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A Methodology for Determining the Target Funding Level of a Deposit Insurer

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Abstract

The aim of this paper is to present a statistical methodology to calculate the target funding level of a deposit insurer. In particular, this document describes a methodology to estimate the deposit insurer's loss distribution and proposes a set of criteria to determine its risk tolerance. In order to define the proportion to be financed ex-ante via the accumulation of a fund and with additional mechanisms such as a contingency credit line, an estimate of the reimbursements resulting from failed bank resolutions is used. In addition, the impact that the reserve's investment policy could have on the financial requirements is briefly analysed, highlighting the importance of investing in financial assets that are negatively correlated with the events insured. Finally, the methodology is illustrated using a hypothetical financial system.

Codes JEL: C63, G01, G21, G22.
Key words: Deposit Insurance, Banking Crisis, Credit Risk, Monte Carlo simulation.

1. Introduction

The general goal of a deposit insurer system (DIS) is to maintain confidence among depositors and financial institutions. In a financial distressed environment, a DIS contributes to financial stability by reducing the probability and severity of a bank run. According to Blinder A. and Wescott R. (2001), the main goal of the DIS is to increase macroeconomic and financial stability. They highlight that to reach this objective less informed depositors must trust that they are not going to lose their deposits in the event of a bank failure or in a financial crisis scenario. In this way, the guarantee offered by the DIS assures that deposits are no different from cash in a crisis. The DIS reduces the incentives to demand cash in moments of high uncertainty and the probability of contagion among depositors.

Having established the importance of a DIS in stress scenarios, it is important to highlight that in those times a DIS is only as good as its financial muscle is strong. A DIS with scarce resources could be an additional source of uncertainty, generating adverse effects over the financial stability and increasing fiscal and social costs. For this reason, identifying its required funding level is a key task for a DIS.

In general terms, a DIS could be financed through an ex-ante, an ex-post or a hybrid system. The ex-ante scheme accumulates the resources needed to cover the bank failures in advance. Under this system, the reserve is funded through the premiums charged to the member institutions and the returns generated by investing them; additional ex-ante mechanisms can also be designed, for instance via pre-arranged mechanisms that provide resources under certain scenarios. The ex-post scheme generally requires that the banks contribute with the resources needed after the bank failure event occurs; hybrid systems combine ex-ante and ex-post schemes.

The ex-ante system has several advantages over the ex-post one. First, ex-ante funding is fairer given that all entities, including those that fail, contribute with premiums. In this way, ex-ante schemes reduce subsidies among banks; in ex-post ones the most risky entities, which actually end up bankrupt, never contribute to the fund. The second advantage is that ex-ante schemes reduce the pro-cyclicality of the funding system. The DIS could use the resources it has accumulated, without demanding additional funds from the member institutions in an adverse financial scenario. In addition, ex-ante funding allows a DIS to establish a differential premium system; this reduces moral hazard[1] generated by the DIS, because incentives to take greater risk are offset by a higher premium.

On the other hand, an ex-ante system has an implicit opportunity cost given that the DIS extracts resources from the financial system that could be used for loans or in activities that are economically more efficient. However, the latest financial crisis severely questioned that this opportunity costs are lower than those associated with an undercapitalized DIS [2].

The main purposes of this document are to present a methodology to identify and quantify the financial requirements (target level fund) of a DIS and to propose criteria to define the proportion that should be financed via different alternatives.

[1] Moral hazard refers to the fact that the deposit insurance guarantee reduces the incentives of depositors (the owners of the debts covered) to monitor the entities, which in turn may encourage institutions to take greater risks.

[2] For example, as a result of the debt crisis, the rate of Spanish bonds with a maturity of 10 years reached 7.62% in July 2012; between 2000 and 2009 their average rate was 4.35%.

Besides this introduction, the document is divided in six sections. The second one analyses the contingent liability of a DIS. The third section describes the proposed methodology to identify the target funding level of a DIS, presents an approach to divide this funding between different funding options, and analyses how to adjust the target rate given the reserve's investment policy. The fourth section illustrates the methodology using a hypothetical financial system and the fifth section concludes. Finally, the appendix presents a brief review of international experience.

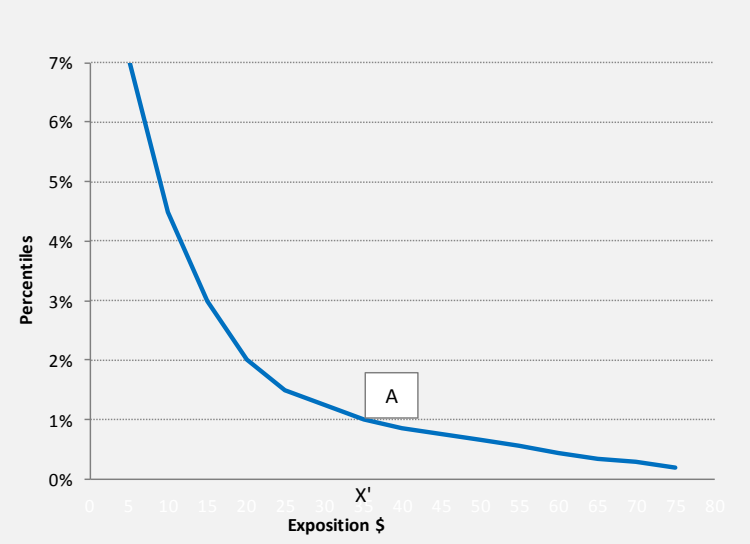
2. Contingent liability and risk level of a DIS

History has demonstrated how difficult it is to anticipate banking crises and their magnitude. This fact complicates the definition of a target funding level since a DIS may underestimate or overestimate the magnitude and probability of the events related to its contingent liabilities. The DIS could end up with insufficient resources to absorb certain failure events, or with a higher than needed ex-ante level reducing the resources available for loans and limiting the efficiency of the financial system.

The definition of the target funding level is closely linked to the DIS' policy objective, regarding the events that it aims to cover. If it wants to cover the most adverse scenario, the bankruptcy of all member institutions, the resources required would equal insured deposits, a costly scenario. For this reason, it is crucial to establish a desired risk tolerance; this level is associated with the likelihood that the DIS does not have enough funds to cover all cash requirements with ex-ante funding in certain scenarios.

This relationship is illustrated in Figure 1, where the *y* axis shows the percentiles of a loss distribution for a hypothetical DIS starting at the 93th percentile, and the *x* axis presents the DIS' exposition; with resources equivalent to *X'* the DIS covers 99% of the events (point A). In order to cover the 1% of the remaining events, the DIS requires additional resources.

Figure 1:
Right Tail of a loss distribution:
Relationship between percentile of the distribution and exposition



3. Defining a target funding level

The calculation of the target funding level begins with the estimation of the loss distribution of the DIS. For this first step, a useful statistical methodology is proposed in "*Evaluation of Deposit Insurance Fund Sufficiency on the Basis of Risk Analysis*" (IADI – 2011).

The main objective of this methodology is to determine the loss distribution using the estimated probability of default (PD) of member institutions and the correlation between them via Monte Carlo simulations. The target level is found after evaluating the potential losses of a portfolio of loans; the loans correspond to the exposures of the DIS to insured institutions.

The procedure to create the loss distribution of the DIS takes into account the characteristics of each member institution. It is summarized as follows:

- **Definition of the DIS' financial exposure to each institution:**

  The DIS' financial exposure to each institution is defined as its insured deposits. Since an insured institution may be subject to another resolution mechanism if it is less costly, defining the exposure as insured deposits represents a conservative simplification.

- **Estimation of the PD and its correlations:**

  Different methodologies to estimate the probability of default (PD) of a bank exist. A good approach is to use fundamental analysis based in financial ratios and a CAMEL score, which allows estimating the PD through econometric models[3]. Other methodologies to calculate the PD include: market analysis, which uses information available in financial markets, such as bond interest rates and stock prices; credit ratings provided by rating agencies; and a combination of all the above. It is important to highlight that the PD used, regardless of how it is calculated, should be associated to periods of financial stress since the losses of the DIS are strongly linked to those periods.

  In order to capture the interrelation of failure events among banks, the correlations of the PD need to be calculated. For this, two types of correlations can be used: parametric and non-parametric. The Pearson's correlation coefficient is the most common parametric measure but it requires variables to have a normal distribution and a linear relationship. In Monte Carlo simulation these conditions are not met, so non-parametric measures are used. Spearman's correlation coefficient is one of the most common non-parametric measures, and the assumption of lineal dependency and the normal distribution between the variables is not required. This implies that correlation between variables with different distributions could be used.

- **Simulation process and loss distribution calculation:**

  Once the PD have been calculated, a significant number of trials is simulated to find the loss distribution of the DIS. The simulation process involves the following steps:

[3] The most popular econometric models used for this estimation are logit, probit, order logit, order probit and duration models

1. For each member institution, the *z-score* in the normal distribution associated to its PD is determined[4].

2. On each trial, a random number from a normal distribution is generated for each institution and compared with the *z-score* previously determined. A bankrupt event is determined to occur when the random number generated is lower than the *z-score*. Variables on each trial are correlated using the correlation matrix.

Bankrupt event: $if\ x \leq z - score$ No bankrupt event: $if\ x > z - score$ where x is $z - \text{score}$ simulated from a normal distribution

3. It is assumed that each time that an event of bankruptcy occurs, the DIS pays an amount equivalent to its exposure to the institution that went bust.

The steps described above are repeated a significant number of times, obtaining a flow of payments equal to the number of trials. The result of this process, once the payments have been ordered, is the loss distribution of the DIS.

3.1 Determining a percentile associated to a level of risk

As previously mentioned, once the loss distribution has been calculated it is necessary to define the risk level that the DIS is willing to take. Defining the desired risk tolerance requires weighing costs and benefits, but certain objective criteria can be used. According to Bennett (2001), the risk level should be associated with the PD of the stronger institution in the system, given that a DIS should be stronger than any of its insured members. Thus, the level of risk must be associated with the lowest PD of the system, which can be determined in two ways: i) based on econometric models such as the ones described above, or ii) using the criteria from the Basel Capital Accord that suggest that the highest rating of a financial institution corresponds to the country risk rating lowered by one notch.

Once the PD is determined, this probability is mapped to a percentile of the loss distribution to identify the size of the fund required to cover payments at the level of risk selected[5].

In general terms, the main advantage of this methodology for defining the loss distribution is that it incorporates the financial characteristics of the insured institutions and the macroeconomic environment. This allows the DIS to prepare for events that, although have not occurred yet, might be likely to happen. The main disadvantage is that it requires processing an important amount of information and needs a proper econometric model.

[4] For example, an entity with a PI of 0.27% would have a z-score of -2.78.

[5] Since insured deposits (coverage level) may change depending on the economic environment, it is important that the target level of funding is not related to an absolute value and is be expressed in relative terms. In this sense, international practices suggest that the target level must be expressed in relative terms to the premium collection base or to the total deposits.

3.2 Splitting ex-ante funding in two

Up to this point, nothing has been said about recoveries associated to a liquidation process. In other words, the methodology described in the previous section assumes that in bank failures the loss given default (LGD)[6] equals 100%. By taking into account a more realistic estimate of recoveries, the DIS can adjust its ex-ante required funding since some of the resources will be recovered.

The resources collected through premiums should be sufficient to cover the percentage of resources that is not expected to be recovered from the liquidation of the insured institution. On the other hand, the percentage of resources that is expected to be recovered can be financed with alternatives sources such as contingent credit lines. This backup-funding scheme seeks to solve a temporary illiquidity problem associated with a mismatch of cash flows.

The LGD can be calculated from historical data. Another option, if the DIS does not have databases of recoveries or previous liquidation experience, is to use the standard method suggested by the Committee on Banking Supervision (2006) in the context of capital requirements. The Committee proposes a LGD of 75% for all subordinated loans to corporates, sovereigns and banks. For the DIS this approximation makes sense given its exposure is to the banking sector.

3.3 Taking into account the investment policy.

The way funds are invested (the investment policy) has important effects on the target funding level. One particularly important consideration is the relationship between the performance of the assets and the expected liabilities of the DIS.

- **Positive correlation between assets and liabilities:**

  When the funds are invested in assets positively correlated with liabilities, for example debt of insured institutions or even local national debt in a systemic crisis, they will probably lose value when the DIS requires the funds. Under this type of investment policy, the value of the target level of funding should be adjusted by the investments' expected loss. The amount that the fund needs to be adjusted can be calculated from historical data or using stressed scenarios.

- **Negative correlation between assets and liabilities:**

  In contrast, if the funds are invested in assets denominated in foreign currency, and the assets themselves and this other currency is not closely linked to the local economy, they could have a neutral or positive performance when funds are need, e.g. a small banking crisis, not affecting or even decreasing the DIS financial requirements. This is especially relevant for small open economies, where the deterioration in macroeconomic and financial indicators is associated with an increase in country risk; in that sense, financial crisis in small open economies have been historically accompanied by an increase in agents' preference for assets denominated in foreign currency and a depreciation of the local currency.

[6] The amount of resources that are not expected to be recovered in a liquidation process is called loss given default (LGD); therefore the complement of this amount corresponds to expected recoveries (1 - LGD).

4. Calculation of the target funding level: an illustration

- **Data**

For purposes of this exercise a DIS with 11 insured institutions is assumed. The insured deposits of the 11 institutions are $20 million (m) and total deposits are $140 m. Table 1 presents the insured deposits and total deposits per entity.

Table 1:
Insured deposits and total deposit for the insured institutions

Insured institutions	Insured deposits	Total deposits
Bank A	*9.00*	*40.00*
Bank B	*3.50*	*20.00*
Bank C	*3.00*	*30.00*
Bank D	*1.10*	*10.00*
Bank E	*0.90*	*13.00*
Bank F	*0.80*	*6.00*
Bank G	*0.80*	*4.80*
Bank H	*0.50*	*8.00*
Bank I	*0.20*	*7.00*
Bank J	*0.10*	*0.20*
Bank K	*0.10*	*1.00*
Total	**20.0**	**140.0**

- **Calculation of the target level of funding**

  - **Exposure:** The exposure is defined as the insured deposits ($20 m).

  - **Calculation of PD and their correlations:**

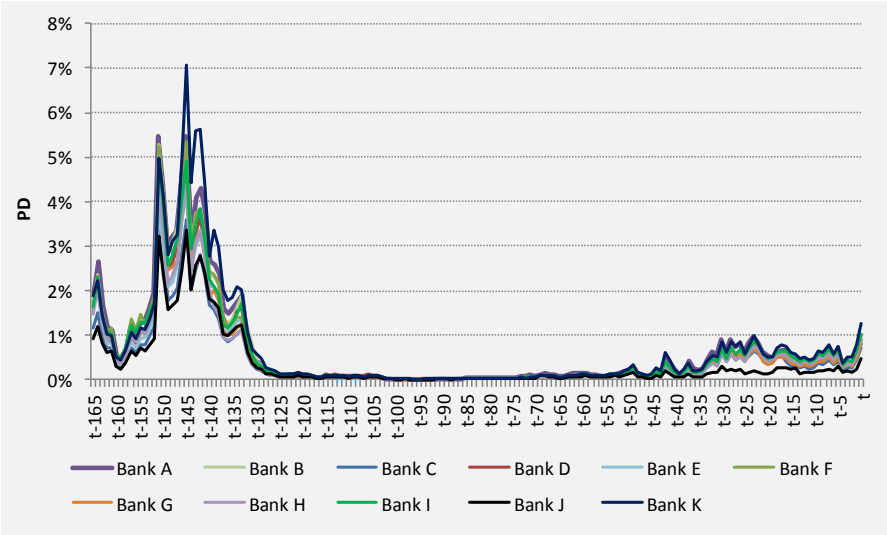
  The probability to get a CAMEL rating of 1, 2, 3, 4 or 5 for each institution is estimated for time t+12 months[7] using the following ordered probit model:

$$CAMEL_{it} = \beta_1 Leverage_{i,t-12} + \beta_2 Profitability_{i,t-12} + \beta_3 Financial\ Margin_{\ i,t-12} + \beta_4 Asset\ quality_{i,t-12} + \beta_5\ Economic\ growth_{t-18} + \beta_6\ Interest\ rate_{t-18} + \beta_7\ Country\ leverage_{t-18}$$

  A default is associated with a CAMEL score lower than 1.5. Figure 2 shows the estimated PD of the 11 insured banks for the analysed period.

[7] The CAMEL rating takes values from 1 to 5, where 5 is better than 1.

Figure 2:
Insured Banks' PD



The PD between t-165 and t-139 is used for the simulations because of the reasons discussed in the previous section: an average of the PD of these periods represent a period of stress. Additionally, the correlation matrix is calculated (Table 2).

Table 2:
Correlation matrix

	Bank C	Bank D	Bank F	Bank A	Bank J	Bank G	Bank K	Bank I	Bank B	Bank H	Bank E
Bank C	1.0000	0.9971	0.9967	0.9980	0.9838	0.9972	0.9833	0.9978	0.9954	0.9969	0.9967
Bank D	0.9971	1.0000	0.9964	0.9979	0.9854	0.9978	0.9798	0.9978	0.9967	0.9955	0.9966
Bank F	0.9967	0.9964	1.0000	0.9964	0.9837	0.9986	0.9780	0.9978	0.9947	0.9968	0.9946
Bank A	0.9980	0.9979	0.9964	1.0000	0.9859	0.9974	0.9820	0.9973	0.9962	0.9944	0.9967
Bank J	0.9838	0.9854	0.9837	0.9859	1.0000	0.9816	0.9866	0.9821	0.9838	0.9771	0.9861
Bank G	0.9972	0.9978	0.9986	0.9974	0.9816	1.0000	0.9769	0.9980	0.9958	0.9975	0.9951
Bank K	0.9833	0.9798	0.9780	0.9820	0.9866	0.9769	1.0000	0.9787	0.9785	0.9764	0.9860
Bank I	0.9978	0.9978	0.9978	0.9973	0.9821	0.9980	0.9787	1.0000	0.9961	0.9981	0.9959
Bank B	0.9954	0.9967	0.9947	0.9962	0.9838	0.9958	0.9785	0.9961	1.0000	0.9932	0.9945
Bank H	0.9969	0.9955	0.9968	0.9944	0.9771	0.9975	0.9764	0.9981	0.9932	1.0000	0.9944
Bank E	0.9967	0.9966	0.9946	0.9967	0.9861	0.9951	0.9860	0.9959	0.9945	0.9944	1.0000

- **Simulation process and calculation of the loss distribution.**

20,000 correlated trials were performed. Table 3 shows the results of the simulation in terms of the number of entities that goes bankrupt in each of the 20,000 correlated events. In 96.7% of cases there is no bankruptcy and in 1.3% of the trials eleven banks end up broken. These results follow the high correlations presented in Table 2 (all correlations were above 97%).

Table 3:
Simulation Results:
Number of entities and likelihood of deposit insurance payment.

Number of entities that fall into bankruptcy in each trial	Number of occurrences of the bankruptcy (frequency)	Probability of occurrence of the event
0.00	*19,346*	96.7%
1.00	*112*	0.6%
2.00	*38*	0.2%
3.00	*27*	0.1%
4.00	*24*	0.1%
5.00	*21*	0.1%
6.00	*18*	0.1%
7.00	*26*	0.1%
8.00	*29*	0.1%
9.00	*39*	0.2%
10.00	*68*	0.3%
11.00	*252*	1.3%
Total	**20,000**	**100.0%**

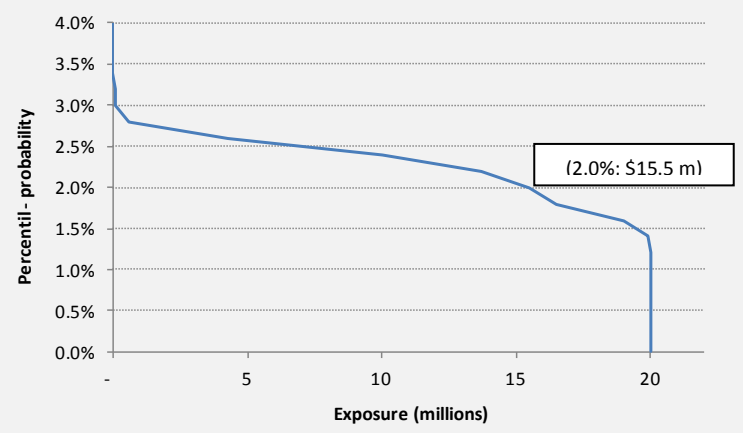
Table 4 presents the results of the 20,000 estimated cash flows.

Table 4:
DIS' Payment flows.

DIS exposure to the event of bankruptcy of the entities (millions)	Number of occurrences (frequency)	Probability of occurrence of the event
0.0	*19,346*	*96.73%*
1.0	*111*	*0.56%*
2.0	*7*	*0.04%*
3.0	*0*	*0.00%*
4.0	*14*	*0.07%*
5.0	*9*	*0.05%*
6.0	*4*	*0.02%*
7.0	*0*	*0.00%*
8.0	*0*	*0.00%*
9.0	*5*	*0.03%*
10.0	*25*	*0.13%*
11.0	*12*	*0.06%*
12.0	*6*	*0.03%*
13.0	*11*	*0.06%*
14.0	*14*	*0.07%*
15.0	*23*	*0.12%*
16.0	*41*	*0.21%*
17.0	*48*	*0.24%*
18.0	*0*	*0.00%*
19.0	*5*	*0.03%*
20.0	*319*	*1.60%*
Total	***20,000***	***100.00%***

Since there would not be any bankruptcy with a probability of 96.73%, an analysis of the tail of the distribution is pertinent. Figure 3 presents the right tail of the loss distribution and the exposure of the DIS at each percentile. It is interesting to note that exposure goes from nil to total deposits within a probability range of 4%.

Figure 3:
Right tail of the loss distribution.



- **Determining a percentile associated to a level of risk.**

The PD associated to a percentile of the loss distribution was calculated using the lowest PD from the set of insured banks in the crisis period and the country credit rating of the same period:

- Econometric model approach: the PD of the set of insured institutions was estimated and the lowest probability of all institutions during the crisis was selected. For this numerical exercise, Bank J had the lowest PD in the peak of the financial crisis (t-145), 3.5%.

- Rating agencies approach: the country credit rating was assumed to be BB in the crisis period, so the strongest entity could have a maximum rating of BB-; this is equivalent to a PD of 1.5%.

Instead of choosing one methodology over the other, the average of the two was used (2.5%).

- **Calculation of the target level of funding ratio.**

The percentile of the loss distribution associated to the selected PD is 97.5 (2.5% PD). This percentile corresponds to a target fund of $9.1 m and represents 6.5% of total deposits ($9.1 m / $140 m). The result can be interpreted as follows: with a 97.5% probability, a fund equivalent to 6.5% of total deposits covers the DIS' required payments in a year.

- **Partitioning ex-ante funding.**

Assuming a recovery rate of 25%, a credit contingency line would correspond to 25% of the target level or 1.625% of total deposits.

- **Taking into account the investment policy**

Assuming that the entire DIS funding (both ex-ante and the credit contingency line) is denominated in foreign currency and that any crisis scenario where the funds need to be

deployed are accompanied by a devaluation of the currency of 30%. Given this scenario, the target level could be reduced to 5% of total deposits.

5. Conclusions.

The DIS contributes to financial stability by reducing the incidence and severity of bank runs. The resources available in the reserve of the DIS as well as other mechanisms previously arranged by the DIS to fund its mandate constitute a critical part of its ammunition when banks face an insolvency event. Therefore, making sure that there are sufficient resources constitutes one of the contributions made by deposit insurers to restore or maintain the stability of the financial system in times of crisis and identifying the target funding level is a critical element in its structure.

This paper describes a methodology to determine the target funding level of a DIS, proposes criteria to incorporate recoveries and the investment policy and finalizes by illustrating the approach with a hypothetical financial system. The expectation is that ideas presented here add value to other DISs in their continuous quest to be prepared for the moments where our actions are required.

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Annex: Existing Practices of Deposit Insurers

The methodologies used by deposit insurers for calculating the target level of funding are diverse. According to a survey conducted by the IADI (2011), from 33 institutions surveyed, 10 deposit insurers[8] use the PD of the insured institutions in calculating the expected losses of the DIS, and therefore the target level of funding. Other entities, like the Canadian Deposit Insurer Corporation (CDIC), employ statistic methodologies and external ratings for the calculation of the PD, and apply Monte Carlo simulations to find the target level. In Indonesia, use internal ratings based on a deposit insurer quantitative models, from those results it is estimated a model based on transition matrices to calculate PD. The deposit insurer of Russia uses econometric methodologies and models based on market prices of bonds issued by insured institutions.

The international financial crisis of 2008 had consequences over the deposit insurers who made a revaluation of the target level of funding. As a result, the Federal Deposit Insurer Corporation of the United States (FDIC) increased its target level of funding from 1.5% a 2% since 2011. In the same way, in Jun 2011 the CDIC published a consultation paper to ask for comments about rising the target funding level (0.40% - 0.50%) to a level of 1% to 1.5%.

Table 1A presents the target level of funding of 21 deposit insurers according to IADI (2011). Four of the entities present the target level of funding as a range and the remaining as a specific value. Besides, 16 deposit insurers present the target level as a proportion of the total deposits[9].

Table 1A:
Target level of funding of some deposit insurers

Seguro de depósitos (País)	Razón Objetivo (%)
Argentina	5
Brasil	2
Bulgaria	5
Canadá	0.40-0.50
El Salvador	1
España	1
Hong-Kong	0.345
Hungria	1.0-1.5
Indonesia	2.5
Jamaica	5
Jordan	3
Kazakhstán	5
Malasia	0.6 - 0.9
Paraguay	10
Rumania	1.5
Rusia	5 - 10
Singapur	0.3
Taiwán	5.045
Uruguay	5
USA	2
Zimbabwe	2

Fuente: IADI (2011)

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[8] Canada, Hong Kong, Indonesia, Nigeria, Russia, Philippines, USA, Singapore and Zimbabwe.
[9] Canada, Jamaica, Malaysia, Russia and USA present the target level as a proportion of the insured deposits.