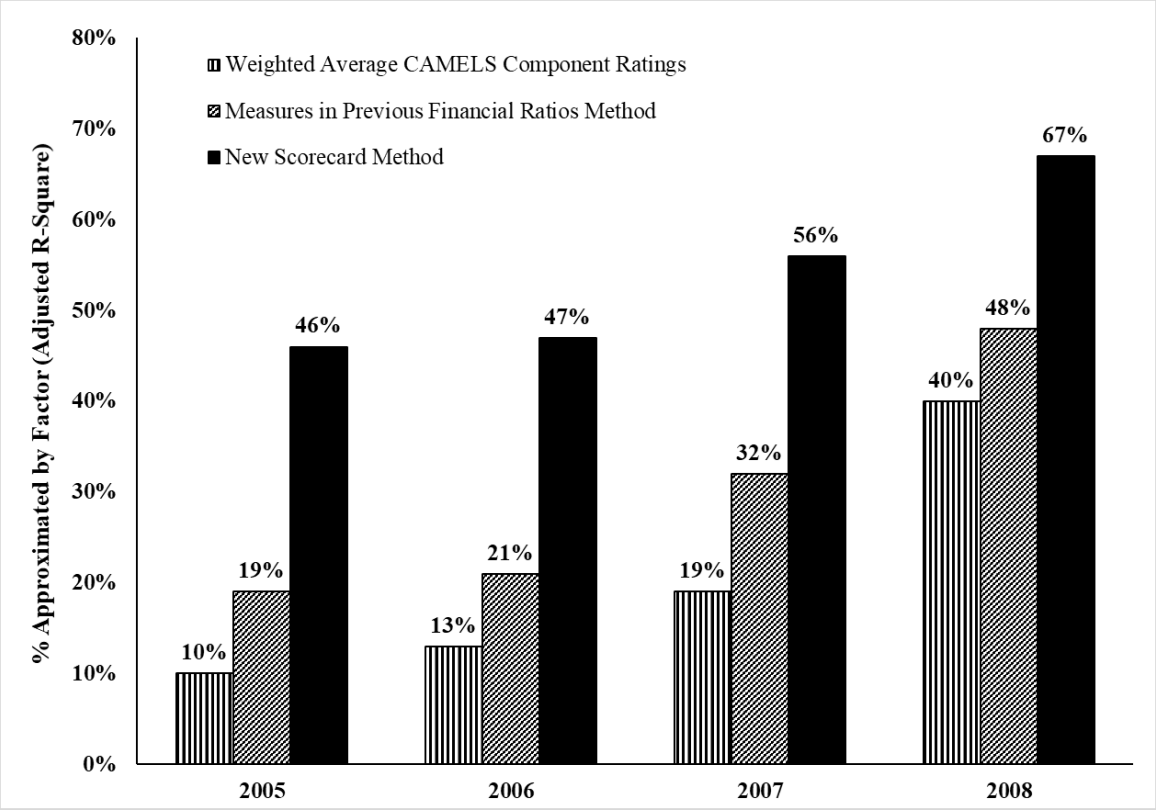
The changes explicitly incorporate a measure of potential losses if a large bank fails. The scorecard method accounts for the effect on loss severity of the entire composition of the large bank's assets and liabilities and changes in a bank's balance sheet during the potential path to failure. The loss severity measure is calculated by applying a standardised set of assumptions about run-off of certain kinds of liabilities and the recovery value of assets to calculate the magnitude of potential loss to the insurance fund.

[125] *See* 75 Federal Register FR (3 May 2010) at 23516, available at www.federalregister.gov.

[126] The expert judgement ranking is a risk ranking of large institutions that was largely based on supervisory information available to the FDIC. Large institutions that failed or that received significant government support in 2008 or 2009 were assigned the worst risk ranking. The FDIC opted to use the expert judgement ranking to select financial measures given the few failures of large institutions that occurred during the crisis. Additional details about the expert judgement ranking, including how it was used to identify risk measures, can be found at 75 Federal Register FR (3 May 2010) at 23516–23556, available at www.federalregister.gov.

In developing the large bank scorecard, the FDIC evaluated how the new scorecard would have performed compared with the pricing method it replaced. Besides the three-year horizon of the scorecard, the FDIC tested prediction horizons of one, two, and five years.[127] As shown in Figure 5, the scorecard measures for the four horizons predicted the expert judgement ranking significantly better than financial and supervisory risk measures used for large bank pricing in 2009 and 2010.[128] The new measures also provided better predictions than the weighted average CAMELS component ratings alone.[129] For example, in 2006, the new measures would have predicted the FDIC's year-end 2009 risk ranking of large IDIs as more than twice as large as the financial and supervisory risk measures used in the previous method.

Figure 5: Comparison of Predicted Risk Rankings vs. Actual Financial and Supervisory Rankings



Source: 75 Federal Register FR (3 May 2010) at 23516-23556, available at www.federalregister.gov.

The FDIC also evaluated how the new scorecard and other changes to the assessment system would affect

[127] In addition to using the expert judgement ranking as the dependent variable, the FDIC tested the robustness of scorecard measures in predicting a large institution's long-term performance using a logistic regression model. The model estimated the ability of those same measures to predict whether a large institution failed or received significant government support prior to year-end 2009. Those tests showed that the difference in predictive ability was generally statistically significant.

[128] Expert judgement risk ranking refers to the relative risk of large institutions as of year-end 2009, over a three-year horizon, based on the FDIC's experience and judgement.

[129] *See* 76 F.R. 10689 (25 February 2011). The existing financial ratios method combined weighted-average CAMELS composite scores, financial ratios, and long-term debt issuer ratings. Lack of historical debt rating data for a significant percentage of large institutions made it difficult to compare the predictive accuracy of the measures in the scorecard to the existing system. However, for a smaller sample with available debt ratings, adding debt ratings to other risk measures did not improve the predictive accuracy of the model. Further, the Dodd-Frank Act required federal agencies to remove reliance on credit ratings and substitute an alternative standard of creditworthiness. *See* Public Law 111-203, § 939A, 124 Stat. 1376, 1886 (codified at 15 U.S.C. 78o-7 note).

the capital and earnings of insured institutions. Although the FDIC intentionally set assessment rates to collect about the same assessment revenue as the previous system, it recognised that the revisions would affect the earnings and capital of individual institutions. The FDIC projected effects to earnings based on the estimated change in assessments for each institution as a percentage of its income. To maintain confidentiality, results were presented in aggregate by the size of the projected change in assessments (e.g., decrease in assessments of 0 to 5 percent of income) and whether the institution had been profitable over the previous two quarters. The FDIC concluded that 98 percent of institutions would pay lower assessments and have higher earnings over the one-year projection period and that no bank that faced an increase in assessments would, because of that increase, fall below key regulatory capital thresholds.[130]

2. Small Bank Pricing

The restoration in 2006 of the ability to charge all banks a premium regardless of the size of the fund allowed the FDIC to change risk-based pricing intended to make the assessment system fairer and to reduce moral hazard. Analysis of historical data (from 1985 to 2000) showed that banks in higher risk categories, or banks that would have been in higher risk categories if a risk-based system had been in effect before 1993, failed at higher rates. The analysis also revealed that the FDIC could reduce the number of risk categories from nine to four based on similarity of failure rates without sacrificing accuracy in differentiating risk.

Subsequent FDIC analysis, shown below in Table 10, confirmed that banks in the higher risk categories as revised in 2006 failed at higher rates in the recent banking crisis than banks in the lower risk categories. Further, among the banks within Risk Category I, those paying the maximum rate for that category failed at rates higher than banks paying the minimum rate in the category. Figures are five-year failure rates using risk category data from 2007 to 2012 and failures through 2017. Since banks in Risk Category I paid a range of rates, failure rates for that risk category are shown by quartile. Each failure rate represents the percentage of banks in a quarter and in a given risk category that failed in the next five years (aggregated over all data quarters from 2007 through 2012).

Table 10: Five-Year Failure Rates for U.S. Banks by Risk Category, 2007–2012

<table>
<tr><th rowspan="2">Capital Group</th><th colspan="3">Supervisory Group</th></tr>
<tr><th>A
CAMELS 1 or 2</th><th>B
CAMELS 3</th><th>C
CAMELS 4 or 5</th></tr>
<tr><td>1: Well Capitalised</td><td>Risk Category I
Quartile 1: 0.51%
Quartile 2: 0.83%
Quartile 3: 1.99%
Quartile 4: 4.57%</td><td rowspan="2"></td><td rowspan="2">Risk Category III
13.09%</td></tr>
<tr><td>2: Adequately Capitalised</td><td colspan="2">Risk Category II
4.82%</td></tr>
<tr><td>3: Under Capitalised</td><td colspan="2">Risk Category III
13.085%</td><td>Risk Category IV
60.60%</td></tr>
</table>

Source: FDIC.
Note: Capital Group refers to the capital categories as defined under Prompt Corrective Action.

[130] As part of its analysis, the FDIC made a number of assumptions to estimate the projected effects on capital and earnings. For a discussion of those assumptions and full results of the analysis, *see* 76 F.R. at 10725 to 10727 (25 February 2011).

Although the new methods to determine assessment rates for banks in Risk Category I (to which most banks were assigned) added complexity, they appeared to improve risk differentiation and make the system fairer. These separate pricing methods increased the system's flexibility and ability to adapt to changing conditions. To mitigate the burden of additional complexity, the FDIC published on its website a spreadsheet calculator that bankers can use to estimate insurance assessment rates for future quarters.[131]

In 2016, the FDIC amended the deposit insurance assessment system for established small banks.[132] The changes were designed to more accurately reflect risk posed by small banks by making the assessment system more forward-looking and by capturing more of a bank's risk when assumed, rather than after losses are incurred.[133] The FDIC incorporated new data from the recent financial crisis and revised the methodology to improve the system to more accurately price risk. Such improvements were intended to further the goal of reducing cross-subsidisation of high-risk institutions by low-risk institutions.[134] Small banks have been assessed for deposit insurance under this system since the third quarter of 2016.

With new data from hundreds of bank failures during and in the aftermath of the crisis, the FDIC updated the underlying model for small bank pricing to directly estimate the probability of failure. The pricing method that the 2016 method replaced was based on an underlying model that estimated the probability that a small bank's supervisory rating would be downgraded during the following year, with downgrades serving as a proxy for failures. The FDIC's updated model adopted a three-year prediction horizon for the probability of failure to yield a more forward-looking view of risk. The revised pricing method eliminated risk categories and uses financial ratios to determine assessment rates for all established small banks. To prevent the system from assigning a rate that reflects either too little or too much risk, the FDIC established minimum and maximum rates based on supervisory ratings. Several financial measures are the same as those previously applicable to banks in the lowest risk category, while other measures are new or revised. One new indicator measures the relative risk of a bank's portfolio based on historical industry-wide charge-off rates during the crisis.

To develop the revised small bank pricing method, the FDIC evaluated whether the new pricing method would improve accuracy in differentiating risk among small banks. The agency back-tested the new method and calculated accuracy ratios to measure how well the new method and previous method differentiated between banks that failed and those that did not during the last crisis.[135] As shown in Table 11, back-testing with accuracy ratios revealed that, while the previous pricing method captured risk relatively well, the new method performed better overall, and significantly better immediately before and at the beginning of the crisis (2006 to 2008).[136]

---

[131] The FDIC updates the spreadsheet calculator to reflect revisions to risk-based pricing. The most current calculator is available at https://www.fdic.gov/deposit/insurance/calculator.html.

[132] Changes referred to in this section did not apply to *de novo* institutions (those chartered within the past five years). Risk-based pricing for those institutions was generally left unchanged.

[133] *See* 80 Federal Register (13 July 2015) at 40838, 81 Federal Register (4 February 2016) at 6108, and 81 Federal Register (20 May 2016) at 32180; available at www.federalregister.gov.

[134] *See* 80 FR (13 July 2015) at 40838 and 40842, available at www.federalregister.gov.

[135] An accuracy ratio compares how well each approach would have discriminated between banks that failed within the projection period and those that did not. In this case, the projection period was the three years following the date of the projection (the last day of the year given). For example, the accuracy ratios for 2006 reflect how well each approach would have discriminated in its projection between banks that failed and those that did not fail from 2007 through 2009. *See* 81 FR (20 May 2016) at 32196-97, available at www.federalregister.gov.

[136] The accuracy ratio is based on bank data through 2011 and failure data through 2014. In a 'perfect' projection with an accuracy ratio of 1, every bank that failed over the period was rated as riskier than every bank that did not fail. In a random projection with an accuracy ratio of 0, the projection does no better than chance.

Table 11: Improvement in Accuracy Ratios for Small Bank Pricing (2016)

Year of Projection	Accuracy Ratios		
	Updated Method	Previous Method	Change
2006	0.7000	0.3491	+0.3509
2007	0.7756	0.5616	+0.2140
2008	0.9003	0.7825	+0.1178
2009	0.9354	0.9015	+0.0339
2010	0.9659	0.9394	+0.0265
2011	0.9543	0.9323	+0.0220

Source: FDIC.

The FDIC also compared the new assessment system's out-of-sample forecast accuracy to the previous system using cumulative accuracy profile (CAP) curves.[137] The FDIC's analysis found that the new system was superior to the previous system over the entire range of risk ranking for 2006. Similar comparisons were done for 2007, 2008, and 2009, and the new system outperformed the old system in each case (but to a lesser extent as the predictive window decreased).

Finally, the FDIC evaluated how changes to the assessment system for established small banks would affect the capital and earnings of those banks. Similar to the analysis performed in 2011, the FDIC projected the effect to earnings based on the estimated change in assessments for each institution as a percentage of its income and presented those changes in aggregate, by the size of the projected change and whether the institution had been profitable over the previous six months. Since the changes to the assessment system for established small banks were implemented with revisions to the assessment rate schedule, the FDIC presented its findings both with and without changes to the rate schedule. Without changes, nearly 80 percent of established small banks would pay the same or lower assessments under the revised DPS over the one-year projection period and no bank that faced an increase in assessments would, because of that increase, fall below key regulatory capital thresholds.[138]

3. U.S. Case Study Conclusion

Since first implementing risk-based pricing, the FDIC has incorporated data and experience gained over nearly 25 years – including two banking crises – and in response to statutory changes that increased the FDIC's flexibility in managing the fund and charging risk-based premiums. The changes made to the DPS over time – separate pricing methods for small, large, and highly complex banks; introducing numerous financial risk measures; and various pricing adjustments – made the system more complex but also, in the FDIC's view, more effective in differentiating risk. Statistical analyses that generally accompanied revisions to risk-based pricing demonstrated that the changes would improve the system's effectiveness in differentiating risk among banks and would create a fairer system that places a greater assessment burden on banks with higher risk profiles.

To mitigate the burden that this additional complexity might add, the FDIC is transparent about the changes made and in helping member institutions understand how the system works. As required by law, the FDIC

[137] A CAP curve is a chart in which the horizontal axis represents the model's prediction of the probability of each institution's failure, in descending order. Those with the highest predicted probability of failure would have a percentile rank near zero, while the banks with the lowest predicted probability of failure would have a percentile rank near 100. The vertical axis represents the cumulative percentage of actual failures. Models are judged by the area underneath the CAP curve, with superior models displaying a greater area beneath its curve.

[138] As part of its analysis, the FDIC made a number of assumptions to estimate the projected effects on capital and earnings. For a discussion of those assumptions and the full results of the analysis, *see* 81 F.R. at 32193 to 32196 (20 May 2016).

follows a 'notice-and-comment' rulemaking process, which provides the public with the opportunity to review and provide comments on proposed regulatory changes.[139] This comment period typically ranges from 30 to 60 days. All comments and proposed alternatives received during the comment period are carefully considered.[140] Following assessment system changes, the FDIC issues press releases and Financial Institution Letters that provide explanations of, and insights into, new regulations.[141] The models and findings underlying the pricing methodologies are available to the public. The FDIC also publishes a spreadsheet calculator on its website to help member institutions and the public understand how individual assessment rates are determined.[142] In addition, it publishes the assessment rate schedules and FDIC numbers that bankers can call if they have questions about their assessment.

As the banking industry evolves and the FDIC continues to monitor and evaluate risk at IDIs, additional changes to risk-based pricing may be warranted. Any updates to the FDIC's risk-based pricing system will continue to be motivated by its desire to improve the system's ability to differentiate for risk.

[139] The FDIC is required under the Administrative Procedures Act to solicit and consider comments from the public as part of its rulemaking process. First, the FDIC issues a Notice of Proposed Rulemaking (NPR) proposing a regulatory change and soliciting public comment on the proposal. The FDIC may issue an Advanced Notice of Proposed Rulemaking before issuing an NPR to notify the public that a rulemaking may be proposed in the future and to request comments. After a public comment period of 30 to 60 days, the FDIC considers the comments and issues a Final Rule with details of the final regulations. Administrative Procedure Act (APA), Pub.L. 79–404, 60 Stat. 237.

[140] FDIC Statement of Policy on Development and Review of FDIC Regulations and Policies. https://www.fdic.gov/regulations/laws/rules/5000-400.html#fdic5000developmentar

[141] Financial Institution Letters are addressed to the Chief Executive Officers of member institutions and announce new regulations and policies, new FDIC publications, and a variety of other matters of interest to executives of member institution.

[142] Spreadsheet calculators for small, large, and highly complex institutions are available at https://www.fdic.gov/deposit/insurance/calculator.html.

VI. QUANTITATIVE EVALUATION

DIs should periodically evaluate their DPS and determine whether to make adjustments. Some jurisdictions establish and maintain formal regulatory review periods, often every five years, while others evaluate more or less continuously as new data become available. A financial crisis or stress event often prompts a DI to evaluate its DPS and generates important information against which the DI can conduct an evaluation. However, the DI needs to recognise the idiosyncratic nature of the event when determining the usefulness of the information for that evaluation.

Although it is challenging to measure the effectiveness of a DPS at reducing moral hazard, many methods exist to evaluate the impact on fairness. Under a fair system, those institutions taking on greater risk are charged for that risk and have a stronger incentive to reduce risk. Therefore, by using methods that evaluate fairness, DIs can proxy their ability to reduce moral hazard in the system. A range of simple to more complex approaches is discussed below.

A. Prior Financial Crisis

Jurisdictions commonly evaluate their pricing systems following a financial crisis or a period of significant stress. While events during a systemic crisis are often extreme, data on the underlying characteristics of failed banks and the scope of their losses can provide an empirical basis against which to measure the accuracy of a proposed or existing DPS model in identifying riskier banks. Examples where prior crises or stress have informed DPSs include: the financial crisis in the United States in the 1980s and early 1990s that prompted the requirement for risk-based deposit insurance pricing; the increase in financial institution failures in Canada in the 1990s that led to a government review of the DIS and legislation calling for a DPS in 1999; and in 1995, depositor runs at community financial institutions in Chinese Taipei that spilled over to other financial firms and resulted in the adoption of the first risk-based premium system in Asia in 1999. In the United States, evaluation of performance during the 2008 crisis resulted in modifications to the DPS.

Implementation or modification of a DPS frequently occurs alongside other reforms, creating challenges in isolating marginal effects from the effects of broader reforms. Nonetheless, the literature review and jurisdictional experience provide evidence that, when coupled with rigorous regulatory oversight and an effective financial regulatory regime, DPSs can both mitigate moral hazard and increase fairness. The FDIC found that changes made to its DPS over time – separate pricing methods for small, large, and highly complex banks, introduction of numerous financial risk measures, and various pricing adjustments – improved the system's effectiveness in differentiating risk among banks, creating a fairer system and placing a greater assessment burden on banks with higher risk profiles.[143]

B. Approaches to Evaluate Effectiveness

The simplest approach to evaluating the effectiveness of a DPS involves periodic comparisons between premiums paid and risk indicators such as historical failure rates or higher insurance losses. For example, a jurisdiction that uses the bucketing approach would expect that banks assigned to the higher risk buckets would be charged higher premiums and fail at higher rates. An analysis of historical data in the U.S. case study showed that banks that are assigned to higher risk categories and that pay higher premiums failed at rates higher than banks in lower risk categories.[144] In the absence of failure data, a DI could compare supervisory ratings or market data with premium rates to verify that riskier institutions are paying more

[143] For example, Ronn and Verma (1986), Blair and Fissel (1991), and Hovakimian, Kane, and Laeven (2003), Pennacchi (2006), and Acharya, Santos, and Yorulmazer (2010).

[144] See Garnett, et. al, 2020: 7, 14.

than less risky institutions.

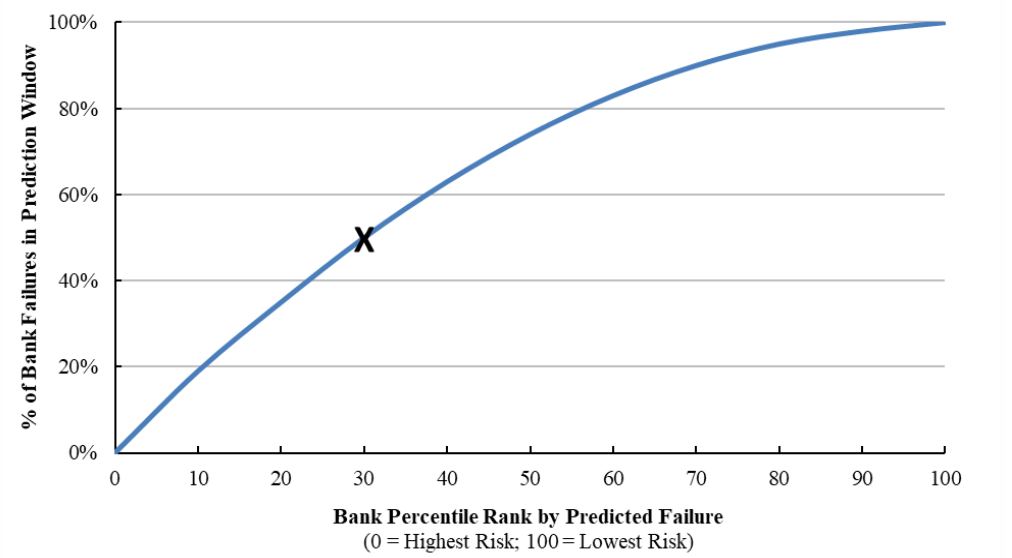
More complex approaches rely on sophisticated statistical analysis that can identify the risk indicators most highly correlated with failure or loss and the relative importance of the factors for accurate pricing. When data are available, statistical analysis brings rigour to determining DPS effectiveness and to the expected value added by proposed system enhancements.

In selecting a set of risk indicators, a statistical analysis of the historical relationship between the proposed set of indicators and the probability of failure or expected insurance losses is especially valuable. Indicators can be objectively compared based on their correlation with historical experience. Lack of substantial experience with bank failures limits the ability to evaluate a DPS. DIs may overcome this limitation if they can rely on prior stress experience to evaluate the DPS against other measures of risk characteristics, such as supervisory downgrades or market indicators. For example, the FDIC based revision of its DPS in 2007 on a statistical model that predicted the supervisory downgrade of a covered institution, since there had been few bank failures following implementation of the initial DPS.[145] Regardless of the indicators chosen, the stronger the statistical relationship, the greater the likelihood that the proposed set of indicators would improve differentiation and create fairer pricing.

Back-testing can further evaluate the effectiveness of DPSs and compare alternatives. This statistical method measures how well the pricing system differentiates between IDIs that failed and those that did not. It quantifies performance through the calculation of accuracy ratios, which are derived from CAP curves.

CAP curves can be used to compare how well different DPS models would have discriminated between banks that failed within a projection period and those that did not fail. A CAP curve shows each institution's probability of failure in descending order. Models are judged by the area underneath the CAP curve, with superior models displaying a greater area beneath its respective curve. A CAP curve is illustrated in Figure 6.

Figure 6: Cumulative Accuracy Profile Illustration

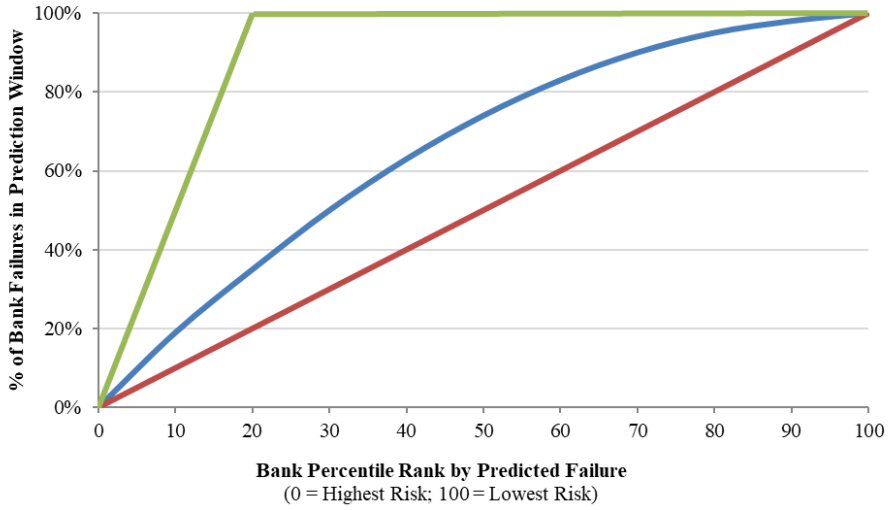


On the horizontal axis, all active banks at the beginning of the prediction window are ranked on a percentile basis according to individual probabilities of failure as predicted by the model being tested. Banks with the highest predicted probability of failure would have a percentile rank near zero, while the safest-rated banks would have a percentile rank near 100. The vertical axis represents the cumulative percentage of actual

[145] See Garnett, et. al, 2020: 12.

failures that the model predicted to have a higher failure probability. For example, the point marked by 'X' indicates that the 30 percent of banks with the highest projected probability of failure included 50 percent of the banks that actually failed. Generally, when comparing a CAP curve for alternative models, a model with a higher CAP curve would be the superior model. Figure 7 shows the model CAP curve compared with two polar CAP curves.

Figure 7: Cumulative Accuracy Profile (CAP) Illustration Compared with Perfect and Random Cases



The random curve (red line) shows what the CAP curve would look like if the model prediction were purely random – for example, the 30 percent of banks with the highest projected failure probability would include 30 percent of actual failures. At the other extreme, the green curve shows a CAP curve for a model that makes perfect projections; if 20 percent of all banks had actually failed, for the perfect model, the 20 percent of banks with the highest projected failure probability would identify all, or 100 percent of failures.

An index of overall performance derived from the CAP curve is the *accuracy ratio*. For Figure 7, the area between the blue curve and the red line is a measure of the superiority of the model over the random benchmark. The area enveloped between the green line and the red line is a measure of the superiority of the 'perfect' model over the random benchmark. The ratio of these two areas is the accuracy ratio for the model depicted by the green line. The value is normalised so it is always less than or equal to 1. An accuracy ratio of 1 occurs with a perfect model, and is 0 with a model that does no better than random guessing.

An example of the output from such an exercise is shown in Table 11 in the U.S. case study. In that example, back-testing confirmed that the updated pricing method outperformed the model underlying the previous DPS, especially in those years leading into the crisis (2006–2008).[146] Back-testing provided strong statistical evidence to support the changes to the DPS.

Regardless of whether a simple or a complex approach is used, there is strong statistical support for including certain risk indicators in a DPS. Foremost among these are capital ratios and supervisory ratings; the absence of these indicators brings into question whether the DPS can be effective. Higher capital enhances an institution's ability to withstand losses, and elevates the owner's stake in maintaining

[146] See Garnett, et. al, 2020: 22.

soundness (and reduces the moral hazard incentive), reducing the probability of failure and the insurance losses if the institution failed.[147] Supervisory ratings add valuable information on risk exposure beyond what is available in financial reports. Other data elements commonly identified as reliable risk indicators by statistical analysis include rapid asset growth, high asset concentrations, growth in NPLs, and heavy reliance on unstable and non-core funding sources.

All statistical analyses are subject to limitations because they are based on the assumption that future relationships among variables in the pricing model will match the past relationships. Therefore, periodic evaluation and recalibration, as necessary, is advised. Despite its limitations, statistical analysis provides scientific grounding for decisions about DPS design and conveys a level of confidence in design choices not otherwise attainable.

[147] Including capital ratios in the pricing model also provides an objective and straightforward way for weaker institutions to lower their deposit insurance premiums. Combined with other financial ratios, capital ratios can provide information on an institution's risk exposure in the periods between bank examinations.

VII. CONCLUSIONS

The lessons learned from DPS TC members' experiences and challenges and the academic literature can assist IADI Members in evaluating or modifying a DPS. The primary goals of a DPS are to reduce moral hazard by charging IDIs based on their risk profiles and to increase fairness by reducing the cross-subsidisation of high-risk IDIs by low-risk IDIs. Certain conditions and circumstances must be in place for a DPS to be effective and DIs must weigh competing considerations including complexity and burden. Most importantly, DIs must have the authority to evaluate and modify the DPS as conditions change. A range of approaches is available to evaluate the effectiveness of a DPS.

Evaluating a DPS should consider whether the conditions and circumstances are favourable for effective risk-based pricing. DPS may not be feasible or suitable for all jurisdictions. Section IV discusses the underlying characteristics necessary in the operating environment of an effective DPS. By necessity, a DPS expands the range of DI decisions that rely on the existing legal, institutional, accounting, and supervisory regimes. Other features of the operating environment such as the availability and quality of data and financial structure will also influence the effectiveness of a DPS.

The evaluation must recognise the trade-offs involved in designing a DPS and whether the system strikes the right balance in areas such as transparency, application of premiums, frequency of data collection, and complexity. When evaluating a DPS, consideration should be given to whether there is sufficient transparency to allow IDIs to understand how risk is being calculated, without compromising confidentiality. An evaluation must also balance the desire for actuarially fair premiums with the practical impact of prohibitively high cost on riskier institutions. This may be especially important for de novo institutions, which typically are found to fail at a higher rate.

The frequency of data collection poses an additional trade-off. The levying of assessments and the corresponding data reporting must be frequent enough for the pricing system to capture changes in risk-taking behaviour, but not so frequent as to impose an excessive burden on the reporting institutions. Pricing risk is a complex task for DIs, which can require large amounts of data from IDIs. The desire for a more accurate system must be balanced against the extra burden imposed on both IDIs and DIs.

DIs have a range of methods to evaluate the effectiveness of DPSs in mitigating moral hazard and enhancing fairness, as discussed in Section V. These methods have been deployed successfully in IADI jurisdictions and have provided valuable information for determining the best design features or the value of proposed enhancements for the jurisdiction.

Section VI presents methods for measuring the performance of a DPS in reducing moral hazard and increasing fairness, by considering simple and more complex approaches. Common to these approaches is a consideration of the data used in calculating risk-based pricing. There is strong empirical evidence across multiple jurisdictions that capital ratios and supervisory ratings are important indicators of risk exposure.[148] Therefore, an effective DPS would be expected to incorporate these types of data, at a minimum. Other data elements commonly identified as reliable risk indicators include rapid asset growth, high asset concentrations, growth in NPLs, and heavy reliance on unstable and non-core funding sources.

[148] *See* recent papers such as: Cole, Rebel A., and Lawrence J. White. "Déjà Vu All Over Again: The Causes of U.S. Commercial Bank Failures This Time Around". *Journal of Financial Services Research* 42, no. 1-2 (2012): 5–29; and Betz, Frank, Silviu Oprică, Tuomas A. Peltonen, and Peter Sarlin. "Predicting Distress in European Banks". *Journal of Banking & Finance* 45 (2014): 225–241.

Although it is challenging to measure the effectiveness of a DPS at reducing moral hazard, a variety of methods exist to evaluate the impact on fairness. Under a fair system, institutions taking on greater risk are charged for that risk and have a stronger incentive to reduce risk. Therefore, by using methods that evaluate fairness, DIs can proxy their ability to reduce moral hazard in the system.

Prior financial crises or stress experiences can provide data against which the accuracy of a DPS in identifying riskier banks can be measured. The simplest approach to evaluate the effectiveness of a DPS compares premiums paid and risk indicators such as historical failure rates or higher insurance losses. In the absence of failure data, supervisory ratings or market data can verify that riskier institutions are paying more than less-risky institutions.

The more complex approaches rely on statistical analysis to identify the risk indicators most highly correlated with failure or loss experience and the relative importance of the factors for accurate pricing. Regardless of the indicators chosen, the stronger the statistical relationship, the greater the likelihood that the proposed set of indicators will improve differentiation and create fairer pricing.

Back-testing can measure how well alternative DPS models perform by comparing how models differentiate between IDIs that exhibited higher versus lower risk in a given period. Back-testing with CAP curves, for example, can produce an index of overall model performance. One benefit of back-testing is that a DI can use historical evidence to rigorously evaluate the merits of proposed changes.

The considerations and methods in this study can provide useful information in the evaluation process. Through periodic evaluation, a DI can determine whether the system is meeting its goals of reducing moral hazard and increasing fairness.

APPENDIX A – TECHNICAL COMMITTEE MEMBERSHIP

Jurisdiction	Name	Organization
United States	Tony Sinopole, Chairperson	Federal Deposit Insurance Corporation
Algeria	Meftah Sebhi	Bank Deposit Guarantee Fund
Brazil	Bruno Lund	Fundo Garantidor de Créditos
Belgium	Michèle Casteleyn	Guarantee Fund for Financial Services
Canada	Rishanthi Pattiarachchi	Canada Deposit Insurance Corporation
Chinese Taipei	Yvonne Fan	Central Deposit Insurance Corporation
Ecuador	Andrea Bayancela	Corporación del Seguro de Depósitos, Fondo de Liquidez y Fondo de Seguros Privados
France	Thierry Dissaux	Fonds de Garantie des Dépôts et de Résolution
Germany	Bernd Bretschneider	Deposit Protection Fund - Association of German Banks
Indonesia	Herman Saheruddin	Indonesia Deposit Insurance Corporation
Kenya	Paul Manga	Kenya Deposit Insurance Corporation
Korea	Taewook Chang	Korea Deposit Insurance Corporation
	Ryan Defina	IADI Secretariat
Turkey	Güçlü Şirin	Savings Deposit Insurance Fund
Zimbabwe	Taurai Togarepi	Deposit Protection Corporation

APPENDIX B – SUMMARIES OF WRITTEN CONTRIBUTIONS FROM THE TC

A. Summary of TC Contributions on DPS Implementation

Thirteen jurisdictions represented on the TC submitted case studies on implementing their DPS.[149] This information summarises those results.

Status of DPS

- Eight of the jurisdictions have a DPS.
- One jurisdiction has a hybrid system – a substantial flat-rate augmented by a minimal risk-based assessment.
- The four jurisdictions without DPS noted barriers to implementation, including legal risks, statutory authority, lack of adequate and accurate data, revenue impacts, and the current macroeconomic environment. Three of the four jurisdictions are actively pursuing DPSs.

Industry Environment

- DIs operate in many environments with few to many institutions (e.g., Turkey covers 40 institutions in its insurance scheme; the United States covers 5,606 institutions).
- Some DIs cover many sectors including commercial banks, savings banks, Islamic banks, credit unions, cooperatives, insurance companies, and securities firms.

Authority of the DI

- Most operate with a paybox mandate.
- Only the U.S. DI has both supervisory and resolution powers; six jurisdictions have resolution powers but not supervisory powers.[150]

Goals

- Most jurisdictions note the importance of DPSs in furthering the goals of increasing fairness and mitigating moral hazard.
- Other goals that members consider when implementing a DPS include:
  - improving predictability of contributions by institutions
  - increasing simplicity
  - limiting administrative burden
  - limiting adverse effect on already weak institutions
  - mitigating pro-cyclicality
  - incentivising regulatory compliance

Assessment Methodology

- Of the four jurisdictions without a DPS, only one identified statutory constraints as a limit on its methodology.
- Respondents' start date with a DPS ranged from 1996 to 2011.
- Complexity increases with both experience and financial sector deepening.
- European Union members' methodologies are controlled by the EBA directive.

[149] The 13 jurisdictions are Belgium, Brazil, Canada, Chinese Taipei, Ecuador, France, Germany, Indonesia, Kenya, Korea, Turkey, United States, and Zimbabwe.

[150] Chinese Taipei has special powers to inspect DPS-related indicators such as CAR and CAMELs and is the legal receiver.

- Each of the eight DPS uses some combination of capital and liquidity measures and supervisory ratings to determine assessments.

Rating System and Structure

- Most DPSs specified a minimum rate charged to member institutions.
- Twelve of thirteen respondent jurisdictions used deposits (covered or eligible) as the assessment base. Only the United States used total assets less capital.
- Most jurisdictions collected assessment premiums quarterly or monthly.
- Two of the eight DPSs charged continuous rates, while the other six used matrix (or bucket) approaches to group like institutions into a single rate. The hybrid system assessed five tiers of risk with an additional basis point assessed at each tier.

B. Summary of TC Contributions on Evaluation

The TC received contributions from 13 jurisdictions.[151] This summary also includes information from the 2017 EBA report on implementation of EBA guidelines for risk-based contributions to deposit guarantee systems; three TC members – Belgium, France, and Germany – are under the EBA.

1. Evaluation Process

Frequency of Evaluation

- Korea's DPS is evaluated annually following completion of its annual premium assessment.
- Canada indicated reviews occur annually and comprehensive reviews occur occasionally.
- Four members – Chinese Taipei, Ecuador, Turkey, and the United States – indicated having evaluated without regular frequency.
- Belgium has not yet evaluated but intends to do so annually.
- Germany evaluates annually based on EBA guidelines.

Most Recent Evaluation

- Eight members – Canada, Chinese Taipei, Ecuador, France, Germany, Korea, Turkey, and the United States – have evaluated their DPS.
- The most recent evaluations for these eight jurisdictions were 2014 (Canada), 2016 (Ecuador, Chinese Taipei, Korea, and the United States), 2017 (France), and 2018 (Turkey and Germany).
- Korea's evaluation was conducted by a third party. The remainder of the evaluations were conducted by the DIs.
- In 2017, the EBA reviewed member countries' application of EBA guidelines, with plans to conduct a wider review in 2019.

Public Input

- The EBA and five members – Canada, Chinese Taipei, Germany, Korea, and the United States – solicit and consider input from outside the government. The United States noted a legal requirement to do so.

Target Evaluation Goals

- Submissions by 12 TC members – Belgium, Brazil, Canada, Chinese Taipei, Ecuador, France, Germany, Kenya, Korea, Turkey, the United States, and Zimbabwe – indicated these evaluation

[151] The 13 jurisdictions are: Belgium, Brazil, Canada, Chinese Taipei, Ecuador, France, Germany, Indonesia, Kenya, Korea, Turkey, United States, and Zimbabwe.

goals:

a. Mitigate Moral Hazard

- Eight members – Belgium, Brazil, Chinese Taipei, Kenya, Korea, Turkey, United States, Zimbabwe – and the EBA Guidelines indicated concern for whether the effect on moral hazard could be calculated.

b. Improve Fairness

- All responding members and the EBA Guidelines indicated concern that DPSs should fairly reflect probability of failure.
- Ten members – Belgium, Brazil, Canada, Chinese Taipei, Ecuador, France, Germany, Korea, Turkey, and the United States – were also concerned that DPSs should fairly reflect loss given failure.
- Four members – Belgium, Brazil, Canada, and the United States – indicated a goal of comparing actual failures with predicted failures or risk category downgrades.

c. Other Goals

- Avoid inducing failure – avoid setting penalty assessments for weak banks so they cause further weakening (the United States).
- Ensure transparency – Maintain communication with institutions and industry (Canada and the EBA Guidelines).
- Minimise industry concentration (Brazil).
- Reduce barriers to entry – consider effects on de novo banks which may be riskier (Brazil).
- Increase compliance and supervisory effectiveness in industry (Turkey).
- Manage contribution changes relevant to mergers and de novo institutions (France).
- Ensure data are plausible and complete (Germany).

2. Evaluation Methodology

Quantitative and Qualitative

- Six members – Belgium, Canada, Chinese Taipei, Germany, Turkey, and the United States – plus the EBA Guidelines indicated using both quantitative and qualitative data.
- Two members – Ecuador and Korea – indicated using only quantitative data.

Data Types and Sources

- Supervisory data
- Korea supplements data with scores provided by credit bureaus.
- Germany indicated using rating system results.
- EBA Guidelines consider survey responses.

Performance Considerations (whole system and/or individual risk measures)

- Four members – Canada, Chinese Taipei, Turkey, and the United States – and the EBA Guidelines consider both the whole system and individual risk measures.
- Two members – Belgium and Brazil – consider (or will consider) only the likelihood of bank failure.
- Ecuador indicates that the supervisory authority calculates risk and categorises institutions.
- Germany focuses on the performance of the system as a whole.

Evaluation Methodology

- Four members – Germany, Korea, Turkey, and the United States – and the EBA Guidelines supported using statistical back-testing to compare the predictive accuracy of models.
- Germany employs back-testing, data validation, gauging model stability, and stochastic tests.

Results from Evaluation

- The United States revised methodology to incorporate more forward-looking and accurate measures.
- Korea acknowledged that assessment rate differentiation based on risk has been minimal and, therefore, may have limited effect.

APPENDIX C – REFERENCES FOR DEPOSIT INSURANCE PRICING LITERATURE SURVEY

Acharya, Viral V., Robert Engle, and Matthew Richardson. 2012. "Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks". *American Economic Review* 102 (3): 59–64.

Acharya, Viral V., João A. C. Santos, and Tanju Yorulmazer. 2010. "Systemic Risk and Deposit Insurance Premiums". *FRBNY Economic Policy Review* 16 (1): 89–99.

Acharya, Viral V., and Tanju Yorulmazer. 2007. "Too Many to Fail – An Analysis of Time-Inconsistency in Bank Closure Policies". *Journal of Financial Intermediation* 16 (1): 1–31.

Allen, Franklin, Elena Carletti, Itay Goldstein, and Agnese Leonello. 2017. "Government Guarantees and Financial Stability". Working Paper Series No. 2032, European Central Bank, February. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp2032.en.pdf.

Allen, Franklin and Douglas Gale. 2000. "Financial Contagion". *Journal of Political Economy* 108 (1): 1–33.

Anginer, Deniz, and Asli Demirgüç-Kunt. 2018. "Bank Runs and Moral Hazard: A Review of Deposit Insurance". Policy Research Working Paper 8589, World Bank Group, Development Economics, Development Research Group.

Anginer, Deniz, Asli Demirgüç-Kunt, and Min Zhu. 2014. "How Does Deposit Insurance Affect Bank Risk? Evidence From the Recent Crisis". *Journal of Banking & Finance* 48: 312–321.

Avery, Robert B., and Allen N. Berger. 1991. "Risk-Based Capital and Deposit Insurance Reform". *Journal of Banking & Finance*, 15(4–5), pp.847–874.

Balla, Eliana, Laurel C. Mazur, Edward S. Prescott, and J.R. Walter. 2019. "A Comparison of Community Bank Failures and FDIC Losses in the 1986-92 and 2007-13 Banking Crises". *Journal of Banking & Finance* 106: 1-15.

Bennett, Rosalind. 2001. "Evaluating the Adequacy of the Deposit Insurance Fund: A Credit-Risk Modeling Approach." Working Paper 2001-02, Federal Deposit Insurance Corporation, December. https://www.fdic.gov/bank/analytical/working/wp01-02.pdf.

Bennett, Rosalind, Vivian Hwa, and Myron Kwast. 2015. "Market Discipline by Bank Creditors During the 2008–2010 Crisis". *Journal of Financial Stability* 20 (C): 51–69.

Bennett, Rosalind, Daniel Nuxoll, Robert Jarrow, Michael C. Fu, and Huiju Zhang. 2005. "A Loss Default Simulation Model of the Federal Bank Deposit Insurance Funds". Proceedings – Winter Simulation Conference, December, 1835–1843.

Bennett, Rosalind L., and Haluk Unal. 2014. "The Effects of Resolution Methods and Industry Stress on the Loss on Assets From Bank Failures". *Journal of Financial Stability* 15 (December): 18–31.

Blair, Christine E., and Gary S. Fissel. 1991. "A Framework for Analyzing Deposit Insurance Pricing." *FDIC Banking Review* 4 (2): 25–37.

Blinder, Alan S., and Robert F. Wescott. 2001. "Reform of Deposit Insurance: A Report to the FDIC". Federal Deposit Insurance Corporation, March. http://www.fdic.gov/deposit/insurance/initiative/reform.html.

Bliss, Robert R., and Mark J. Flannery. 2002. “Market Discipline in the Governance of U.S. Bank Holding Companies: Monitoring vs. Influencing”. *Review of Finance* 6 (3): 361–396.

Bloecher, Eric, Gary Seale, and Robert Vilim. 2003. “Options for Pricing Federal Deposit Insurance”. *FDIC Banking Review* 15 (4): 1–18.

Bovenzi, John F., and Arthur J. Murton. 1988. “Resolution Costs of Bank Failures”. *FDIC Banking Review* 1(1): 1–13.

Brickley, James A., and Christopher M. James. 1986. “Access to Deposit Insurance, Insolvency Rules, and the Stock Returns of Financial Institutions”. *Journal of Financial Economics* 16(3): 345–371.

Brown, Richard A., and Seth, Epstein. 1992. “Resolution Costs of Bank Failures: An Update of the FDIC Historical Loss Model”. *FDIC Banking Review* 5(1): 1–16.

Calomiris, Charles. 1990. “Is Deposit Insurance Necessary? A Historical Perspective”. *Journal of Economic History* 50 (2): 283–295.

Carlson, Mark A., Thomas King, and Kurt Lewis. 2011. “Distress in the Financial Sector and Economic Activity”. *BE Journal of Economic Analysis & Policy* 11(1).

Chan, Yuk-Shee, Stuart I. Greenbaum, and Anjan V. Thakor. 1992. “Is Fairly Priced Deposit Insurance Possible?” *Journal of Finance* 47(1): 227–245.

Chang, Roberto, and Andres Velasco. 2001. “A Model of Financial Crises in Emerging Markets”. *Quarterly Journal of Economics* 116 (2): 489–517.

Chari, Varadarajan and Ravi Jagannathan. 1988. “Banking Panics, Information, and Rational Expectations Equilibrium”. *Journal of Finance* 43(3): 749–761.

Cooperstein, Richard L., George G. Pennacchi, F. Stevens Redburn. 1995. “The Aggregate Cost of Deposit Insurance: A Multi-Period Analysis”. *Journal of Financial Intermediation* 4(3): 242–271.

Crosbie, Peter J. 1999. “Modeling Default Risk”. KMV Corporation, San Francisco.

DeLong, Gayle and Anthony Saunders. 2011. “Did the Introduction of Fixed-Rate Federal Deposit Insurance Increase Bank Risk?” *Journal of Financial Stability* 7 (1): 19–25.

Demirgüç-Kunt, Asli and Enrica Detragiache. 2002. “Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation”. *Journal of Monetary Economics* 49 (7): 1373–1406.

Demirgüç-Kunt, Asli and Edward J. Kane. 2002. “Deposit Insurance Around the Globe: Where Does It Work?” *Journal of Economic Perspectives* 16 (2): 175–195.

Diamond, Douglas W., and Philip H. Dybvig. 1983. “Bank Runs, Deposit Insurance, and Liquidity”. *Journal of Political Economy* 91 (3): 401–419.

Duffie, Darrell, Robert Jarrow, Amiyatosh Purnanandam, and Wei Yang. 2003. “Market Pricing of Deposit Insurance”. *Journal of Financial Services Research*, 24(2-3): 93–119.

European Banking Authority. 2015. “Guidelines on Methods for Calculating Contributions to Deposit Guarantee Schemes”. http://www.eba.europa.eu/documents/10180/1089322/EBA-GL-2015-10+GL+on+methods+for+calculating+contributions+to+DGS_EN.

Federal Deposit Insurance Corporation. 2000. "Options Paper". https://www.fdic.gov/deposit/insurance/initiative/options_080700m.pdf.

Federal Deposit Insurance Corporation. 2001. "Keeping the Promise: Recommendations for Deposit Insurance Reform". https://www.fdic.gov/deposit/insurance/initiative/direcommendations.pdf.

Flannery, Mark J. 1991. "Pricing Deposit Insurance When the Insurer Measures Bank Risk With Error". *Journal of Banking & Finance* 15 (4-5): 975–998.

Flannery, Mark J. 2001. "The Faces of 'Market Discipline'". *Journal of Financial Services Research 20* (2-3): 107–119.

Flood, Mark D. 1990. "On the Use of Option-Pricing Models to Analyze Deposit Insurance". *Review*, Federal Reserve Bank of St. Louis (Jan): 19–35.

Forssbaeck, Jens. 2011. "Ownership Structure, Market Discipline, and Banks' Risk-Taking Incentives Under Deposit Insurance". *Journal of Banking & Finance* 35 (10): 2666–2678.

Gropp, Reint, Jukka Vesala, and Giuseppe Vulpes. 2006. "Equity and Bond Market Signals as Leading Indicators of Bank Fragility". *Journal of Money, Credit and Banking* 38(2): 399–428.

Grossman, Richard S. 1992. "Deposit Insurance, Regulation, and Moral Hazard in the Thrift Industry: Evidence From the 1930s". *American Economic Review* 82 (4): 800–821.

Harada, Kimie, Takatoshi Ito, and Shuhei Takahashi. 2010. "Is the Distance to Default a Good Measure in Predicting Bank Failures? Case Studies". No. 16182. National Bureau of Economic Research.

Hasan, Iftekhar, Liuling Liu, and Gaiyan Zhang. 2016. "The Determinants of Global Bank Credit-Default-Swap Spreads". *Journal of Financial Services Research* 50(3): 275–309.

Hirschhorn, Eric. 1986. "Developing a Proposal for Risk-Related Deposit Insurance". Banking and Economic Review, Federal Deposit Insurance Corporation, 4 (September/October): 3–10.

Hoelscher, David S., Michael Taylor, and Ulrich Klueh. 2006. "The Design and Implementation of Deposit Insurance Systems". Washington, D.C.: International Monetary Fund. Volume 251.

Hovakimian, Armen, Edward J. Kane, and Luc Laeven. 2003. "How Country and Safety-Net Characteristics Affect Bank Risk-Shifting". *Journal of Financial Services Research* 23 (3): 177–204.

International Association of Deposit Insurers. 2011. "General Guidance for Developing Differential Premium Systems". https://www.iadi.org/en/assets/File/Papers/Approved%20Guidance%20Papers/IADI_Diff_prem_paper_FINAL_updated_Oct_31_2011_clean_version.pdf.

International Association of Deposit Insurers. 2014. "IADI Core Principles for Effective Deposit Insurance Systems". https://www.iadi.org/en/assets/File/Core%20Principles/cprevised2014nov.pdf

Jacklin, Charles J. and Sudipto Bhattacharya. 1988. "Distinguishing Panics and Information-Based Bank Runs: Welfare and Policy Implications". *Journal of Political Economy* 96 (3): 568–592.

James, Christopher. 1991. "The Losses Realized in Bank Failures". *Journal of Finance* 46 (4): 1223–1242.

Kahn, Charles M. and João Santos. 2005. "Allocating Bank Regulatory Powers: Lender of Last resort, Deposit Insurance, and Supervision". *European Economic Review* 49 (8). 2107–2136.

Kane, Edward J. 1989. “The S&L Insurance Mess: How Did it Happen?” Washington, D.C.: The Urban Institute Press.

Kane, Edward J. 1995. “Three Paradigms for the Role of Capitalization Requirements in Insured Financial Institutions”. *Journal of Banking & Finance* 19(3–4): 431–459.

Kendall, Sarah B., and Mark E. Levonian. 1991. “A Simple Approach to Better Deposit Insurance Pricing”. *Journal of Banking & Finance* 15 (4–5): 999–1018.

Kuritzkes, Andrew, Til Schuermann, and Scott M. Weiner. 2005. “Deposit Insurance and Risk Management of the U.S. Banking System: What is the Loss Distribution Faced by the FDIC?” *Journal of Financial Services Research* 27 (3): 217–242.

Laeven, Luc. 2002. “Pricing of Deposit Insurance”. Policy Research Working Paper 2871, World Bank, July. https://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-2871.

Lee, Shih-Cheng, Chien-Ting Lin, and Ming-Shann Tsai. 2015. “The Pricing of Deposit Insurance in the Presence of Systematic Risk”. *Journal of Banking & Finance* 51: 1–11.

Maccario, Aurelio, Andrea Sironi, and Cristiano Zazzara Sr. 2003. “Credit Risk Models: An Application to Deposit Insurance Pricing”. Working Paper No. 03-84, SDA BOCCONI Research Division, May.

Maechler, Andrea M., and Kathleen M. McDill. 2006. “Dynamic Depositor Discipline in U.S. Banks”. *Journal of Banking & Finance* 30 (7): 1871–1898.

Marcus, Alan J., and Israel Shaked. 1984. “The Valuation of FDIC Deposit Insurance Using Option-Pricing Estimates”. *Journal of Money, Credit and Banking* 16 (4): 446–460. www.jstor.org/stable/1992183.

McCoy, Patricia A. 2007. “The Moral Hazard Implications of Deposit Insurance: Theory and Evidence”. Presented at the Seminar on Current Developments in Monetary and Financial Law, International Monetary Fund, Washington, D.C., 2006.

Merton, Robert C. 1974. “On the Pricing of Corporate Debt: The Risk Structure of Interest Rates”. *Journal of Finance 29* (2): 449–470.

Merton, Robert C. 1977. “An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option-Pricing Theory”. *Journal of Banking & Finance* 1 (1): 3–11.

Merton, Robert C. 1978. “On the Cost of Deposit Insurance When There Are Surveillance Costs”. *Journal of Business* 51(3): 439–452.

Milne, Alistair. 2014. “Distance to Default and the Financial Crisis”. *Journal of Financial Stability* 12: 26–36.

Ngalawa, Harold, Fulbert Tchana Tchana, and Nicola Viegi. 2016. “Banking Instability and Deposit Insurance: The Role of Moral Hazard”. *Journal of Applied Economics* 19 (2): 323–350.

Nolte, Jan P., and Isfandyar Z. Khan, ed. 2017. “Deposit Insurance Systems: Addressing Emerging Challenges in Funding, Investment, Risk-Based Contributions and Stress Testing”. Washington, D.C.: The World Bank.

Pantalone, Coleen C., and Marjorie B. Platt. 1987. “Predicting Commercial Bank Failure Since Deregulation”. *New England Economic Review*, Federal Reserve Bank of Boston (July): 37–47.

Pennacchi, George. 1987. “A Reexamination of the Over- (or Under-) Pricing of Deposit Insurance”. *Journal of Money, Credit and Banking* 19 (3): 340–360.

Pennacchi, George. 1999. “The Effects of Setting Deposit Insurance Premiums to Target Insurance Fund Reserves”. *Journal of Financial Services Research* 16 (2–3): 153–180.

Pennacchi, George. 2005. “Risk-Based Capital Standards, Deposit Insurance and Procyclicality”. *Journal of Financial Intermediatio*n 14 (4): 432–465.

Pennacchi, George. 2006. “Deposit Insurance, Bank Regulation, and Financial System Risks”. *Journal of Monetary Economics* 53 (1): 1–30.

Pennacchi, George. 2010. “Deposit Insurance Reform”. Private Markets and Public Insurance Programs, Jeffrey Brown ed., 20–53. Washington, D.C.: American Enterprise Institute Press.

Ronn, Ehud I., and Avinash K. Verma. 1986. “Pricing Risk-Adjusted Deposit Insurance: An Option-Based Model”. *Journal of Finance* 41 (4): 871–895.

Seelig, Steven A., Nataliya Mylenko, Claire McGuire, and Sebnem Sener. 2012. “Enhancement of Insurance Reserves Targeting Framework”. Philippine Deposit Insurance Corporation.

Staum, Jeremy, 2012. “Systemic Risk Components and Deposit Insurance Premia”. *Quantitative Finance* 12 (4): 651–662.

APPENDIX D – IADI CORE PRINCIPLES

Principle 1 – PUBLIC POLICY OBJECTIVES

Principle 2 – MANDATE AND POWERS

Principle 3 – GOVERNANCE

Principle 4 – RELATIONSHIPS WITH OTHER SAFETY-NET PARTICIPANTS

Principle 5 – CROSS-BORDER ISSUES

Principle 6 – DEPOSIT INSURER'S ROLE IN CONTINGENCY PLANNING AND CRISIS MANAGEMENT

Principle 7 – MEMBERSHIP

Principle 8 – COVERAGE

Principle 9 – SOURCES AND USES OF FUNDS

Principle 10 – PUBLIC AWARENESS

Principle 11 – LEGAL PROTECTION

Principle 12 – DEALING WITH PARTIES AT FAULT IN A BANK FAILURE

Principle 13 – EARLY DETECTION AND TIMELY INTERVENTION

Principle 14 – FAILURE RESOLUTION

Principle 15 – REIMBURSING DEPOSITORS

Principle 16 – RECOVERIES

From International Association of Deposit Insurers, "A Handbook for the Assessment of Compliance With the Core Principles for Effective Deposit Insurance Systems", 14 March 2016.