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Financial reform and the adequacy of deposit insurance fund: Lessons from Taiwanese experience

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ABSTRACT

Financial reforms and capital adequacy are probably the most critical issues for the banking industry in the world. This study examines the effectiveness of financial reforms carried out in Taiwan recently and measures the adequacy of the deposit insurance fund (DIF), including financial restructuring fund and Designated Reserve Ratio (DRR) strategy in Taiwan. We have improved on the methodology of Episcopoc (2004) and report estimates of the cost of deposit insurance and implied reserves for each bank or financial holding company. Estimates of the implicit cost of government guaranty of the DIF are also included. To stabilize its financial environment in 2000, the Taiwanese government amended many bank regulations, including the enactment of the Financial Holding Company Act (FHC Act) of 2001 and the Financial Restructuring Fund Statute. Our evidence shows lower volatilities and average unit cost of deposit insurance for seven sampled FHCs compared to sixteen sampled banks, even though the FHCs are larger. These results indicate the effectiveness of the financial reforms put forward by the Taiwanese government. When implied reserves are compared with the Designated Reserve Ratio (DRR) strategy of 2%, imposed by the Central Deposit Insurance Corporation (CDIC) in 2007, we find that the DIF would have been sufficient in 2006, but not in 2000. The results imply that the fixed target ratio for the DIF may not be appropriate. In addition, the details of financial reforms in Taiwan starting in 2001 are provided and demonstrate resolve in implementing financial reforms. Finally, financial reforms of Taiwan and the calculations of DRR and estimates of the implicit cost of government guaranty of the DIF can be used as lessons for other countries.

1. Introduction

Financial reforms and capital adequacy are probably the most critical issues for the banking industry in the world. Using Taiwan as an example, this study examines the effect of certain financial reforms, provides improved methods of calculating estimates of the cost of deposit insurance and implied reserve, and discusses the strategy of Designated Reserve Ratio. In order to integrate the financial market and stabilize the financial environment, the Taiwanese government implemented a series of financial reforms in the early 2000s. Among these, an important one is the enactment of the Financial Holding Company Act in 2001. The act provided the basis for the mergers of financial institutions and accelerates the process of financial consolidation. This enhances the strength and competitiveness of financial institutions in Taiwan.

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Another reform was the adoption of the Financial Restructuring Fund Statute in June 27, 2001. The Financial Restructuring Fund is funded by a special budget of the Taiwanese government and supports the Central Deposit Insurance Corporation (CDIC) to deal with problem financial institutions. Due to the financial reforms, the number of insured institutions decreased from 456 in 2000 to 392 in 2011 (see Appendix A). Moreover, in order to improve the quality of bank assets, the Taiwanese government reduced the bank business tax rate from 5% to 2% in 1999. The tax savings resulted from the lower tax rate were required to write off non-performing loan (NPL). The average NPL ratio decreased from 6.2% in 2000 to 0.43% at the end of 2011 (see Appendix B). At the same time, the average NPL coverage ratio rose from 15.34% to 251.83%. This indicates that there has been a significant improvement in the quality of bank assets in Taiwan.

Five failing financial institutions were taken over by the CDIC in 2006 and 2007.[3] In the wake of these five failed banks, the Taiwanese government revised the Deposit Insurance Act in 2007 to ensure the adequacy of the Deposit Insurance Fund (DIF). Among the amendments in the Deposit Insurance Act the most important one sets up a target ratio (i.e. Designated Reserve Ratio, DRR) for the DIF at the fixed ratio of 2% of insured deposits. Low DRR will increase the possibility of serious shortage on the DIF when the CDIC faces a large financial institution failure or systemic collapse. The DIF is implicitly guaranteed by the government; however, its shortage will be transferred to the government and eventually born by the ordinary taxpayers. On the other hand, high DRR can alleviate the spillover problem, but high DRR may increase bank's cost of capital and hence loan rates, which will shrink the investment of firms and disturb overall economic growth. How to set up an adequate DRR level becomes an important issue for bank managers, regulators and depositors. In this study, we examine the relationship between the levels of DRR and the implicit cost to the Taiwanese government to insure financial institutions. We also examine the effectiveness of these financial reforms and its effects on the adequacy of the DIF.

A fairly large body of literature focuses on the valuation of deposit insurance including Merton (1977, 1978), Marcus and Shaked (1984), McCulloch (1985), Pyle (1986), Ronn and Verma (1986), Pennacchi (1987), Allen and Saunders (1993), Duan and Yu (1994, 1999), and Duan, Moreau, and Sealey (1995).[4] Merton (1977) and other researchers propose actuarially fair premiums based on the option-pricing model and suggest that premiums should depend on the size of insured deposits and the bank's asset risk. Because the deposit insurance is implicitly fully guaranteed by the government in most countries, these studies did not consider the effect of the insolvency of the DIF on the deposit insurance valuation. However, a series of studies, such as Kane (1989, 2000), Hovakimian and Kane (1996), and Demirguc-Kunt and Kane (2002) points out the relations among a failed DIF, government regulators, and insured banks, in terms of risk-taking incentives. [5] In addition, the forbearance of authority may encourage financially deteriorating banks to take higher risks, leading to increased losses for the deposit insurance agent. Under the political pressure the government may be forced to supply unlimited DIF in the case of bank failures. The shortage of the DIF eventually will be transferred to the taxpayers. Episcopos (2004) addresses the shortage of the DIF and tries to incorporate the effect of the reserve of the DIF on the deposit insurance valuation.

There are two implications to be drawn from this stream of the literature. First, if governments do not guarantee the solvency of the DIF, then there are more incentives for depositors to monitor banks. Second, if governments guarantee the DIF, they take on the role of reinsurer, and adequacy of the DIF remains an important issue due to the cost of reinsurance. When a government guarantees the DIF, the insolvency risk may be shifted from the troubled banks to the deposit insurance agent, then to the government, and finally to taxpayers. Taxpayers would like to know the cost of the guaranty. It is obvious that a guaranty is costly when the DIF is insolvent. Even when the DIF remains solvent, a guaranty is still costly, *ex ante*, so it is important to estimate its implied costs. One example is the U.S. Government guarantee of Chrysler's debt in 1979. Even though Chrysler survived, and it cost the government nothing, there was an ex ante implied cost of guaranty.

In this study, we apply the model of Episcopos (2004) to measure the coverage ratio provided by the current level of DIF, and the implicit costs of government to guarantee the DIF. We measure the effectiveness of financial reforms put forward mainly during the period from 2001 to 2005 in Taiwan, in particular, the enactment of the FHC Act and the establishment of Financial Restructuring Fund.[6]

Our results show that the average premium for the FHCs in 2006 is lower than that for the corresponding individual banks in 2000 even though the FHCs are larger. This suggests that the FHC Act has achieved its objectives. Moreover, the average implied reserves in 2006 are lower than in 2000. This indicates that the financial reforms improved the quality of financial institutions and the financial environment in Taiwan. When implied reserves are compared with the Designated Reserve Ratio (DRR) strategy of 2%, imposed by the Central Deposit Insurance Corporation (CDIC) in 2007, we find that the DIF would have been sufficient in 2006, but not in 2000. The results imply that the fixed target ratio for the DIF may not be appropriate.

[3] See Appendix C for details.

[4] In contrast to the studies focused on the valuation of deposit insurance, there is a series of studies contributed to empirically examine the effect of deposit insurance on the bank's risk-taking behavior and the probability of bank failure. For example, Gueyie and Lai (2003) examined the effect of the introduction of flat-rate deposit insurance on the bank risk-taking behavior in Canada. Hwang, Lee, and Liaw (1997) examined the factors that can be used to detect the bank failure and estimated the costs of insuring the U.S. banks.

[5] Kupiec (2004) developed a model to value deposit insurance while incorporating the interaction effect of the endogenous Internal-Model-Based capital requirement recommended by Basel II and bank risk-taking incentives.

[6] In order to improve the competiveness and capital status of financial institutions in Taiwan, the FHC Act was passed in 2001. Moreover, in order to deal with the problem financial institutions and stabilize the financial environment, the Taiwanese government established the Financial Restructuring Fund in 2001. The Financial Restructuring Fund which is independent of the DIF provided a temporary blanket guarantee from July 2001 to July 2005.

Our results of the effect of Taiwan financial reforms, improved methods of calculating estimates of the cost of deposit insurance and implied reserve, and discussion of the strategy of DRR can be used as lessons for other countries. For example, some countries (e.g., Korea and Thailand) provided blanket guarantee deposit insurance (full coverage) during 2007 financial crisis. Using our methods, each country can calculate the implicit costs of government guaranty of the DIF. The evidence in Taiwan that a fixed target ratio for DIF may not be appropriate can be a lesson for other counties.

This study is outlined as follows. Section 2 briefly presents the background to financial system and the main financial reforms in Taiwan and other countries. The methodology of options models in deposit insurance pricing for the value of coverage with/without the government guaranty are presented in Section 3. Section 4 describes the data and summary statistics. Section 5 provides the results. We discuss the solvency issue of the DIF in Section 6. Section 7 is a conclusion.

2. Background to financial system and financial reforms in Taiwan and other countries

This section first provides a history in the financial environment in Taiwan and then discusses deposit insurance premium assessments and the role of the CDIC. We also provide a history of financial reforms and discuss issues related to deposit insurance premium assessments and the role of deposit insurance agent for four countries. We select two developed countries (Japan and U.S.) and two developing countries (Korea and Thailand) for the purpose of discussions.

2.1. Changes in the financial environment and financial reforms

Most financial institutions were owned by the Taiwanese government before 1990. Under strict regulation and conservative lending, commercial banks were profitable and healthy. Around 1990, during a period of financial liberalization and globalization, the government approved the establishment of 16 new private banks. Liberalization increased competition and contributed to oversaturation in the market. This narrowed profit margins as well as lowered the growth of financial institutions. The Asian financial crisis in 1997 and the following global economic recession also resulted in a rapid increase in non-performing loan (NPL). Bad loans continued to soar through 2000. In 2000, the total NPL amount for all financial institutions was NT$1021 billion (approximately US$310 million). The NPL ratio was 6.2% (compared to a 3.0% value before 1995).

To stabilize the financial environment, the Taiwanese government put forward a series of financial reforms.[7] Among these reforms the enactment of the FHC Act in 2001 and the establishment of the Financial Restructuring Fund are the two most important ones. The FHC Act was intended to enhance synergies in financial institutions, to consolidate supervision of the cross-financial industries, to promote the sound development of financial markets, and to protect the public interest. Under the FHC Act, some banks became subsidiary banks of FHCs. Thus the FHC Act speeded up the process of integration across industries, as it established a mechanism to deal with the bad debts of financial institutions.[8]

The FHC Act also gave the CDIC greater authority to supervise all financial institutions and their merger and acquisition activities. To increase the effectiveness of supervision and to protect financial institutions from insolvency, the CDIC revised the "Financial Examination Rating System" and "Financial Early-Warning System".[9] These revisions were intended to encourage better reporting from financial institutions, allowing for the earliest possible discovery of problems. According to the revised Banking Law, banks' capital adequacy ratios must achieve at least 8%. If the ratio falls below 8%, banks are required to recapitalize. An amendment in the Bank Law that authorizes the CDIC to take over a bank within 90 days when its capital adequacy ratio falls below 2% was passed by the Legislative Yuan in 2008.[10]

On June 27, 2001 the Legislature approved the Statute for Establishment and Management of the Executive Yuan's Financial Restructuring Fund to rescue potentially insolvent banks.[11] Independent of the DIF, the Financial Restructuring Fund provided a temporary blanket guarantee, on domestic financial institutions (from July 2001 through July 2005). This was aimed at preventing a regional banking crisis, closing problem financial institutions smoothly, strengthening the environment for financial operations, and safeguarding depositors. The resources of the Financial Restructuring Fund included government financial business tax revenue and deposit insurance premium income from the financial sector.[12] The Financial Restructuring Fund entrusts the CDIC with the full amount required to settle both deposit and non-deposit-related claims on troubled financial institutions with unsound operations.[13] The Fund has overseen the graceful departure of 56 troubled financial institutions from the market and has

[7] The amended laws and regulations include the Banking Law, Financial Institutions Merger Law, FHC Act, six Financial Regulations, and a *Statute for the Establishment and Management of the Executive Yuan Financial Restructuring Fund*.

[8] Four holding companies were formed in December 2001, and sixteen have been established since then.

[9] Other revised system includes Quarterly Analysis Reporting System, Internet Transmission Surveillance System, Call Report Percentile Ranking System, and Financial Holding Company Call Report System.

[10] The Legislative Yuan is equivalent to a parliament in other countries.

[11] Executive Yuan is an executive branch of the Taiwanese government.

[12] The financial business tax revenue for 2002–2005 was estimated to be about NT$120 billion. The CDIC's incremental insurance premium income for the ten-year period starting January 2002 has risen as a result of the increase in the insurance assessment rate that took effect on January 1, 2000, and was expected to amount to approximately NT$20 billion.

[13] Originally, the Financial Restructuring Fund amounted to NT$140 billion. In June 2005, the legislature increased the fund by NT$110 billion. The total resources of the Financial Restructuring Fund amounted to about NT$250 billion in 2005 and about NT$2992 million in August 2008.

paid out claims amounting to NT$206.8 billion since July 2001.[14] Five private problem financial institutions have been taken over by the CDIC, with the prescribed repayment by the Financial Restructuring Fund and the DIF in 2006 and 2007 (see Appendix C). The Financial Restructuring Fund paid NT$1157.62 million and the DIF paid NT$3761.64 million to rescue Enterprise Bank of Hualien, for example. During the period from 2001 through its termination on December 31, 2011, the Financial Restructuring Fund successfully enabled problem financial institutions to withdraw from Taiwan financial market.

After the enactment of a series of financial reforms (see Appendix D), the asset qualities of financial institutions have improved significantly. The average non-performing loan (NPL) ratio declined from 6.2% in 2000 to 0.61% in 2010. In 2010, we find the average NPL ratio in Taiwan was much lower than others countries, e.g., the US (4.96%), Japan (2.5%), Korea (1.88%) and Thailand (3.89%) (see Appendix E).

While the purposes are different from Taiwan FHC Act, U.S. Financial Services Modernization Act replaced Glass–Steagall barriers of 1933 between commercial banks and investment banks in 1999. Financial Services Modernization Act like FHC Act of Taiwan also allowed for the creation of a financial services holding company that engaged in banking activities, securities underwriting and any other financial activities. After the Financial Services Modernization Act, there were 26 deposit institutions failed in 2008 and 140 additional failures occurred in U.S.

In order to stabilize financial market and to resolve failing enterprises, the U.S. government implements some acts. For example, Temporary Liquidity Guarantee Program (including Debt Guarantee Program and Transaction Account Guarantee Program) and Term Asset-Backed Securities Loan Facility were created by Federal Deposit Insurance Corporation (FDIC). Emergency Economic Stabilization Act of 2008 (EESA) was passed by U.S. Congress in 2008. In 2010, the congress passed the Wall Street Reform and Consumer Protection Act to prevent a similar crisis from ever recurring and repeating of the market meltdown of 2008.[15]

While most of countries do not enact acts similar to FHC Act in Taiwan, many countries also provide funds that are similar to Financial Restructuring Fund in Taiwan. For example, Japanese government created the Resolution and Collection Corporation (RCC) to handle the disposal of bad loans in 1991. In particular, Japan banks had written off over US$650 billion in non-performing loan during period from 1992 to 2002. During the 1997 Asian financial crisis, Korea government sets up the Deposit Insurance Fund (DIF) and Non-Performing Asset Management Fund (NPAF) to resolve insolvent financial institutions. Following the Asia financial crisis, Thailand began its financial system reform. The Thailand government established the Financial Restructuring Authority (FRA) and Asset Management Corporation (AMC) in 1997 to resolve insolvent financial institutions. Jeon (2010), Shimada and Yang (2010), and Yam (2009), pointed out the implementation of a series of financial reforms contributed to the fast recovery of the Asian countries from the effect of the 2008 global financial crisis.

In summary, the lessons learned from the experiences from the reforms of Taiwan and other countries are stated below. First, FHC Act was successfully implemented in Taiwan because the FHC speeded up the process of integration across industries and promoted the sound development of financial markets. Once evidence of the success of FHC Act was successful is the NPL ratio in Taiwan was the lowest in 2010 after the global financial crisis. On the other hand, Financial Services Modernization Act in U.S. cannot be deemed as successful. In fact some have claimed that Financial Services Modernization Act caused the global financial crisis. It seems that the concept of holding company structure is appropriate as long as the regulator can effectively regulate firms such that firms would not misuse their new found power such as the misuses of derivatives. Second, some types of restructuring funds such as Financial Restructuring Fund in Taiwan, Resolution and Collection Corporation in Japan, or Non-Performing Asset Management Fund to resolve insolvent financial institutions are critical to the stability of financial markets.

2.2. Background of the deposit insurance premium assessment

Taiwan founded its deposit insurance system and adopted a flat premium rate in 1985. There was much discussion over the fairness of the flat rate system with its tendency to cause an ethical hazard and its inability to differentiate various risk levels. To facilitate legislative objectives, the Deposit Insurance Act vests the CDIC with managing deposit insurance, assisting and disposing of problem institutions. The goals of deposit insurance are to safeguard the benefits of depositors, enhance the sound development of financial operations, and maintain an orderly credit system.

The CDIC adopted a Deposit Insurance Risk-Based Premium System on July 1, 1999, making Taiwan the first Asian country to implement such a system.[16] The CDIC also required participation in the deposit insurance system. Previously, the system was voluntary, with the world's lowest premium rates. However, the DIF accumulated too slowly to be sufficient. Thus, on January 1, 2000, the CDIC raised the three-tiered deposit insurance assessment rates from the previous rates of 0.015%, 0.0175%, and 0.02% of insured deposits to 0.05%, 0.055%, and 0.06%. On October 15, 2007, the CDIC raised the rates again. For domestic banks, local branches of foreign banks and credit cooperatives, the premium rates became 3, 4, 5, 6, and 7 basis points of insured deposits according to a risk-based rate system. Revised in November 2010, the assessment rates are based on five different levels of risk and effective from

[14] The restructuring fund handled claims for 38 credit departments of Farmers and Fishermen's Associations, with total payments of NT$49.5 billion (24%); nine credit cooperatives, with total payments of about NT$43.3 billion (21%); and nine banks (including trust and investment companies), with total payments of about NT$114.8 billion (55%) as of December 31, 2011.

[15] Saunders and Cornett (2011), *Financial institutions management — A risk management approach*, seventh international edition (New York: McGraw-Hill), page 54.

[16] Pennacchi (2000) discusses the relative merits of a targeting policy and a flat-rate insurance policy.

January 1, 2011. For domestic banks and local branches of foreign banks, the premium rates are 0.05%, 0.06%, 0.08%, 0.11%, and 0.15%, and the flat premium rate for insured deposits in excess of coverage limit is 0.005%. For credit cooperatives, the premium rates are 0.04%, 0.05%, 0.07%, 0.10% and 0.14%, and the flat premium rate for insured deposits in excess of coverage limit is 0.005%. For credit departments of farmers' and fishermen's associations, they are 0.02%, 0.03%, 0.04%, 0.05%, and 0.06% of covered deposits and the flat premium rate for insured deposits in excess of coverage limit is 0.0025% (see Appendix F).

Taiwan adopted the risk-based premium system was similar to that of U.S., Japan, and Korea. These countries adopted both flat premium rate and special premium rate system (e.g., Japan and Korea). However, Thailand uses the flat premium rate for insured deposits. Based on the experiences of various countries, it seems risk-based premium system in Taiwan and, U.S., and Japan is an appropriate system. Thailand may need to rethink its flat premium rate for insured deposits.

2.3. Deposit insurance funds (DIF)

In the wake of the bank failures, the Deposit Insurance Act was revised in January 12, 2007. Amendments in the act mainly focused on enhancing deposit insurance mechanisms, including “replenishing and reforming the DIF”, “tightening controls over risk taking behavior”, “strengthening the mechanism for handling failed institutions”, “protecting the interests of depositors”, “effectively assisting insured institutions in reducing operating risk”, and “maintaining financial stability”.[17] Authorized with rights of ex ante prevention and ex post resolution, the CDIC can fulfill its mission more effectively. Major amendments to the Deposit Insurance Act that are most relevant to this study are: setting a target ratio of the DIF at 2% of insured deposits to ensure the adequacy of the DIF, increasing the confidence of depositors, and changing the method for calculating the assessment base for deposit insurance.[18]

Table 1 shows annual DIF reserve ratios for Taiwan from 1986 to 2010. The actual reserve ratios of the DIF and the target level of DRR are graphed in Fig. 1. The target level was set at 2% in 2007. It can be seen that the level of the reserve was far below the target level. In fact, the DIF was negative (about − NT$403 million) at the end of 2007. The DIF was used to share some of the compensation to the deposits of failed financial institutions in line with the mechanism for the combined utilization of the financial restructuring fund since September 2007. In October 2008, the government announced that deposits in all financial institutions would receive full coverage until December 31, 2009.[19] It is safe to assume that the Taiwanese government will step in and provide additional financing when a bank fails.

U.S. Congress addressed the insolvent Bank Insurance Fund (BIF) by enacting the Federal Deposit Insurance Corporation Improvement Act (FDICIA) in 1991.[20] FDICIA required the FDIC to have an assessment system in place by 1994 wherein each bank's assessment would be reflective of the risks it posed to its insurance fund. The Deposit Insurance Funds Act of 1996 set the DRR at 1.25% of total insured deposits for the BIF and SAIF (Saving Associations Insurance Fund). The requirement of DRR also implicitly demanded the FDIC to set assessment rates of premiums at a level that maintains the DRR.

The DIF of the U.S. was established on March 31, 2006 as a result of a BIF-SAIF merger pursuant to the enacted deposit insurance reform legislation. The Reform Act (February 2006) and its regulations (published in November 2006) established a range for the DRR (1.15 to 1.50% of estimated insured deposits) and nullified a fixed rate of 1.25%. This legislation provided the FDIC with greater discretion to charge insurance assessments and imposed sensitive risk-based pricing. The legislation also required declaration and payment of dividends from DIF, if reserve ratio equaled or exceeded 1.35% of estimated insured deposits at the end of any calendar year. The FDIC Board reset the DRR at 1.25% in 2007. During the period of global financial crisis, due to the large payment on resolving trouble financial institutions, the DIF had a deficit of 8.2 billion in 2009. In order to address the falling balance in the fund, the FDIC was levied one special assessment in early 2009 and a second in the fall of 2009. In addition, the FDIC charged the raising premium rate for banks and required banks to prepay premiums by the end of 2009.[21] Currently, the maximum level of deposit insurance protection is set at $250,000 per depositor per bank. The FDIC announced the deposit coverage will be adjusted according to the CPI index every five years from January 2011.

In Korea, there are three DRR (i.e. DIF target fund) ranges for financial institutions. For banks, investment traders and brokers, and non-life insurance companies, the target value is set at 0.825% to 1.1% of insured deposits. For life insurers, it is set at 0.66% to 0.935%; and for mutual savings banks, it is set at 1.65% to 1.925%.[22] From 1997 to 2001, Korea government resolved about 487 financial institutions. In 2001, Korea Deposit Insurance Corporation (KDIC) changed deposit coverage from the blanket deposit coverage to limited coverage. The limited coverage is KRW 50 million (US$44,986) per depositor.

[17] See page 11 of the 2007 CDIC annual report.

[18] The amended Act does not include methods for reviewing the insurance premium system once the target DRR of DIF at 2% has been achieved.

[19] In October 2009, the Taiwanese government announced that the deposit insurance system of temporary full coverage extended to December 31, 2010. On August 12, 2010, the Taiwanese government announced that the limited coverage was increased from NT$1.5 million (US$51,168) on July 1, 2007 to NT$3 million (US$102,340) starting from January 1, 2011.

[20] Federal Deposit Insurance Corporation (FDIC), 1998.

[21] Saunders and Cornett (2011), *Financial institutions management — A risk management approach*, seventh international edition (New York: McGraw-Hill), pages 585–586.

[22] KDIC, *Management of Deposit Insurance Funds*; available from http://www.kdic.or.kr/english/major/sub1_2.jsp.

Table 1
Insured deposits, the deposit insurance fund (DIF), and reserve ratios, 1986–2010 in Taiwan.

Year	Insured deposits (NT$ million)	Deposit Insurance Fund (DIF) (NT$ million)	Reserve ratio (%)
2010	Blanket guarantee	0	0.00
2009	Blanket guarantee	0	0.00
2008	Blanket guarantee (notes 1)	0 (notes 2)	0.00
2007	10,472,346	(403)	0.00
2006	9,686,079	15,125	0.15
2005	9,528,182	13,579	0.14
2004	9,018,811	12,154	0.13
2003	8,613,531	10,946	0.13
2002	8,273,608	9662	0.12
2001	8,116,092	8528	0.11
2000	7,701,342	4840	0.06
1999	7,769,067	1752	0.02
1998	6,991,799	2200	0.03
1997	3,289,797	1793	0.05
1996	3,058,978	1421	0.05
1995	2,772,773	1080	0.04
1994	1,923,972	820	0.04
1993	1,608,539	618	0.04
1992	1,151,692	481	0.04
1991	943,196	396	0.04
1990	753,861	300	0.04
1989	618,248	222	0.04
1988	483,378	157	0.03
1987	379,379	116	0.03
1986	201,850	48	0.02

Notes:

(1) The government announced in October 2008 that deposits of depositors in all financial institutions participating in deposit insurance will receive full coverage until December 31, 2009. This was later extended by one year to December 31, 2010. From 2007 to 2011 the deposit insurance reserves for general financial institutions as well as the fund as a proportion of covered deposits were both 0.
(2) Beginning in September 2007 the CDIC's DIF was used to share some of the compensation paid in relation to the disposition of failed financial institutions in line with the mechanism for the combined utilization of the Financial Restructuring Fund and the DIF as approved by the Executive Yuan.
(3) Insured deposits: the amount of each depositor's insurable deposits that do not exceed the maximum coverage.
(4) On July 1, 1999, the deposit insurance system shifted from a flat premium rate (0.015%) to a risk-based differential rate at three rate levels of 0.015%, 0.0175%, and 0.02%. On January 1, 2000, the rate levels were adjusted to 0.05%, 0.055%, and 0.06%. From 2007, the premium of covered deposits for general financial institutions was divided into five-tired risk-based premium rates. But from 2011, the premium of covered deposits for insured institutions was revised (see Appendix F).
(5) In September 1999, the CDIC provided assistance in the amount of NT$1.284 billion to help Taiwan Bank to acquire the Dong-gang Credit Cooperative, reducing in deposit insurance fund.
(6) Article 4 of the Financial Restructuring Fund Statute stipulates that the Fund's resources include the CDIC's incremental insurance premium income covering a 10-year period starting January 2002 that arose as a result of the adjustment in the deposit insurance premium rate that took effect on January 1, 2000.
(7) Annual figures are as of December 31.

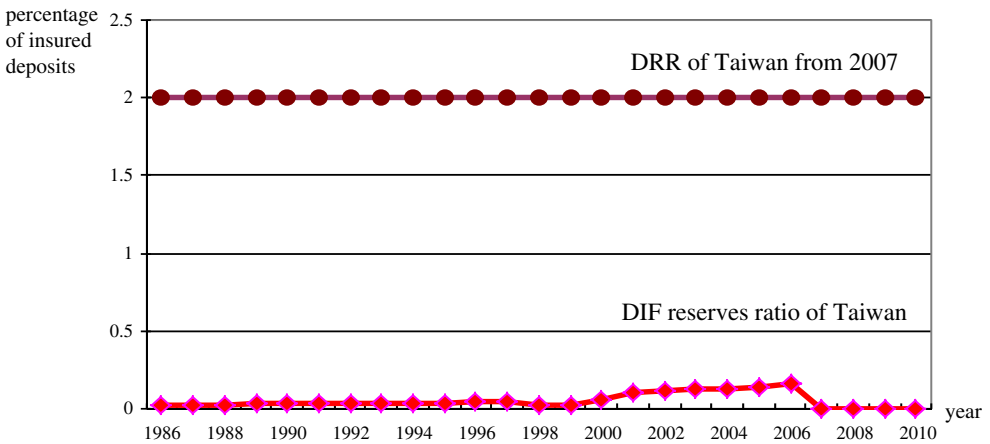


Fig. 1. Deposit Insurance Fund (DIF) reserve ratio and Designated Reserve Ratio (DRR), 1986–2010.

However, some countries (e.g., Japan and Thailand) lacked any setting of DIF target level.[23] In order to lessen the effect of the Asian financial crisis, the Japan government provided a blanket deposit guarantee from1996 to 2005.[24] The Deposit Insurance Fund (DIF) was rapidly declining during the Asian financial crisis. Currently, the general deposits were insured up to 10 million (US$128,220) in Japan. In Thailand, during the 2008 global financial crisis, the government extended the blanket deposit guarantee for two more years, until 10 August 2011. Due to the economic and financial recovery, the deposit coverage was decreased to Baht 50 million (US$1.6 million) in August 2012 and to Baht 1 million (US$32,431) per depositor per bank currently.

The DIF is implicitly guaranteed by the government. It is debatable whether the need to set a DIF target level. However, as mentioned previously, an adequate level of DIF can alleviate the spillover problem experienced in financial crisis. It can also build a merit to form a practical bank's cost of capital and loan rate. In this study, we examine the relationship between the levels of DRR and the implicit cost to Taiwanese government to insure the DIF. The result not only can shed a light on examining the effectiveness for setting a fixed target ratio for the DIF and can be used as lessons for other counties.

3. Methodology

There is not much research on measuring the adequacy of a deposit insurance fund in the options-based literature. Episcopos (2004) provides a model to estimate the implied reserves of a DIF under an exogenous coverage ratio set by the insuring agent. In this study, we first follow Merton (1977) and Ronn and Verma (1986) to estimate the values of deposit insurance for individual banks when insolvency of the DIF is not considered. We then follow Episcopos (2004) to estimate the implied reserves of the DIF under alternative targeted coverage ratios when insolvency is considered. Finally, we examine the adequacy of the DIF held by the CDIC. It should be noted that there are limitations with respect to option-based models of deposit insurance. For example, the models include an exogenous asset return-generating process that is unchanged in the face of losses when banks face an elevated probability of closure. This assumption is highly unrealistic, since when banks face impending insolvency many incentives enter their investment decision thinking.

3.1. Implied reserves and coverage ratio

Episcopos (2004) extends a framework from Johnson and Stulz (1987) to value deposit insurance while incorporating the effect of the insolvency of the DIF. We follow Episcopos (2004) to consider banks are insured by the CDIC with an initial level of the DIF. The initial DIF, along with the premiums received, is invested at a risk-free rate until the deposit insurance contract matures. When the government guarantee is not taken into account, the value of the coverage provided by the CDIC depends on the adequacy of the DIF. Following Episcopos (2004), the coverage ratio is defined as follows:

$$\alpha = \frac{p(V,\theta)}{P} \tag{1}$$

where P denotes the value of deposit insurance computed without considering the insufficiency of the DIF. That is, the CDIC is assumed to provide full coverage of bank deposits under the government guaranty. With a government guaranty, α is set at 100%, and the value of deposit insurance a single bank, P, can be directly estimated following Ronn and Verma (1986). $p(V, \theta)$ denotes the value of deposit insurance for partial coverage, where the government's guaranty is not taken into account. In the case of partial coverage, where α is set to be less than 100%, the value of $p(V, \theta)$ will depend on the level of DIF reserves, V, and a set of parameters, θ, including bank asset volatility. When α is set below 100%, there is a probability that the CDIC cannot fulfill its promises without the government's subsidy. For an exogenous targeted coverage ratio, the value of deposit insurance for partial coverage, $p(V, \theta)$, can be derived from Eq. (1).

In the case of a government guaranty, the value of deposit insurance, P, can be assessed by discounting the expected payoffs of the CDIC as follows:

$$P = e^{-rT} E_1\{Max(D_T - S_T k, 0)\} \tag{2}$$

where E_1 denotes the risk-neutral expectation over bank assets; D_T is the value of a bank's insured domestic deposits at maturity (time T); S_T is the value of bank assets at maturity; and k is the proportion of a bank's insured deposits to its total liabilities. Deposit insurance can be valued as a put option written on the bank asset value with a strike price equaling the value of the insured deposits.

Because the market value of the bank's assets and its volatility are not observable, we follow the framework of Ronn and Verma (1986) to estimate the value of a bank's assets and its volatility by solving Eqs. (3) and (4) simultaneously:

$$E = SN(x) - LN\left(x - \sigma_s\sqrt{T}\right) \tag{3}$$

[23] International Association of Deposit Insurers, the Research Subcommittee of the Asia-Pacific Regional Committee, *Funding Mechanisms of Deposit Insurance Systems in the Asia-Pacific Region* (International Association of Deposit Insurers, the Research Subcommittee of the Asia-Pacific Regional Committee, 2011).

[24] The Deposit Insurance Corporation of Japan (DICJ) gradually modified deposit insurance coverage from blanket guarantee coverage to limited coverage. In 2005, deposits under full coverage have been limited to only two conditions: payment and settlement services deposits were fully protected as a permanent measure.

$$\sigma_s = \frac{\sigma_E E}{SN(x)} \tag{4}$$

where

$$x = \frac{\ln(S/L) + \sigma_s^2 T/2}{\sigma_s \sqrt{T}}.$$

E denotes the market value of the bank's equity; S is the market value of the bank's assets; $N(\cdot)$ is the standard normal cumulative distribution function; L is the total liability of the bank; σ_s is the unobserved asset volatility; T is the time to the next audit date; and σ_E is the instantaneous standard deviation of the return on the bank's equity.

Once the values of the bank's assets and its volatility have been estimated, any value of deposit insurance under full coverage can be computed using Eq. (5):

$$P = \frac{e^{-rT}}{\sigma_s \sqrt{T}} \left[\int_0^{D_T/k} \frac{D_T - sk}{s} f_s ds \right] \tag{5}$$

where r denotes the risk-free rate. f_S is the probability density function (pdf) of the return on the bank's assets, assumed to be normally distributed.[25] The variables D_T, σ_S, L, k, and T are described previously. Definitions of all variables are also provided in the Appendix G.

When a bank fails, the CDIC pays depositor losses from the DIF first because deposit insurance is implicitly guaranteed by the government. If the amount to be paid by the CDIC is higher than the DIF, the government needs to cover the shortage from general tax revenues. Therefore, the implied value of the government guaranty can be estimated as the difference in the values of the deposit insurance with and without the government guaranty.

We follow Episcopos (2004) to incorporate the impact of the adequacy of the DIF and value deposit insurance without the government guaranty as a "vulnerable option".[26] At a certain level of the DIF reserve, the value of deposit insurance under partial coverage can be described as follows:

$$p = e^{-rT} E_1 \left\{ Min\left(V_T, Max(D_T - S_T k, 0) \right) \right\} \tag{6}$$

where V_T denotes the DIF available at time T.

Under the assumption that the bank asset value is log normally distributed, and by analogy with Eq. (5), the value of deposit insurance computed without considering the government guaranty, p, can be described as follows:

$$p = \frac{e^{-rT}}{\sigma_s \sqrt{T}} \left[\int_0^{\infty} \frac{Min\left(V_T, Max(D_T - sk, 0) \right)}{s} f_s ds \right]. \tag{7}$$

Recall that p is the value of deposit insurance computed as though the government guaranty is not considered. P is the value of deposit insurance of full coverage. In general, given a targeted coverage ratio, $p(V, \theta)$ can be determined, and the implied reserves associated with the targeted coverage ratio can be computed using Eq. (7).

3.2. Correlation among banks

Since the CDIC insures the deposits of a large number of banks, it faces the same portfolio risk as insured banks. To simplify the analysis, Episcopos (2004) uses the average of correlation coefficients of the sample for all banks (0.54). We apply the estimated correlation coefficients among the banks to estimate the implied reserves.[27] We find the average correlation coefficient of the 36 banks in 2000 is 0.59, which is similar to Episcopos' average correlation coefficient in 2000. In 2006, the average correlation coefficients of 7 financial holding companies are 0.46 and of 16 individual banks is 0.32.

There is a close relation among banks in Taiwan; thus, one bank's failure may likely accompany another bank's failure. This is of particular concern, as five insured financial institutions have recently been taken over by the CDIC.

[25] Under the traditional assumption of option pricing models, the value of bank assets is assumed to be governed by a geometric Brownian motion. This implies that the return on the bank assets at the next audit date will be normally distributed.

[26] See Johnson and Stulz (1987) for the valuation of "vulnerable options".

[27] We include the true correlation coefficients of the banks and use *Mathematica* software to compute the implied reserves by a numerical approach.

The aggregate premiums for insuring N multiple banks in the cases with and without a government guaranty can be described as follows:

$$P = \frac{e^{-rT}}{\prod_{i=1}^{N} \sigma_{s_i} \times T^{\frac{N}{2}}} \left[\int_0^{\infty} \cdots \int_0^{\infty} \frac{\sum_{i=1}^{N} Max(D_{iT} - s_i k_i, 0)}{s_1 \cdots s_N} f_N(s_1, \cdots, s_N) ds_1 \cdots ds_N \right] \tag{8}$$

$$p = \frac{e^{-rT}}{\prod_{i=I}^{N} (\sigma_{s_i} T^{\frac{N}{2}})} \left[\int_0^{\infty} \cdots \int_0^{\infty} \frac{Min\left(V_T, \sum_{i=I}^{N} Max(D_{iT} - s_i k_i, 0) \right)}{S_I \cdots S_N} f_N(s_i, \cdots, s_N) ds_1 \cdots ds_N \right]. \tag{9}$$

We estimate the aggregate premium under the government guaranty using Eq. (8). By analogy with the case of an individual bank, the aggregate premium under partial coverage, $p(V, \theta)$ can be derived under a targeted coverage ratio, α, and the implied reserves of the DIF associated with the targeted coverage ratio, V, can be calculated using Eq. (9).

4. Data and summary statistics

The sample consists of 7 financial holding companies (FHCs) and 16 banks in 2006 and 36 banks in 2000.[28] To investigate the effectiveness of the passage of FHC Act and the implementation of Financial Restructuring Fund, we compare the costs for insuring financial institutions in 2000 with the costs in 2006. This is because the main financial reforms were set up and implemented during the period from 2001 to 2005. For example, the FHC Act was enacted in 2001, and the Financial Restructuring Fund provides blanket coverage from 2001 to 2005.

It should be noted, following the FHC Act, 7 banks merged with other financial institutions to become 7 new FHCs in 2001. Only publicly traded companies are included in our sample. Market equity value and total liabilities are extracted from the *Taiwan Economic Journal*. The market value of equity is computed by the price per share times the number of common shares outstanding on December 31, 1999, and December 31, 2005. The volatility of equity is calculated as the annualized standard deviation of rate of return on equity from the daily return time series for the years 2000 and 2006. The risk-free rate (Taiwan bank's term deposit interest) for 1 year is 5.00% in 2000 and 2.33% in 2006. The percentages of insured deposits and domestic deposits are provided by the CDIC. Insured deposits are equal to the maximum insurance coverage, which is set at NT$1 million and is limited to the principal of deposit. Domestic deposits are defined as the sum of checking accounts, passbook deposits, passbook savings deposits, time deposits, time savings deposits, and trust funds in New Taiwan dollars.[29]

FHCs consist of various types of subsidiaries, so we cannot identify the particular volatility of equity of a bank that is part of an FHC. To be included in our sample, we require that the ratio of the subsidiary banks' assets to total assets of the FHC be higher than 50%. This narrows the sample to 7 FHCs.[30] Among these 7 banks the lowest ratio of the bank assets to total assets of the FHC ratio is 55%. In 2006, the sum of the domestic deposits for 7 FHCs and 16 banks accounted for 50% of total deposits and 55% of all banks. In 2000, the sum of the domestic deposits for 36 domestic banks in our sample is accounted for 88% of total domestic deposits.

A special note must be made on Mega FHC because of its uniqueness. Mega FHC as one of the 7 FHCs has two subsidiary banks. We examine only the International Commercial Bank of China (ICBC) whose asset size is twice as large as the other bank subsidiary, Chiao Tung Bank (CTB). ICBC and CTB formally merged into one bank under the name of Mega International Commercial Bank Co., Ltd., on August 21, 2006. At present, the ICBC and CTB conglomerate are subsidiaries of Mega FHC.

5. Results

Table 2 reports the basic information and the estimated asset values and asset volatilities for FHCs and banks in 2000 and 2006. Panels A and B report the descriptive statistics for 7 FHCs and 16 banks in 2006, respectively. Panel C shows descriptive statistics for 36 banks in 2000. We divide the data into FHCs and banks to highlight the difference between the financial institutions with different organize structures. Panel A shows that the 7 FHCs had higher average market values of equity, total liabilities, domestic deposits, and market values of assets than 16 banks in 2006. Panel B also shows huge differences in market values of equity, total liabilities, domestic deposits, and market values of assets between the largest and smallest bank. For example, the market value of equity of the largest bank (Bank 2) is NT$78,868 million and that of the smallest bank (Bank 16) is NT$2453 million.

[28] To avoid the bias during the period of financial crisis, we stop our period in 2006.

[29] In 2007, domestic deposits were redefined as the sum of checking accounts, passbook deposits, time deposits, and other deposits that the Financial Supervisory Commission has approved as insurable. All deposits are restricted to those denominated in New Taiwan Dollars.

[30] Sixteen FHCs were established after passage of the FHC Act in June 2001.

Table 2
Basic data and estimated market value of assets and volatility of assets for sample in 2006 and 2000.

FHCs/bank	Market value of equity (NT$ million)	Total liability (NT$ million)	Domestic deposit (NT$ million) (1)	Percent insured deposit (2)	Volatility of equity	Market value of assets (NT$ million)	Volatility of assets
Panel A 7 financial holding companies (FHCs) in 2006							
1	226,049.85	2,046,407.85	619,992.91	29.18	0.265429	2,272,457.23	0.026404
2	161,084.80	1,570,959.93	924,224.55	33.08	0.302709	1,732,041.63	0.028160
3	217,593.70	1,494,408.59	581,888.37	44.71	0.271160	1,712,001.79	0.034465
4	121,191.00	1,581,471.57	1,044,237.91	37.97	0.187702	1,702,662.57	0.013360
5	126,307.68	1,444,109.50	947,271.61	42.90	0.187703	1,570,417.18	0.015097
6	58,693.53	591,766.68	370,804.30	38.62	0.209224	650,460.21	0.018879
7	16,266.66	313,444.25	192,925.49	39.54	0.271547	329,710.83	0.013398
Total	927,187.22	9,042,568.38	4,681,345.13	266.00	1.695474	9,969,751.43	0.149764
Average	132,455.32	1,291,795.48	668,763.59	38.00	0.242211	1,424,250.75	0.022526
Panel B 16 banks in 2006							
1	41,131.80	1,902,013.76	969,589.25	38.08	0.276535	1,943,145.20	0.005854
2	78,867.60	1,279,990.72	856,986.44	41.84	0.300542	1,358,856.52	0.017449
3	52,876.90	1,016,667.32	665,301.13	36.10	0.223505	1,069,544.22	0.011050
4	23,972.02	380,379.33	301,787.74	50.40	0.254522	404,351.32	0.015090
5	16,689.04	317,492.36	193,165.50	34.25	0.293580	334,181.12	0.014665
6	16,936.00	310,645.01	229,866.29	41.26	0.175257	327,581.01	0.009061
7	18,781.91	296,833.98	207,383.53	28.48	0.375930	315,609.36	0.022440
8	26,721.72	283,891.45	175,887.40	26.51	0.317625	310,612.10	0.027338
9	19,655.64	248,509.30	228,058.89	54.55	0.305024	268,164.44	0.022364
10	9313.20	258,834.36	173,350.16	44.10	0.331099	268,146.65	0.011512
11	23,908.50	235,287.41	197,616.42	44.82	0.202305	259,195.91	0.018661
12	5243.49	200,289.08	142,187.55	45.46	0.434028	205,524.40	0.011190
13	6500.03	183,567.37	153,978.95	51.25	0.492762	190,040.93	0.017227
14	12,574.40	143,503.51	132,679.12	52.78	0.280390	156,077.83	0.022592
15	8782.38	142,955.38	99,654.91	48.31	0.290902	151,737.63	0.016840
16	2453.10	58,476.49	56,167.77	66.84	0.598869	60,893.03	0.025527
Total	364,407.73	7,259,336.81	4,783,661.04	705.04	5.152875	7,623,661.67	0.268859
Average	22,775.48	453,708.55	298,978.81	44.06	0.322055	476,478.85	0.016804
Bank	Market value of equity (NT$ million)	Total liability (NT$ million)	Domestic deposit (NT$ million) (1)	Percent insured deposit %(2)	Volatility of equity	Market value of assets (NT$ million)	Volatility of assets
Panel C 36 banks in 2000							
1	100,413.58	1,096,443.34	728,406.31	38.45	0.507917	1,196,437.39	0.043561
2	100,647.36	1,026,954.49	705,236.03	36.19	0.505999	1,127,201.64	0.046129
3	67,384.65	1,001,209.14	705,301.67	39.46	0.505652	1,068,297.68	0.032630
4	41,156.83	791,746.33	501,818.84	35.65	0.480316	832,772.85	0.024167
5	76,875.40	657,817.01	277,879.03	28.61	0.512345	734,377.91	0.054772
6	95,336.00	575,983.91	386,250.00	48.97	0.482588	671,109.87	0.069435
7	80,104.00	558,937.80	453,450.45	34.75	0.449705	638,935.11	0.056872
8	63,880.00	489,988.93	129,094.41	14.65	0.506660	553,638.75	0.059578
9	26,411.00	520,963.33	332,946.41	38.03	0.479283	547,291.68	0.023544
10	19,328.76	526,722.74	210,797.83	30.57	0.556812	545,868.01	0.020542
11	32,109.75	277,133.38	183,194.61	40.65	0.561645	308,992.27	0.060385
12	27,937.28	267,410.17	215,528.29	40.17	0.519990	295,214.90	0.050387
13	9419.04	254,143.90	235,924.98	49.96	0.502469	263,518.98	0.018401
14	23,041.28	219,164.56	151,711.52	41.66	0.542217	242,059.37	0.053154
15	158,570.30	66,549.87	37,988.26	1.39	0.430925	225,119.92	0.303540
16	19,419.75	203,333.37	151,276.96	40.16	0.500054	222,681.76	0.044472
17	9192.70	210,348.83	143,590.89	40.94	0.643877	219,329.35	0.029129
18	16,640.26	198,231.14	151,776.86	44.65	0.421720	214,855.48	0.032887
19	16,487.36	195,719.18	182,540.80	58.95	0.519116	212,123.88	0.041367
20	24,076.80	183,326.93	131,077.35	36.29	0.494410	207,331.82	0.058365
21	15,321.70	181,894.07	127,417.48	31.13	0.334372	197,214.50	0.026001
22	15,139.02	179,939.08	129,585.93	35.44	0.495134	195,024.35	0.039181
23	9103.56	177,874.11	125,374.02	38.50	0.576632	186,874.07	0.029423
24	11,060.00	173,755.00	130,026.35	43.25	0.464901	184,788.96	0.028222
25	9444.35	170,578.19	123,432.21	31.94	0.462295	180,000.60	0.024600
26	11,304.00	165,287.73	107,774.40	29.62	0.589538	176,451.31	0.039658
27	17,154.90	156,809.75	114,813.88	50.16	0.503770	173,901.11	0.050678
28	7055.10	164,768.18	116,451.67	48.23	0.526489	171,778.36	0.022293
29	9524.76	151,655.60	104,439.40	34.62	0.528815	161,121.91	0.032192
30	5134.75	153,931.82	109,997.46	42.53	0.460751	159,053.93	0.015098
31	3176.32	154,331.75	106,959.72	33.70	0.534630	157,483.82	0.011171

Table 2 (*continued*)

FHCs/bank	Market value of equity (NT$ million)	Total liability (NT$ million)	Domestic deposit (NT$ million) (1)	Percent insured deposit (2)	Volatility of equity	Market value of assets (NT$ million)	Volatility of assets
32	8004.00	139,817.92	110,652.60	38.12	0.425976	147,812.57	0.023256
33	5205.56	126,736.66	120,361.09	54.41	0.537310	131,903.87	0.021938
34	9882.90	111,584.99	97,566.68	35.97	0.495644	121,433.07	0.041114
35	2546.50	90,731.57	85,240.44	62.04	0.621451	93,228.24	0.018185
36	5871.72	35,848.65	33,059.03	72.9	0.666065	41,602.99	0.100263
Total	1,153,361.24	11,657,673.39	7,758,943.85	1422.71	18.347473	12,806,832.29	1.646590
Average	32,037.81	323,824.26	215,526	39.52	0.509652	355,745.34	0.045739

Notes: Panel A reports the results of the sample of 7 financial holding companies with asset ratio of higher than 50% and Panel B reports the results for the 16 banks in 2006. Panel C reports the results of the entire sample of 36 banks in 2000. Banks are ranked by market value of assets.
(1) Domestic deposits include the total of checking accounts, passbook deposits, passbook savings deposits, time deposits, time savings deposits, and trust funds in NT dollars for specific uses accepted by each deposit money institution.
(2) The percent of insurable deposits is the ratio of total insurable deposits of insured institutions to those of insurable institutions in each year. Insured deposits are the total of each individual depositor's deposits below the maximum insurable coverage. (The maximum insurance coverage was originally set at NT$700,000, but was increased to NT$1,000,000, effective in FY 1988.)

Table 3
Costs and implied reinsurance costs of the deposit insurance for individual financial institution in 2000 and 2006.

Bank	Cost of deposit insurance (full coverage)		Implied reinsurance cost	Implied reserves (NT$ million) at various coverage ratio				
	Unit cost (in basis points)	Cost NT$ million	($\alpha = 0.95$)	$\alpha = 0.99$	$\alpha = 0.95$	$\alpha = 0.90$	$\alpha = 0.75$	$\alpha = 0.50$
Panel A 7 financial holding companies in 2006								
1	0.00229	0.04114	0.00206	4420.28	2993.82	2322.29	1422.20	741.38
2	0.01975	0.60238	0.03012	8786.96	5952.93	4659.67	2879.53	1468.62
3	0.00337	0.08832	0.00442	8447.03	5695.74	4449.71	2740.09	1393.88
4	0.00000	0.00002	0.00000	3882.56	2555.39	2012.54	1211.26	640.09
5	0.00000	0.00002	0.00000	4482.66	2995.87	2308.29	1399.22	727.51
6	0.00001	0.00015	0.00001	1648.17	1278.02	1084.77	751.96	420.8
7	0.00259	0.01997	0.00100	1001.42	898.62	798.31	581.17	334.64
Total	0.02801	0.75198	0.03760	32,669.09	22,370.39	17,635.58	10,985.44	5726.92
Average	0.00400	0.10743	0.00537	4667.01	3195.77	2519.37	1569.35	818.13
Panel B 16 banks in 2006								
1	0.00185	0.06837	0.00342	1704.56	1293.84	1096.49	759.05	424.98
2	0.01404	0.50532	0.02527	6508.77	4402.95	3445.03	2128.81	1085.93
3	0.00005	0.00122	0.00006	2161.98	1331.37	1121.42	772.62	431.04
4	0.00089	0.01342	0.00067	1590.22	1263.17	1074.91	746.7	418.29
5	0.00903	0.05933	0.00297	998.36	896.19	796.34	579.94	334.01
6	0.00000	0.00000	0.00000	972.25	875.38	779.45	569.28	328.51
7	0.21993	1.27706	0.06385	1169.75	1026.42	899.76	643.96	366.79
8	0.03774	0.17923	0.00896	1094.84	970.97	856.21	617.24	353.15
9	0.01985	0.24899	0.01245	2818.86	1952.07	1472.59	960.34	523
10	0.03484	0.26574	0.01329	996.86	895.01	795.38	579.34	333.7
11	0.00000	0.00003	0.00000	1059.93	944.28	834.96	604.06	346.39
12	0.40782	2.60943	0.13047	990.48	889.94	791.28	576.75	332.37
13	1.44194	11.32348	0.56617	1405.42	1181.49	1017.63	714.65	402.63
14	0.00567	0.03985	0.00199	1167.29	1024.45	898.12	642.87	366.2
15	0.00864	0.04131	0.00207	980.08	881.65	784.55	572.5	330.17
16	6.25223	23.47210	1.17361	1141.97	1006.39	884.25	634.61	362.07
Total	8.45453	40.10487	2.00524	26,780.21	20,838.23	17,550.22	12,103.78	6739.22
Average	0.52841	2.50655	0.12533	1673.76	1302.39	1096.89	756.49	421.2
Panel C 36 banks in 2000								
1	3.82627	107.1633	5.3582	16,527.10	11,508.80	9139.08	5766.09	2997.32
2	3.897	99.46115	4.9731	15,862.90	11,048.10	8773.34	5535.54	2877.47
3	2.95749	82.31053	4.1155	12,454.40	8657.90	6869.12	4328.93	2248.23
4	1.64585	29.44396	1.4722	5839.77	4043.29	3201.81	2012.01	1042.32
5	4.78099	38.00945	1.9005	5837.33	4073.25	3237.55	2045.35	1064.30
6	3.64662	68.9746	3.4487	14,957.72	11,639.95	9252.00	5835.61	3031.63
7	1.90885	30.07853	1.5039	11,147.46	7739.45	6129.21	3850.42	1993.44
8	4.69763	8.88429	0.4442	1491.98	1041.06	827.43	522.69	271.93
9	1.58651	20.08827	1.0044	4025.50	2786.58	2206.43	1386.32	718.09
10	3.48378	22.4498	1.1225	1937.80	1351.46	1074.35	679.27	353.89
11	9.05219	67.41051	3.3705	6273.06	4403.90	3511.35	2229.04	1164.89
12	4.95683	42.91504	2.1458	5927.80	4137.24	3288.96	2078.50	1081.92

(*continued on next page*)

Table 3 (*continued*)

Bank	Cost of deposit insurance (full coverage)		Implied reinsurance cost	Implied reserves (NT$ million) at various coverage ratio				
	Unit cost (in basis points)	Cost NT$ million	($\alpha = 0.95$)	$\alpha = 0.99$	$\alpha = 0.95$	$\alpha = 0.90$	$\alpha = 0.75$	$\alpha = 0.50$
Panel C 36 banks in 2000								
13	1.72971	20.38773	1.0194	3022.45	2095.77	1661.02	1045.25	542.22
14	6.68331	42.24066	2.112	4647.28	3252.48	2589.28	1639.91	855.28
15	0.03695	0.00195	0.0001	128.28	89.75	71.3	44.92	23.28
16	3.50952	21.32135	1.0661	3626.05	2523.19	2002.83	1262.87	656.07
17	10.08712	59.29831	2.9649	2663.73	1875.58	1498.55	954.94	501.08
18	0.80325	5.44353	0.2722	2772.41	1909.04	1507.29	942.79	486.36
19	4.22294	45.44221	2.2721	6116.77	4263.19	3386.98	2138.66	1112.52
20	3.92241	18.65807	0.9329	3634.97	2532.64	2011.35	1268.99	659.49
21	0.06972	0.27656	0.0138	1130.01	768.66	603.17	373.98	191.25
22	2.98684	13.71715	0.6859	2419.64	1681.56	1333.96	840.39	436.27
23	5.824	28.11186	1.4056	2091.07	1463.20	1165.13	738.5	385.56
24	1.49858	8.42743	0.4214	2095.45	1449.21	1146.89	719.95	372.62
25	1.28621	5.07078	0.2535	1282.84	886.6	701.28	439.98	227.62
26	8.4953	27.11924	1.356	1859.45	1304.87	1040.51	660.84	345.61
27	4.05165	23.33376	1.1667	3899.45	2716.90	2157.87	1361.76	707.92
28	2.72623	15.31179	0.7656	1777.65	1236.39	981.44	619.08	321.8
29	3.85378	13.93403	0.6967	1634.52	1138.80	904.66	571.24	297.2
30	0.82088	3.8402	0.192	944.29	651.81	515.38	322.88	166.88
31	1.57124	5.66363	0.2832	581.56	405.11	320.92	202.35	106.01
32	0.66836	2.81919	0.141	1243.93	855.86	675.49	422.37	217.84
33	3.02559	19.8141	0.9907	2061.90	1435.55	1140.18	719.82	374.5
34	3.12015	10.9501	0.5475	1936.19	1346.04	1067.94	672.93	349.4
35	5.49294	29.04824	1.4524	1491.41	1045.96	834.09	529.99	277.4
36	32.74166	78.90743	3.9454	3485.72	2488.03	2000.42	1285.97	679.5
Total	155.6683	1116.33	55.8164	158,829.83	111,847.18	88,828.55	56,050.12	29,139.11
Average	4.32412	31.00913	1.5505	4411.94	3106.87	2467.46	1556.95	809.42

Table 2 shows that the average volatilities of equity for 7 FHCs are about 24% and 32% for 16 banks in 2006. That is, equity for FHCs is, on average, less volatile than for banks. The evidence supports the intention of the FHC Act of 2001 to diversify the risk of financial institutions by the merging of financial institutions. We also find the average volatility of equity in 2000 (51%) to be much higher than the values in 2006. The stock market conditions may have led to this result. The differences in average market value and volatility of assets between FHCs and banks are similar to those in average equity value and volatility of equity.

Table 3 shows the unit cost of deposit insurance, total cost of deposit insurance, implied reinsurance cost, and implied reserves according to the various coverage ratios for individual banks. Similar to Table 2, Table 3 also consists of three panels. In the case of coverage of deposit insurance when inadequacy of the DIF is not considered, the average unit cost of deposit insurance for 7 FHCs is the lowest among the three panels. The average unit cost of deposit insurance for 7 FHCs is about 0.004 and 0.528 basis points for 16 banks in 2006 and 4.32 basis points for 36 banks in 2000. The three average unit costs of deposit insurance are lower than the CDIC required premium rates of 5.0, 5.5, and 6.0 basis points before October 15, 2007.[31] It should be noted that there were six banks with unit cost of deposit insurance higher than 5 basis points in 2000. In fact, the highest is 32.74 basis points (Panel C). Interestingly, the same bank had the highest unit cost of deposit insurance in 2006 (6.25 basis points). We also find that the three banks with the highest unit cost of deposit insurance (6.25, 1.44, and 0.408 basis points) were taken over by the CDIC between December 2006 and August 2007. Apparently our results are consistent with the actions of the CDIC.

When considering the shortage of the DIF, the coverage ratio can be lower than 100%. For example, a coverage ratio of 95% means the DIF can cover, on average, 95% of the claims on the insured deposits. When the DIF is implicitly guaranteed by the government, the government serves as a reinsurer. That is, the shortage of the DIF will be met by the government. The cost of the government guaranty can be regarded as reinsurance cost to the government for the deposit insurance. Recall that $\alpha = p/P$, where α is the coverage ratio, p is the unit cost of deposit insurance for partial coverage, and P is the unit cost for full coverage. The unit cost for partial coverage can be derived as α times the unit cost for full coverage. Therefore, the implied reinsurance cost can be computed as the difference between the unit cost for full coverage and the unit cost for partial coverage. The average implied reinsurance costs for 7 FHCs and 16 banks in 2006 and for 36 banks in 2000 were about 0.005, 0.125, and 1.551 NT$ million, respectively, when the coverage ratio is set at 95%. The lower implied reinsurance costs in 2006 indicate that the reforms have improved the financial strength of these institutions in Taiwan.

Table 3 also reports the implied reserves based on alternative coverage ratios in the fifth through twelfth columns in Table 3. The implied reserve decreases with the coverage ratio. For example, the implied reserves for insuring the first FHC at coverage

[31] The three rates represent three types of premium rates in Taiwan's system before October 15, 2007. The CDIC current premium rate system is a risk-based rate system with five rates.

Table 4
Implied reserves (NT$ million) with true correlation coefficients of the four largest financial holding companies in 2006.

Implied reserves (NT$ million) in various coverage ratio					
	$\alpha = 0.99$	$\alpha = 0.95$	$\alpha = 0.90$	$\alpha = 0.75$	$\alpha = 0.50$
Panel A Individual data for the four largest financial holding companies (FHCs) in 2006					
FHC 1	4420.28	2993.82	2322.29	1422.20	741.38
FHC 2	8786.96	5952.93	4659.67	2879.53	1468.62
FHCs 1 & 2	13,207.24	8946.75	6981.96	4301.73	2210.00
FHC 3	8447.03	5695.74	4449.71	2740.09	1393.88
FHCs 1 & 2 & 3	21,654.27	14,642.49	11,431.68	7041.82	3603.88
FHC 4	3882.56	2555.39	2012.54	1211.26	640.09
FHCs 1 & 2 & 3& 4	25,536.83	17,197.88	13,444.21	8253.08	4243.97
Panel B With true correlation coefficients of the four largest financial holding companies (FHCs) in 2006					
FHC 1	4420.28	2993.82	2322.29	1422.20	741.38
FHCs 1 & 2	8701.88	5879.32	4608.46	2875.89	1499.60
FHCs 1 & 2 & 3	12,112.60	8925.46	7402.74	5166.36	3178.19
FHCs 1 & 2 & 3& 4	13,068.40	10,409.20	8812.82	6075.50	3384.44

ratios of 99%, and 50% are about NT$4420 million and NT$741 million, respectively. Panels A and B show that average implied reserves for 7 FHCs are significantly higher than 16 banks in 2006, because FHCs are larger than banks. However, the average implied reserves of 7 FHCs in 2006 are not much different from those of 36 banks in 2000. For example, the average implied reserves at the 99% coverage ratio are NT$4667 million for 7 FHCs in 2006 and NT$4412 million for 36 banks in 2000. This result indicates the FHC Act of 2001 has successfully consolidated the financial institutions without increasing their risk.

Table 4 shows the implied reserves for the four largest FHCs when the estimated correlation coefficients among the banks are considered and when they are not. The four largest FHCs held about 44% of the total assets of the industry in 2006. We choose only the four largest FHCs because we are not able to calculate implied reserves for more than four companies when the estimated correlations of companies are taken into account.[32]

Panel A shows the implied reserves without taking into account the estimated correlation. Specifically, we estimate the implied reserves for insuring the largest four FHCs individually. We then estimate the implied reserves for the CDIC insuring two or more FHCs simultaneously. Panel B shows the implied reserves under various coverage ratios when the effect of the estimated correlations among FHCs is taken into account. Comparing the values in Panels A and B, we find much lower estimated implied reserves when the effect of estimated correlations among FHCs is considered than when it is not. For example, in the case of a 99% coverage ratio, the implied reserves for the CDIC insuring the four largest FHCs simultaneously declines from NT$25,537 million to NT$13,068 million when the estimated correlations are taken into account.

Excessive deposit insurance funding will lead to inefficiency of capital operations for all insured financial institutions. However, insufficient DIF cannot provide timely assistance to failed financial institutions. Therefore, it is important for the CDIC to set an optimal and feasible level of coverage. In this study, we have improved on the methodology of Episcopos (2004) to estimate the implied reserves by using the estimated correlation coefficient rather than the average coefficient. We believe the results can better help the CDIC to find the appropriate level of DIF. This result also can be used to measure the effectiveness of the financial reforms.

In Fig. 2, we portray the relation between the coverage ratios and implied reserves for insuring one, two, three, and four FHCs. As expected, the slope is positive in all four cases. This evidence is consistent with the results in Episcopos (2004). We also find that the curves come closer together as the number of FHCs insured increases. This reflects that, at a specified coverage ratio, the increase in the implied reserves for insuring one more FHC declines with the numbers of FHCs insured by the CDIC.

Table 5 shows market values of assets, asset volatilities, and implied reserves for the banks in 2000 (before the implementation of the FHC Act 2001) and the banks that became FHCs in 2006. The size of assets, on average, increased after a bank became a FHC. For example, the assets of FHC#1 were about NT$1,822,196 million in 2006 compared to the assets of Bank #1 at NT$663,860 million in 2000 (note that FHC1 was Bank1 in 2000). Assets also become more volatile after the banks become FHCs (except for FHC4 and FHC5). These increases in asset volatilities and sizes result in higher levels of implied reserves for providing coverage to FHCs. The consolidation, however, also reduces the asset volatilities of FHCs 4 and 5, and hence the implied reserves of the DIF despite larger asset sizes. For example, at the 99% coverage ratio, the market value for the FHC4 was about NT$1,645,819 million, the volatility of assets was 13%, and the implied reserves were NT$94,748 million in 2006 compared to NT$1,032,655 million, 24%, and NT $137,284 million in 2000, respectively. That is, for FHC4, the assets increased by NT$613,164 million; the volatility of assets declined by 11%; and the implied reserves declined by NT$42,536 million. These changes may have been the result of asset diversification with the bank's consolidation into a FHC.

The market values of assets and the volatility of assets for the other FHCs rose, however, leading to increases in default risk and implied reserves. This finding is consistent with Jones and Oshinsky (2009).[33]

[32] We use *Mathematica* software to calculate the implied reserves. The program does not work for more than four banks.

[33] Jones and Oshinsky (2009) note that insolvency risks of the bank insurance funds (BIF) have increased significantly due to recent industry consolidation, mainly because of the concentration of deposits in the ten largest U.S. banking companies. They also find that recent deposit insurance reforms will cause only a marginal reduction in the risk of BIF insolvency.

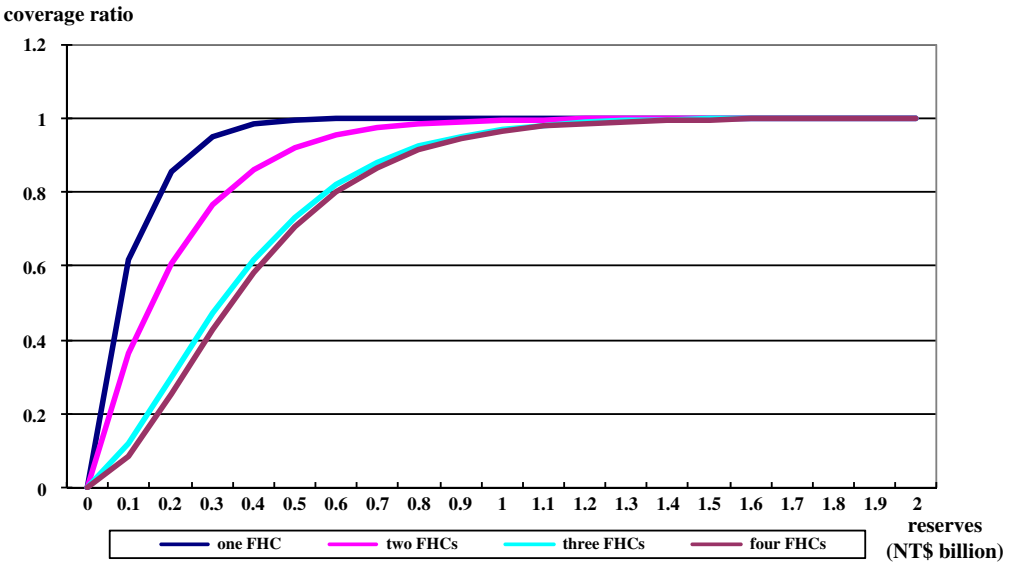


Fig. 2. Coverage ratio and implied reserves with correlation coefficient of the four largest financial holding companies (FHCs) in 2006.

Table 5
Comparison of implied reserves (NT$ million) of financial holding companies (FHCs) in 2006 and banks in 2000.

Year		Market value of assets	Volatility of assets	Implied reserves (NT$ million) in various coverage ratio				
				$\alpha = 0.99$	A = 0.95	$\alpha = 0.90$	$\alpha = 0.75$	$\alpha = 0.50$
2006	FHC1	1,822,195.59	0.42608	110,882.00	90,375.80	78,007.60	56,138.30	32,966.30
2000	Bank1	663,860.19	0.280909	35,988.90	28,142.00	23,758.10	16,507.10	9382.50
Difference		1,158,335.40	0.145172	74,893.10	62,233.80	54,249.50	39,631.20	23,583.80
2006	FHC2	1,171,823.07	0.60185	229,415.00	192,083.00	169,473.00	126,454.00	76,568.20
2000	Bank2	615,271.33	0.312972	90,375.00	69,799.90	58,836.00	40,744.60	23,059.40
Difference		556,551.74	0.288878	139,040.00	122,283.10	110,637.00	85,709.40	53,508.80
2006	FHC3	1,319,438.85	0.536019	181,789.00	149,744.00	130,337.00	94,949.30	56,314.80
2000	Bank3	523,603.40	0.312972	29,472.20	22,231.90	18,439.70	12,483.90	6942.20
Difference		795,835.45	0.223047	152,316.80	127,512.10	111,897.30	82,465.40	49,372.60
2006	FHC4	1,645,818.89	0.132429	94,747.70	70,931.20	58,552.00	39,296.90	21,646.90
2000	Bank4	1,032,655.30	0.238546	137,284.00	80,001.60	67,146.20	46,371.70	26,226.30
Difference		613,163.59	−0.106117	−42,536.30	−9070.40	−8594.20	−7074.80	−4579.40
2006	FHC5	1,513,495.74	0.148072	106,500.00	79,964.80	66,099.20	44,445.80	24,518.90
2000	Bank5	1,097,652.19	0.228546	114,540.00	85,429.10	71,512.80	49,344.80	27,895.50
Difference		415,843.54	−0.080474	−8040.00	−5464.30	−5413.60	−4899.00	−3376.60
2006	FHC6	607,860.14	0.210341	52,065.80	39,947.40	33,396.60	22,858.40	12,818.70
2000	Bank6	207,942.90	0.137334	16,520.70	12,359.20	10,196.80	6836.20	3761.00
Difference		399,917.24	0.073007	35,545.10	27,588.20	23,199.80	16,022.20	9057.70
2006	FHC7	276,844.85	0.266205	36,747.60	29,284.20	25,015.40	17,756.00	10,328.30
2000	Bank7	207,942.90	0.137334	7062.70	5258.20	4333.60	2905.90	1602.50
Difference		68,901.96	0.128871	29,684.90	24,026.00	20,681.80	14,850.10	8725.80

We are also interested in whether actual reserves of the deposit insurance fund at the end of years 2006 and 2000 are sufficient and whether the new Designated Reserve Ratio (DRR) set at 2% by the CDIC in 2007 is adequate when we look at our estimated implied reserves. The actual reserve at the end of year 2006 was NT$15,125 million.[34] Panel A of Table 6 shows that, in 2006, the coverage ratio supported by the actual DIF reserve was reduced from 100.00% to 97.99% as the number of FHCs insured increased from one to four. This indicates that the coverage ratio supported by the actual DIF reserve dropped as more FHCs & banks came into the pool. We next calculate the reserve requirement and coverage ratios based on 2% of DRR for insuring one to four FHCs. For example, the reserve requirement for FHC1 based on 2% of DRR would be about NT$3618 million. The coverage ratio supported by the requirement of 2% of DRR would be 97.46%.

[34] The financial restructuring fund is a temporary fund. Thus, we consider the amount of DIF, not the restructuring fund.

Table 6
Coverage ratio for the 4 largest financial holding companies (FHCs) in 2006 and 4 banks in 2000.

FHCs	FHC 1	FHCs 1–2	FHCs 1–3	FHCs 1–4
Panel A: DIF, DRR, and coverage ratio in 2006				
Actual DIF reserve (NT$ million)	$15,125	$15,125	$15,125	$15,125
Coverage ratio based on actual DIF reserve	100%	99.95%	99.53%	97.99%
Reserves based on 2% DRR (NT$ million)	$3617.72	$9732.58	$14,935.53	$22,866.30
Coverage ratio based on 2% DRR	97.46%	99.45%	99.78%	100%
Banks	Bank 1	Banks 1–2	Banks 1–3	Banks 1–4
Panel B DIF, DRR, and coverage ratio in 2000				
Actual DIF reserve (NT$ million)	$4840	$4840	$4840	$4840
Coverage ratio based on actual DIF reserve	68.29%	38.11%	35.82%	27.28%
Reserves based on 2% DRR (NT$ million)	$5602.00	$10,706.76	$16,273.64	$19,851.50
Coverage ratio based on 2% DRR	73.91%	80.46%	78.34%	81.37%

The second row in Panel B shows that the actual DIF reserve of NT$4840 million at the end of 2000 could provide only 68% of the necessary coverage. That is a 32% default risk for the DIF just for insuring one bank. The coverage ratio was as low as 27.28% for insuring four banks. If the reserve of the DIF is set at 2%, then the coverage ratio ranges from 73.91% to 81.37%. Thus, the actual DIF reserve or a DIF based on 2% of DRR is not sufficient to cover potential bank failures, given our calculation of implied reserves.

The results in Table 6 do not purport to say that 2% of DRR is sufficient for the entire banking industry. Rather, the results demonstrate two main points. First, the actual DIF reserve of NT$4840 million was severely insufficient in 2000. Second, 2% of DRR may have been sufficient in 2006 but might not have been adequate in 2000.

In Table 6, our analysis is based on four FHCs and four banks. We extend the analysis to include all FHCs and banks in the sample and report the results in Table 7. Column 1 of Table 7 shows the sum of insured deposits, and column 2 shows the reserves based on 2% of DRR. Column 3 shows our estimates of the sum of implied reserves for all FHCs and banks in the sample. For example, the reserves based on 2% of DRR would be NT$35,384 million, while the sum of implied reserves (coverage ratio 99%) is NT$32,669 million for the 7 FHCs in 2006. This means that a 2% DRR is sufficient. On the other hand, Panel C of Table 7 shows the reserves based on 2% of DRR would be NT$60,555 million, while the sum of implied reserves (coverage ratio 99%) is NT $158,830 million for the 36 banks in 2000. In other words, 2% of a DRR requirement is not sufficient. Another way to look at the issue is to examine how high a DRR is sufficient. For coverage ratio at 99%, we find that DRRs of 1.85%, 1.36%, and 5.25% were adequate for 7 FHCs in 2006, 16 banks in 2006, and 36 banks in 2000, respectively. The evidence shows that while 2% of DRR was adequate for 2006, it was not sufficient for 2000. The results imply that the fixed target ratio for the DIF set by the CDIC may not be appropriate in various financial market environments. Pennacchi (2000) shows that target policy may lead to distortions in banks' cost of deposit financing. There are fewer distortions if premiums are adjusted and the fund/deposit ratio is targeted slowly.

6. Discussion and recommendations on the adequacy of the deposit insurance fund

Our result shows that 2% of DRR was not adequate for the condition in 2000.[35] To ensure that the DIF in Taiwan should have been adequate in 2000, one alternative, according to our calculations, is to increase the DRR to 5.25%. Although adding to the DIF may ensure stability of the financial system, there are also additional costs involved. A higher DIF results in a higher cost of capital for banks, thereby reducing competitiveness. It also means too much money stays unused for other purposes (e.g., defense, health care for the poor, and other government programs).

The U.S. FDIC provides some interesting points for discussion.[36] The FDIC proposes consideration of statutory factors in setting the DRR, such as risk of losses to the DIF, economic conditions affecting FDIC-insured institutions, and prevention of sharp swings in assessment rates, among others. Specifically, when the risk of losses to the DIF is high, the DRR should be high. As we consider the U.S. experience, the CDIC in Taiwan may want to consider economic stress events and their impact on losses to the DIF.

Some have argued that the FDIC should reduce DRR when the economy and banking industry is in good health. The FDIC current practice is that the DIF is allowed to increase when economic conditions are good and decline when conditions are bad. Thus, the FDIC need not raise assessments sharply when economic conditions are bad. In other words, the FDIC should charge premiums on a countercyclical basis; apparently the FDIC believes that favorable economic conditions and strong banking

[35] Please see Section 5.
[36] Please refer to the FDIC website http://www.fdic.gov/deposit/insurance/initiative/designated.pdf.

Table 7
Reserves based on 2% DRR and DRR required at coverage ratio of 99% for all financial holding companies (FHCs) and banks.

Sum of insured deposits (NT$ million)	Reserves based on 2% DRR (NT$ million)	Sum of implied reserves for FHCs or banks based on coverage ratio = 0.99 (NT$ million)	DRR required at coverage ratio = 0.99 (NT$ million)
Panel A 7 FHCs in 2006			
$1,769,177	$35,384	$32,669.09	1.85%
Panel B 16 banks in 2006			
$1,975,462	$39,509	$26,780.21	1.36%
Panel C 36 banks in 2000			
$3,027,760	$60,555	$158,829.83	5.25%

industry conditions are not necessarily a justification for lowering the DRR. The CDIC in Taiwan should benefit from the experience of the FDIC in U.S. and consider the cost of the capital invested in a bank insurance fund.

7. Conclusion

To stabilize its financial environment, the Taiwanese government has put forward a series of financial reforms. Among these reforms, the enactment of Financial Holding Company Act and the establishment of Financial Restructuring Fund are important ones. The FHC Act of 2001 was enacted to increase the synergies among financial institutions, to stabilize the financial market, and to protect the public interest. The result shows that the implied reserves for insuring the whole sample of financial institutions were lower in 2006 than in 2000. The evidence supports the objective of the FHC Act. The Financial Restructuring Fund was established in 2001 to provide blanket coverage to financial institutions from 2001 to 2005. In this study, we have examined the effectiveness of these financial reforms and their effects on the adequacy of deposit insurance fund (DIF). We also have assessed the adequacy of the Designated Reserve Ratio (DRR) strategy imposed by the CDIC in 2007.

Our results show that FHCs, on average, are less volatile than banks despite higher average equity (asset) for FHCs than banks in 2006, and also show lower unit cost of deposit insurance for insuring 7 FHCs than for insuring banks despite the FHCs have larger size than the banks. Furthermore, we find the implied reserves estimated when incorporating the estimated correlations among FHCs are much lower than the implied reserves estimated when the average coefficient is used. We also find that the assets are less volatile and implied reserves are smaller for two out of 7 FHCs despite their having become larger. These results are consistent with the objectives of the FHC Act and the Financial Restructuring Fund Statute.

Finally, when comparing the estimated implied reserves with the actual reserve of DIF, we also conclude that the DIF was quite insufficient in 2000. Nor would the DIF have been sufficient in 2000 according to the new Designated Reserve Ratio (DRR) strategy of 2% imposed by the CDIC in 2007. On the other hand, the DIF might have been sufficient in 2006 at a 2% DRR. We therefore recommend that, rather than use a fixed rate, the CDIC alter the DRR over time according to economic conditions and insured deposit growth. Excess lending by banks in Europe might be one of the reasons that caused European financial crisis. Apparently, DIFs for countries such as Greece and Spain were not sufficient. For example, Spain spent more than 22 billion euro to bailout Bankia. On June 6, 2010 the European Commission proposed that each financial institution would need to 1% of the deposits for a special fund to finance the resolution for future banking crisis starting in 2018. The concept of 1% fixed rate may not be appropriate. We believe that a flexible rate based on economic conditions and insured deposit growth may be better based on the experience from Taiwan.

Our results of the effect of Taiwan financial reforms, improved methods of calculating estimates of the cost of deposit insurance and implied reserve, and the discussion of the strategy of DRR can be used as lessons for other countries. For example, some countries (e.g., Korea and Thailand) provided blanket guarantee deposit insurance (full coverage) during 2007 financial crisis. Using our methods, each country can calculate the implicit costs of government guaranty of the DIF. The evidence in Taiwan shows that a fixed target ratio for DIF may not be appropriate. Instead, altering the DRR over time according to economic conditions and insured deposit growth may be more appropriate. This type of strategy can be a lesson for other countries.

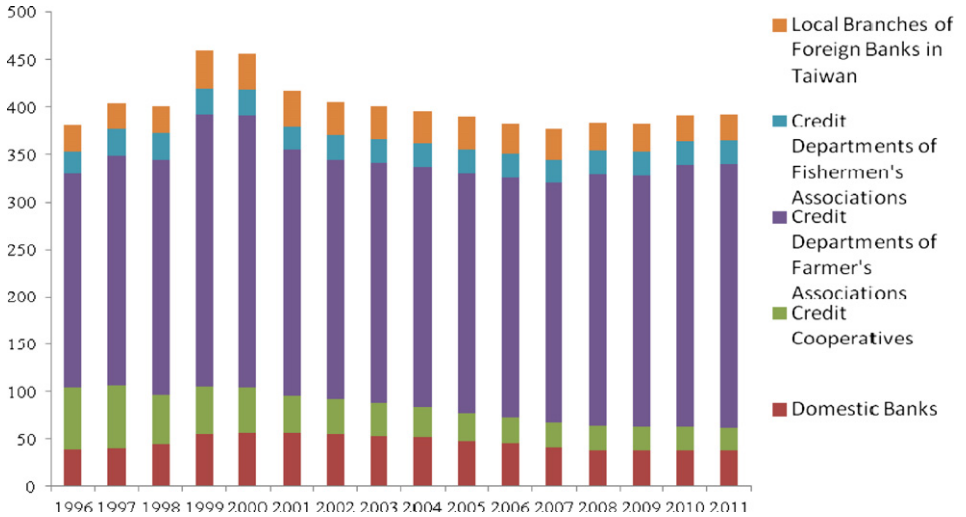
Other lessons learned from the experiences from the reforms of Taiwan and other countries are stated below. First, FHC Act was successfully implemented in Taiwan and reduces the volatilities of the financial market. It is worthwhile for other countries to consider this approach as long as the regulators are careful the negative effects of holding company structure such as the misuse of derivatives. Finally, some types of restructuring funds such as Financial Restructuring Fund in Taiwan. Resolution and Collection Corporation in Japan, or Non-Performing Asset Management Fund in Korea to resolve issues related to insolvent financial institutions are critical to the stability of financial markets.

Acknowledgments

We thank the editor and referees for helpful suggestions.

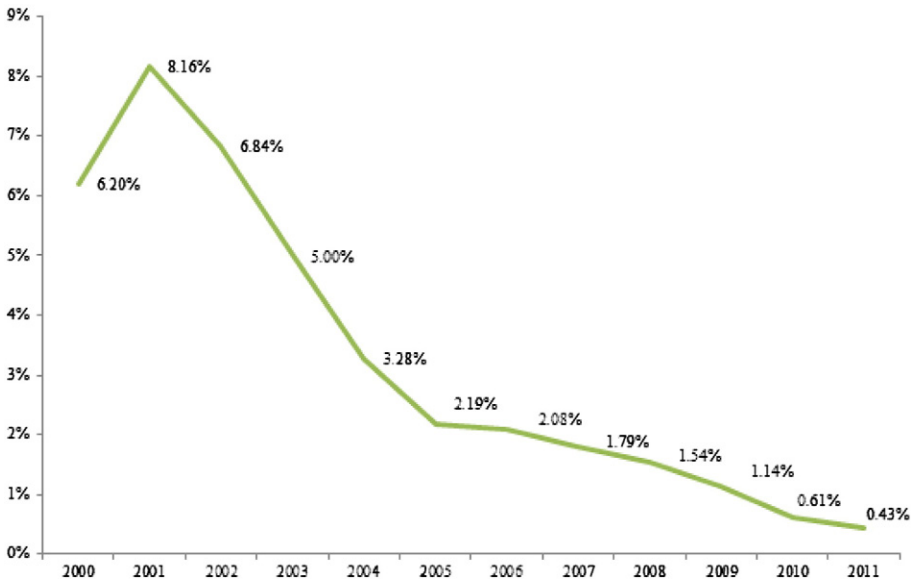
Appendix A. Numbers of insured institutions for the years 1996–2011

Year	Domestic banks	Credit cooperatives	Credit Departments of Farmer's Associations	Credit Departments of Fishermen's Associations	Local branches of foreign banks in Taiwan	Total
1996	39	65	226	23	29	382
1997	40	66	243	27	28	404
1998	44	52	249	27	29	401
1999	55	50	287	27	40	459
2000	56	48	287	27	38	456
2001	56	39	260	25	37	417
2002	55	37	253	25	35	405
2003	53	35	253	25	35	401
2004	52	32	253	25	34	396
2005	48	29	253	25	35	390
2006	45	28	253	25	32	383
2007	41	27	252	25	31	376
2008	38	27	264	25	30	384
2009	38	26	264	25	30	383
2010	38	26	275	25	27	391
2011	38	25	277	25	27	392



Source: CDIC.

Appendix B. NPL ratios (non-performing loan ratio) in Taiwan from 2000 to 2011



Appendix C. Financial institutions taken over by the CDIC in 2006 and 2007

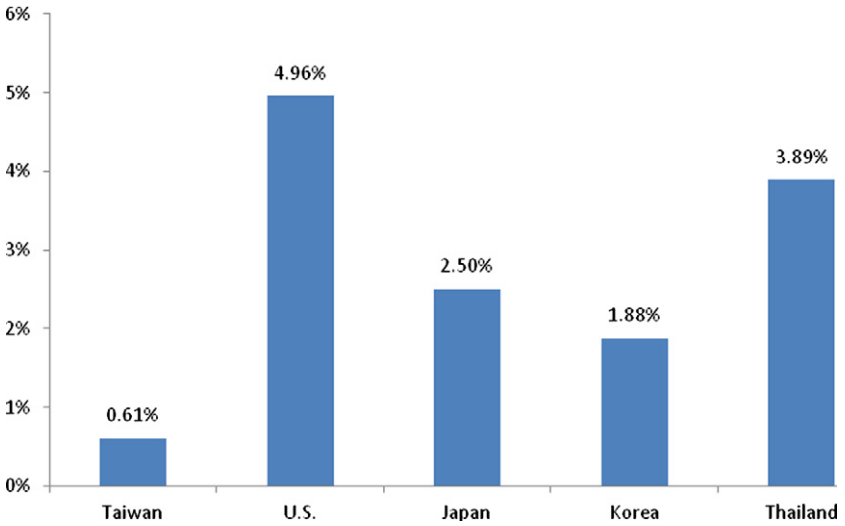
Private financial institutions	Date of take-over by CDIC	Financial Restructuring Fund (NT$ million)	DIF of CDIC (NT$ million)	Total (NT$ million)
Enterprise Bank of Hualien	2006/12/15	−1157.62	−3761.64	−4919.26
Taitung Business Bank	2007/01/05	−1175.62	−4632.85	−5808.47
Chinese Bank	2007/01/06	−1708.85	−6081.74	−7790.59
China Hina United Trust & Investment Group	2007/03/30	−19,900.62	−29,652.05	−49,552.67
Bowa Bank	2007/08/10	−16,676.01	−25,014.01	−41,690.02
Total		−40,618.72	−69,142.29	−109,761.01

Notes: The Executive Yuan, an executive branch of Taiwan government approved the combined DIF and Financial Restructuring Fund on November 15, 2006.

Appendix D. Financial reforms in Taiwan from 2001 to 2011

Year	Financial reforms	Purpose
2001	Financial Holding Company Act	To strength and competitiveness of financial institutions in Taiwan.
2001	Financial Restructuring Fund	To deal with problem financial institutions to withdraw from Taiwan financial market.
2007	Taiwanese government revised the Deposit Insurance Act in 2007. The CIDC raised the three-tiered deposit insurance premium rate and set up a target ratio (i.e. DRR) for the Deposit Insurance Fund at the fixed ratio of 2% of insured deposits.	To ensure the adequacy of Deposit Insurance Fund.
2008–2009	Taiwanese government announced that the deposit insurance system of temporary full coverage extended to December 31, 2010.	To protect all depositors during the period of global financial crisis.
2010	On August 12, 2010, the Taiwanese government announced that the limited coverage was increased from NT$1.5 million on July 1, 2007 to NT$3 million starting from January 1, 2011.	To avoid moral hazard for financial institutions.
2011	CDIC again revised the premium rate system (see Appendix F). Financial restructuring fund terminated on December 31, 2011.	Financial restructuring fund successfully enabled problem financial institutions.

Appendix E. NPL ratios (non-performing loan ratio) in selected countries in 2010



Notes: Data for Japan is end-September 2010, while the others are end-December of 2010.
Source: Financial stability report 2011.

Appendix F. Grades and premium rates in 2011

Risk-based premium grading for all financial institutions			
CSRPRS capital adequacy ratio (CAR)	Grade A	Grade B	Grade C
Well capitalized	Group 1	Group 2	Group 3
Adequately capitalized	Group 4	Group 5	Group 6
Undercapitalized	Group 7	Group 8	Group 9
Risk premium rates for domestic banks and local branches of foreign banks			
CSRPRS CAR	65 and over	50 to under 65	Less than 5
12% or over 1.5 times the lowest CAR stipulated by the competent authority	Grade 1 0.05%	Grade 2 0.06%	Grade 3 0.08%
8% to less than 12% or the lowest CAR to less than the 1.5 times of CAR	Grade 2 0.06%	Grade 3 0.08%	Grade 4 0.11%
Less than 8% or below the lowest CAR	Grade 3 0.08%	Grade 4 0.11%	Grade 5 0.15%
12% and over	Grade 1 0.04%	Grade 2 0.05%	Grade 3 0.07%
8% to less than 12%	Grade 2 0.05	Grade 3 0.07%	Grade 4 0.10%
Less than 8%	Grade 3 0.07%	Grade 4 0.10%	Grade 5 0.14%
*Insured deposits in excess of coverage limit applied to the flat rate of 0.005%.			

(continued on next page)

Appendix F (*continued*)

Risk premium rates for credit Departments of Farmers' and Fishermen's Associations			
CSRPRS capital adequacy ratio (CAR)	10% and over	8% to less than 10%	less than 8%
12% and over	Grade 1 0.02%	Grade 2 0.03%	Grade 3 0.04%
8% to less than 12%	Grade 2 0.03%	Grade 3 0.04%	Grade 4 0.05%
Less than 8%	Grade 3 0.04%	Grade 4 0.05%	Grade 5 0.06%
*Insured deposits in excess of coverage limit applied to the flat rate of 0.0025%.			

Notes:

1. The CSRPRS refers to the Composite Score of the Risk-based Premium Rating System. It uses the financial data reported by the insured institutions or from the examination report provided by the competent authority to generate scores for each insured institution.
2. For banks and credit cooperatives, CAR (capital adequacy ratio) equals to the ratio of equity capital to risk weighted assets; for local branches of foreign banks CAR equals to the ratio of equity capital to risk weighted assets of the foreign bank; for the credit departments of farmers' and fishermen's associations, CAR equals the ratio of eligible net worth to risk weighted assets.

Source: CDIC.

Appendix G. Definitions of variables

Variable	Definition
D	Bank's insured domestic deposits is equal to total insurable deposits
D_T	Value of bank's insurable deposit (exercise price)
S	Unobserved asset value of an insured bank
S_T	Unobserved bank's asset value (underlying price)
L	Total liabilities of the bank, i.e., the present value of the striking price
k	=D/L, the proportion of insured deposits to total liabilities
E	Market value of the bank's equity: Market price of shares times the number of shares outstanding
V	Reserves; Pre-insurance market value of the bank insurance fund assets without government support
T	From time to next CDIC audit of the bank, T is equal to 1
σ_S	Unobserved asset volatility
σ_E	Instantaneous standard deviation of the return of equity
ρ_{ij}	Unobserved correlation coefficient between asset returns of banks i and j
r	Risk-free rate, assumed to be constant for all maturities, e.g., Taiwan bank's term deposit interest for one year is 5% in 2000 and 2.33% in 2006.
f_S	Lognormal diffusion process for asset value

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