The Deposit Insurance and the Risk-Shifting Incentive
Evidence from the Blanket Deposit Insurance in Japan

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Abstract
Using the option pricing based model of the deposit insurance, for all the listed banks in Japan, we compute the actuarially fair insurance premium as well as the market value of assets and asset volatility implied by banks’ stock prices. The findings based on these variables imply that banks shifted risks to the deposit insurer who charged them risk insensitive premiums. The temporary unlimited blanket coverage of all the deposits had accelerated risk-shifting before the prompt corrective action (PCA) though such acceleration of risk-shifting was prevented when the PCA was in effect as the regulatory discipline discouraged banks to lever.

Keywords: deposit insurance, blanket coverage, risk-shifting, prompt corrective action
JEL classification: G21, G28

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1. Introduction

As the world has undergone the unprecedented financial crisis, there are ongoing discussions on regulatory reforms that are centered at the risk based capital adequacy standard and the deposit insurance system. The discussions on reforms have generally lead to tougher prudential regulations and a greater protection of deposits. The latter promptly took in effect. In October 2008, the Federal Deposit Insurance Corporation (FDIC) of the United States for instance increased the deposit insurance cap per depositor per institution from 100 thousand dollars to 250 thousand dollars temporarily through December 2010. The cap at 250 thousand dollars was later made permanent under the Financial Regulation Law that was signed into law in July, 2010. On the other hand, there is a long way to go toward agreements on the reforms on prudential regulations, let alone their implementation.

The more generous insurance protection during a crisis is aimed at relieving depositors who might otherwise panic and run on their viable banks to withdraw their deposits because they are poorly informed of their bank and they know that due to the first come first service nature of demand deposits their bank would run out of its liquidity after other depositors’ withdrawals. Series of such bank runs would drain liquidity from the entire banking system.¹ There is, however, a broad consensus that the negative side effect of the publicly run deposit insurance is a danger of the moral

¹ See Diamond and Dybvig (1983) for the classical discussion on the problem of an inefficient bank run caused by the coordination failure among depositors and the role played by the publicly run deposit insurance system as a measure to prevent depositors’ panic. The recent global financial crisis, however, gives us a different picture. As Ivashina and Scharfstein (2009) finds, banks that were in trouble and reduced credit were those that were heavily dependent on short-term debts raised from capital markets as short-term debtors left banks when the crisis erupted. According to Shin (2009), even as for the case of Northern Rock that is often publicized as a rare event of a bank run in the recent crisis, the root cause of the bank’s demise was its heavy reliance on short-term debts. Based on such empirical evidence, the increased insurance protection may not be the most desirable response to the crisis.
hazard problem, that is, insured banks’ excessive risk taking.\(^2\) The policy discussions place particular emphasis on the seriousness of the moral hazard problem. “Core Principle for Effective Deposit Insurance Systems” published in June, 2009 by the Basel Committee on Banking Supervision states, “Moral hazard should be mitigated by ensuring that the deposit insurance system contains appropriate design features and through other elements of the financial system safety net” (Principle 2). The design of the modern day deposit insurance is characterized as the “flat” premium design. The risk profile of the premium that the public insurer charges banks is flatter than that of the actuarially fair premium that the private insurer would charge in absence of the public insurer. The premium is sometimes “perfectly flat” so that the premium is independent of an insured bank’s risk, and is pro rated to the amount of deposits to be insured. Thus, insured banks’ shareholders are willing to take greater risks to pursue higher returns as their greater risk taking does not cost them the larger insurance premium. This is the classical moral hazard.

The mixed results have been reported in the literature that attempts to assess the impact of the deposit insurance system on banks’ risk taking. (Grossman, 1992; Brewer and Mondschean, 1994; Brewer, 1995; Wheelock and Wilson, 1995; Karels and McClatchey 1999; Demirguc-Kunt and Detragiache, 2002; Hooks and Robinson, 2002; Hovakimian et al., 2003; Gropp and Vesala, 2004; Wagster, 2007; and Ioannidou and Penas, 2009). Some authors shed the light on the complementarity between the publicly run deposit insurance and tougher regulations (Grossman, 1992; Duan et al, 1992, Hovakimian and Kane, 2000). They discuss that an insured bank’s moral hazard

\(^2\) For the review of the theoretical literature on the relationship between the deposit insurance system and insured banks’ risk taking, see Gropp and Vesala (2004). An excellent read on this subject is Freixas and Rochet (2008).
incentive is restrained by a well functioning regulator (a tougher enforcer of regulations) who successfully disciplines the bank. We extend the literature by examining the impacts of the temporary blanket deposit insurance and the subsequent disciplinary regulatory framework on banks’ risk taking in Japan, a large bank centered economy.

The extraordinary policy change was made during the financial crisis period in Japan; the deposit insurance coverage cap at 10 million yen per depositor per institution was temporarily abandoned and the deposit insurance system was transformed from limited to unlimited insurance. This policy change was one of the earliest policy measures to deal with the financial crisis that had overshadowed the banking system until as recently as the mid 2000’s. A more rigorous regulatory action framework known as the Prompt Corrective Action (PCA) that mandates regulatory interventions into a poorly capitalized bank was enacted with a delay. As it happens, the immediate increase in deposit insurance protection and the delayed reforms toward tougher prudential regulations are one of parallels to the current global regulatory reforms. Utilizing these policy changes, we ask ourselves whether the blanket insurance drove banks to risk-shifting and whether the PCA mitigated banks’ risk-shifting incentives of insured banks if such incentives existed at all. To the best of our knowledge, this is the first study to examine the acceleration of the moral hazard incentive of banks protected by the unlimited deposit insurance. Japan is a desirable testing ground for the moral

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3 A temporary blanket insurance of deposits is a widely adopted policy during the period of crisis. Many crisis hit countries indeed adopt the blanket guarantees of bank debts beyond deposits. See Laeven and Valencia (2008) for the list of blanket bank debt guarantee episodes including the blanket deposit insurance.

4 It is a growing approach to stress parallels between policy measures taken in response to the past Japanese financial crisis and those taken in response to the recent global financial crisis. In the literature, Japanese policies are primarily compared to the policies employed in the United States. Hoshi and Kashyap (2010) are seminal in this regard. More rigorous empirical studies to assess Japanese policies in light of policies in the U.S. are Allen et al. (2010) and Giannetti and Simonov (2010).
hazard hypothesis also because the insurance premium has been perfectly flat. If a bank in Japan during the blanket coverage era were not to exploit the deposit insurance, what other banks would do so?

Following Duan et al (1992), Hovakimian and Kane (2000), Hovakimian et al. (2003) and Wagster (2007, 2008), we test the risk-shifting hypothesis, the hypothesis that an insured bank passes its risks on to the deposit insurer who is liable to all the losses at the bank’s failure. Using the daily stock prices and semiannual balance sheets of all listed Japanese banks, for each bank, we compute the semiannual “actuarially fair” insurance premium per dollar (IPP), which represents what a bank would have to pay as an insurance premium per dollar of deposits if the deposit insurance were priced in an actually fair manner. The major test is based on the relationship between a bank’s IPP and the volatility of the market value of a bank’s assets. When the actual premium is fixed, the bank is taking advantage of the flat rate based deposit insurance if a bank’s actuarially fair premium increases with its overall asset risk. This is because the greater asset risk of a bank is reflected on the fair value of the deposit insurance that the bank would have to pay to the (hypothetical) privately run insurer but is not on the fixed rate premium that it actually pays to the publicly run real world insurer.

Our methodological contribution hinges on the unique episode of the introduction of the PCA in Japan that allows us clean tests of effects of the interplay of the deposit insurance with the regulatory discipline on banks’ risk taking behavior. The PCA was introduced to banks that the regulator allowed to operate internationally (international banks) and then was expanded to banks that the regulator allowed to operate only domestically (domestic banks), one year later. Since the timing of adoption of the PCA is not uniform across banks, the effects of distinct regulatory regimes, notably
regimes of the limited insurance coverage, the blanket coverage with PCA and the blanket coverage without PCA are distinguishable from macroeconomic developments or other relevant policy changes that would coincide regulatory regimes we intend to examine if the PCA had been introduced to insured banks all at once. In the abovementioned literature that directly tests the risk-shifting incentive, comparisons are made between different periods of time associated with different regulatory regimes. In other words, banks’ risk taking behavior is assumed to change all at once. Using regime dummies that are not the indicators of certain time periods for all the sample banks, we can isolate effects of regulatory regimes from other effects.

Our major findings are five. First, banks that are insured by the flat rate based deposit insurance are engaged in risk-shifting regardless of the insurance coverage. Second, banks with a greater asset risk, however, tend to restrain risk taking by reducing leverage. Third, the blanket insurance not accompanied by the PCA accelerated banks’ risk-shifting when riskier banks did not reduce leverage, whereas the blanket insurance accompanied by the PCA did not when the PCA worked as a restraint to riskier banks’ appetite for leverage. Fourth, risk-shifting incentives of fully insured banks subject to the PCA were not stronger than those of partially insured banks before the insurance cap was abandoned. The PCA’s disciplinary force was so powerful that it offset acceleration of moral hazard incentives due to the blanket insurance. Fifth, poorly capitalized banks that generally have a greater risk-shifting incentive did not have the incentive when both the blanket coverage and the PCA were in place. These findings suggest that the blanket deposit insurance is undoubtedly a source of the moral hazard but that its incentive can be mitigated by well functioning regulators. In the modern day context, delayed implementations of tougher prudential regulations are a grave
concern to crisis hit economies where deposit insurance protection is greatly expanded. Our evidence shows that such regulatory forbearance may rekindle banks’ risk taking when generous insurance itself is meant to contain the crisis caused by banks’ earlier excessive risk taking.

The remainder of the paper is organized as follows. Section 2 introduces the institutional background. Section 3 discusses the empirical methodology and the relevant empirical literature. Section 4 discusses data and empirical results. Section 5 concludes.

2. Institutional Background and the Empirical Literature

Modeled after the Federal Deposit Insurance Corporation (FDIC) of the United States, the Deposit Insurance Corporation of Japan (DICJ) was established in July 1971. The deposit insurance in Japan has been characterized as a compulsory system with perfectly flat rate pricing. All depository institutions were mandated to join the system at the cost of the fixed premium pro rated to the amount of deposits on a bank’s balance sheet. The flat pricing remains to today though deposit insurers in many developed countries have gradually shifted to some form of the risk sensitive pricing.

At the establishment of the system, deposits in principal were insured up to 1 million yen per depositor per institution so that deposits in excess of 1 million yen were exempted from the insurance protection. The insurance cap had progressively increased. In June 1974, the cap was raised to 3 million yen. In July 1986, another raise of the cap to ten million yen was implemented, which shaped more or less the present system. The insurance cap at ten million yen continues to today, albeit the
present cap pertaining to deposits in principal as well as accruing interests and that the insurance cover of demandable non-interest bearing deposits are unlimited. It was in 1991, exactly two decades after the DICJ’s establishment, that the insurance was paid off for the first time to Iyo Bank, an Ehime prefecture based regional bank, to help the bank acquire a financially distressed Toho Mutual Bank.

In June 1996, as a temporary measure intended to contain the ongoing crisis, the insurance cap was eliminated and deposits became fully insured. This blanket deposit insurance lasted almost six years until March 2002 when the 10 million yen cap was reinstated to time deposits in principal plus accruing interests. This was a dramatic increase in the size of insured deposits. As of end of May, 1996, immediately before the start of the blanket insurance, among time deposits, which constitutes roughly two thirds of total deposits, 57 percent are in excess of 10 million yen in the amount of principal.5

As recent worldwide deposit insurance reforms are followed by a long debate on reforms toward tougher prudential regulations, the blanket coverage in Japan was followed by a tougher regulatory framework with a considerable delay. The new regulatory action framework known as the Prompt Corrective Action (PCA) was introduced first for banks that the regulator allowed to operate internationally (international banks) in April 1998 and then the PCA was expanded to the remaining banks that are allowed to operate only domestically (domestic banks).6 The PCA

5 The data’s source is the Bank of Japan. The data on deposits by size are publicly available only for time deposits. Note that for every deposit, the amount in excess of 10 million is uninsured so that the proportion of uninsured time deposits to total time deposits is less than 57 percent.

6 International banks pertain to 8 percent minimum standard for the risk based capital adequacy ratio whereas domestic banks pertain to the lenient standard of 4 percent.
employs the Basel risk based capital adequacy as a yardstick for regulatory actions for the first time in Japan. Under the PCA, a bank that falls short of the regulatory minimum standard, faces progressively tougher regulatory actions as a shortfall of the bank’s capital adequacy widens.\footnote{For the details of the PCA in Japan, please see Allen et al. (2010).}

In April, 2002, the unlimited coverage was narrowed only to payable deposits that are non-interest bearing, payable on demand and provide settlement services, which effectively ended the blanket insurance protection.

3. Empirical Methodology and the Empirical Literature

3.1. The Option Pricing Based Model of Deposit Insurance

Under the publicly run deposit insurance system, a bank potentially has an incentive to take excessive risks to seek higher returns as the premium is insensitive to an insured bank’s asset risk. Merton (1977) shows that the flat rate deposit insurance can be viewed as a put option on an insured bank’s asset with a value of the bank’s insured liabilities as an exercise price. The value of the put obtained using the Black-Scholes formula is a function of a bank’s leverage and asset volatility. Merton (1977) shows that partial derivatives of the put with respect to the leverage and the asset volatility are both positive, that is, other things being equal, the value of the deposit insurance is increasing in both the leverage and the asset volatility.

In practice, we follow the empirical strategy of Duan et all. (1992), which is built on Merton’s theory. At the maturity date, T, when the deposit insurer audits an insured bank, prior to any payment from the deposit insurer, insured depositors receive the value
of their deposits if the bank is solvent and the prorated fraction of the value of the bank’s assets if it is insolvent. Thus, depositors receive the following amount from their bank at time T.

\[
\min \left\{ FV(B_1), \frac{V_T B_1}{B_1 + B_2} \right\} \quad (1)
\]

Where

- \( FV(\cdot) \): future value operator,
- \( B_1 \): face value of insured deposits,
- \( B_2 \): face value of uninsured deposits,
- \( V_T \): value of the bank assets at time T

The deposit insurer pays depositors the (future) value of deposits less the amount received from their bank. Thus, depositors receive the following amount from the deposit insurer at time T.

\[
\max \left\{ 0, FV(B_1) - \frac{V_T B_1}{B_1 + B_2} \right\} \quad (2)
\]

Following Merton (1977), the present value of the insurance payment expressed by equation (2), IP, is,\(^8\)

\[
IP = B_1 N \left( \nu + \sigma \sqrt{T} \right) - \frac{(1 - \delta)^\nu V_B}{B} N(\nu) \quad (3)
\]

Where:

\(^8\) All debts (insured deposits and other uninsured liabilities) are assumed to have the same maturity, which then serves as the expiration date of the option.
Scaling down both sides of the equation (3) by $B_1$, the premium per dollar of insured deposits, IPP, can be expressed as follows:

$$IPP = N\left(y + \sigma_y \sqrt{T}\right) - \frac{(1-\delta)^n}{B} N\left(y\right)$$  \hspace{1cm} (4)

Dividends are included in equation (4) since the deposit insurer is not dividend protected. Since dividends are paid twice a year in Japan so that $n$ in equation (4) is equal to one.\(^9\)

The valuation of IPP requires estimating two unobservable variables, $V$ and $\sigma_y$. Black and Scholes (1973) discuss that the value of equity of a firm (bank) can be represented as a call option on the value of its assets with the maturity being the same as the maturity of its debt and a striking price equal to the value of a firm’s debt at maturity.\(^10\) Thus the equity value at time $T$, $E_T$, is given by:

\(^9\) Although dividend payouts occur twice a year, the data on dividend payouts are available only annually. Therefore, the amount of dividend payouts is halved in order to adjust to the semiannual frequency.

\(^10\) Ronn and Verma (1986) and Giammarino et al. (1989) also take this approach to compute $V$. Even though maturities of call and put options are conceptually different, Ronn and Verma (1986) describe that they cannot be separated in the context of banks. The reason is that the boundary condition for the value of equity as a call, i.e., $\text{Max } [0, V_T - pB]$ comes into effect at the time of the
The exercise price is \( \rho B \) rather than \( B \) because that the insurer is assumed to declare the bank’s bankruptcy when the value of the bank’s assets falls below \( \rho B \) rather than immediately after it is undercapitalized.\(^1\) \(^2\) \(^3\)

Using the Black and Scholes option pricing formula, the present value of \( E_T \) is:

\[
E_T = \max \{ 0, V_T - FV(\rho B) \}
\]

(5)

\[
E = VN(x) - \rho BN\left( x - \sigma_v \sqrt{T} \right)
\]

(6)

\[
\ln\left( \frac{V}{\rho B} \right) + \frac{\sigma^2 T}{2} / \sigma_v \sqrt{T}
\]

Where \( x \equiv -\frac{\ln\left( \frac{V}{\rho B} \right) + \frac{\sigma^2 T}{2}}{\sigma_v \sqrt{T}} \) and \( 0 < \rho < 1 \)

According to Ito’s lemma, we have also the following equation:

\[
\sigma_E = \frac{VN(x)}{E} \sigma_v
\]

(7)

Where \( \sigma_E \) is the instantaneous standard deviation of the return on \( E \).\(^4\) We can audit when the insurer decides whether to dissolve the bank or not. It is therefore reasonable to argue that the time until next audit should be the appropriate value for the maturity in both put and call pricing equations.

\(^1\) \( \rho \) reflects what Ronn and Verma (1986) refer to as \textit{bail-out effect}; an insurer does not liquidate a bank immediately when its net worth turns negative. The insurer likely makes an attempt to revive a bank by directly infusing funds or temporarily waiving closure. \( \rho B \) represents, hence, the limit beyond which erosions in assets value would make the revival efforts excessively costly, and consequently the dissolution of bank assets would be the only feasible alternative that the insurer can choose.

\(^2\) Duan et al. (1992) give two other rationales for \( \rho \). First, because the bank closure rules depend on book value rather than market value, an insolvent bank by market standards may not be closed since its book value may not indicate insolvency. Second, the insurer may postpone the date of the insolvent bank’s closure in order to avoid or delay incurring bankruptcy costs.

\(^3\) Ronn and Verma (1986), Giammarino et al. (1989) and Duan et al. (1992) assume \( \rho \) to be time invariant.

\(^4\) \( \sigma_E \) is the annualized instantaneous standard deviation. More precisely, we compute \( \sigma_E \) based on the following formula.

\[
\sigma_E = \sqrt{252 \text{ var}\left( \frac{S_t}{S_{t-1}} \right)}, \text{ where } S_t \text{ is the daily price of a bank’s stock price at date } t.
\]

We thank Ehud Ronn for clarifying this point.
solve the two-equation system (6) and (7) for V and $\sigma_V$ numerically.\(^{15}\)\(^{16}\)

Following the literature (Ronn and Verma, 1986; Giammarino et al. 1989; and Duan et al., 1991), we set T and $\rho$ to be one year and 0.97, respectively.\(^{17}\)\(^{18}\)

3.2. Empirical Methodology

We adopt the regression equations developed by Duan et al. (1992) and Hovakimian and Kane (2000), which are later employed by Hovakimian et al. (2003) and Wagster (2007, 2008). The two equations are:

\[
\frac{B_{jt}}{V_{jt}} = \alpha_0 + \alpha_1 \Delta \sigma_{jt} + \varepsilon_{jt} \quad (8)
\]

\[
\Delta IPP_{jt} = \beta_0 + \beta_1 \Delta \sigma_{jt} + \xi_{jt} \quad (9)
\]

In equations (8) and (9), j represents j\textsuperscript{th} bank and t represents date t. $\varepsilon$ and $\xi$ are error terms. Hovakimian and Kane (2000) give slope coefficients of equations (8) and (9).

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\(^{15}\) To solve the system of two nonlinear equations, a Matlab’s optimization toolbox routine is employed.

\(^{16}\) In contrast to the valuation of IPP in equation (4), the equation (6) models equity as a fully dividend-protected call option because being the recipient of dividends, equity is in fact dividend-protected.

\(^{17}\) Ronn and Verma (1986) advance two reasons behind the use of a maturity of one year. First, it helped them to circumvent the problem of annualization in that they could directly arrive at the annual deposit insurance premium. Second, the data on bank examination by the deposit insurer are not easily available.

\(^{18}\) As mentioned by Ronn and Verma (1986), $\rho$ is policy parameter that is difficult to estimate empirically. As mentioned by Pyle (1984) the value of this parameter depends on the nature and scope of disruption that a particular closure may bring about in its wake, which in turn will depend on the bank concerned and perhaps on the economic conditions at the time when the insurer is confronted with the closure decision.
\(\alpha\) and \(\beta\), the following interpretations:\(^{19}\)

\[\alpha_1 = \frac{d(B/V)}{d\sigma_v}\]  \hspace{2cm} (10)

\[\beta_1 = \frac{dIPP}{d\sigma_v} = \frac{\partial IPP}{\partial \sigma_v} + \frac{\partial IPP}{\partial (B/V)} \alpha_1\]  \hspace{2cm} (11)

The risk-shifting incentive exists if \(\beta_1\) is positive. This is because positive \(\beta_1\) means that a bank takes asset risk so as to increase a value of IPP. According to the discussions of Duan et al. (1992), the comparative statistic results regarding equation (4) show that \(\frac{\partial IPP}{\partial \sigma_v}\) and \(\frac{\partial IPP}{\partial (B/V)}\) are both positive. Thus, it is when \(\alpha_1\) is substantially negative that \(\beta_1\) could be negative. Negative \(\alpha_1\) implies that a bank exposed to greater asset risk is restrained from increasing leverage. If \(B/V\) is negatively related to \(\sigma_v\) so that \(\alpha_1\) is negative, there are a positive direct effect of \(\sigma_v\) on IPP and a negative indirect effect of \(\sigma_v\) on IPP through the negative correlation between \(\sigma_v\) and \(B/V\). If the latter effect exceeds the former, correlation between IPP and \(\sigma_v\) becomes negative. In summary, we test on the following two hypotheses.

\[H1: \alpha_1 \leq 0\]

\[H2: \beta_1 \leq 0\]

If H1 is rejected, an increase in asset risk does not restrain an increase in leverage. If H2 is rejected, banks have risk-shifting incentives.

As discussed in Duan et al. (1992) and Hovakimian and Kane (2000), the restraints

\(^{19}\) More precisely, equations (8) and (9) follow specifications employed by Hovakimian and Kane (2000). Duan et al. (1992) use levels rather than changes for variables in both sides of equations.
could be attributed to regulatory and/or market pressures. As for regulatory pressures, the very spirit of the Basel risk based capital requirements is to request riskier banks to hold more capital and reduce leverage. We modify equations (8) and (9) so as to make slope parameters $\alpha_1$ and $\beta_1$ vary across different regulatory regimes. More specifically, equations (8) and (9) become,

$$
\Delta \frac{B_{jt}}{V_{jt}} = \alpha_0 + \left( \alpha_i + \sum_{i=2}^{I} \alpha_i D_{ij} \right) \Delta \sigma_{vjt} + \epsilon_{jt} 
$$

(12)

$$
\Delta IPP_{jt} = \beta_0 + \left( \beta_i + \sum_{i=2}^{I} \beta_i D_{ij} \right) \Delta \sigma_{vjt} + \xi_{jt} 
$$

(13)

Where $i$ represents $i$’th regulatory regime and I is the number of regimes. $D_i$ is a dummy variable that takes a value of one if a bank $j$ is under the $i$’th regime at date $t$.

3.3. The Related Literature

The extant literature under our empirical framework is grouped in the studies that primarily aim at examining the effect of introducing tougher regulatory reforms on banks’ moral hazard (Duan et al, 1992; Hovakimian and Kane, 2000) and the studies that aim at examining the effect of the deposit insurance (protection) system per se (Hovakimian et al., 2003; Wagster, 2007, 2008).

Duan et al. (1992) find that banks in the United States became more restrained from risk-shifting after introduction of numerical capital adequacy standards in 1981. Similarly, Hovakimian and Kane (2000) find that American banks became more restrained from risk-shifting after regulatory reforms in 1991, which introduced the deposit insurance premium associated with a bank’s capital adequacy and the PCA.
Using the cross country data, Hovakimian et al. (2003) find that explicit deposit insurance without risk mitigating features such as risk-sensitive premium and coverage limits induces banks’ risk-shifting but that insurance with such features does no harm. Wagster (2007) finds that Canadian banks had greater risk-shifting incentives after the adoption of the deposit insurance in 1967. Finding that the extent of banks’ risk-shifting became greater from 1932, Wagster (2008) argues that the Canadian government granted implicit deposit guarantees to banks in response to the abandonment of the gold standard in 1931.

A few studies directly test insured banks’ risk taking by looking at their asset compositions. Finding that the equity return is positively related to an increase in holdings of risky assets such as junk bonds for poorly capitalized S&Ls but not for well capitalized ones in the 1980s, Brewer and Mondchean (1994) and Brewer (1995) argue that shareholders value risky investment strategies employed by the institutions that are great beneficiaries of the deposit insurance protection. Hooks and Robinson (2002) find that, in Texas in the 1920s, highly levered insured banks took greater risks as measured by greater concentrations on risky asset types such as agricultural loans but that highly levered uninsured banks did not.

The studies that make comparisons of ex post performances between insured and uninsured banks produce mixed results. A series of studies using the sample of banks in Kansas in the 1920s (Wheelock, 1992; Wheelock and Wilson, 1995) and Hooks and Robinson (2002) both present the evidence that insured banks are more likely to fail than uninsured banks. Ioannidou and Pena (2009) find that introduction of explicit deposit insurance in Bolivia in 2001 induced banks to make loans that are internally rated risky.
Some studies present evidence against the moral hazard hypothesis. Keeley (1990) finds that the charter value as measured by market to book asset ratio worked as a restraint to an insured bank’s leverage. Using the sample of banks in Milwaukee and Chicago in the 1930s, Grossman (1992) finds that insured thrifts held less foreclosed loans than uninsured thrifts. He also finds that the risk reducing effect of the deposit insurance was less pronounced in Chicago where regulation was lenient than in Milwaukee where regulation was tough, the evidence consistent with stricter regulation’s disciplinary effect on insured banks. Using the sample of credit unions in Iowa in the 1970s after the establishment of the deposit insurance covering these institutions, Karels and McClatchey (1999) find that insured credit unions were better capitalized than uninsured ones, suggesting that the insurance did not encourage but discourage banks to lever.

Using the cross country data, Demirguc-Kunt and Detragiache (2002) show that a country with explicit deposit insurance is more likely to experience banking crises and that, the more generous the insurance is, the more likely a country experiences crises. Gropp and Vesala (2004), however, find the opposite result for banks in EU countries; banks operating in an environment with explicit deposit insurance are more levered but hold less non-performing loans than banks operating in an environment without.

4. Data and Empirical Results

4.1. Data

We need total liabilities and dividend payouts reported in banks’ balance sheets and daily stock prices of banks to compute V, the market value of bank assets, and \( \sigma_v \), the
instantaneous standard deviation of the return on \( V \). Banks’ balance sheets are collected from semiannually published “Financial Statements of All Banks” published by the Japanese Bankers’ Association, “Financial Statements of All Mutual Banks” published by the National Mutual Bank Association and the Nikkei NEEDS databank.\(^{20}\) The numbers for total liabilities and dividend payouts at interim closings before September 1997 are hand collected from hard copy versions of the “Financial Statements of All Banks” and “Financial Statements of All Mutual Banks”. The data on daily stock prices are extracted from the Nikkei NEEDS databank.

Banks included in our original sample are 123 banks that are listed in at least one of the following four stock exchanges in Japan, Tokyo Stock Exchanges, Osaka Stock Exchanges, Nagoya Stock Exchanges and Fukuoka Stock Exchanges. Our semiannual sample is selected to cover the period from the second half of fiscal year 1986, which spans from October 1, 1986 through March 31, 1987, to the second half of fiscal year 2007, which spans from October 1, 2007 through March 31, although the data needed to compute \( V, \sigma_V, B/V \) and IPP are available from the first half of fiscal year 1985. Thus, the longest time series data among sample banks encompass twenty-one and half years. The beginning of the sample is set at the second half of fiscal year 1986 because it is during this period that deposits were insured up to 10 million yen for the first time throughout a half year period.\(^{21}\) Following Hovakimian et al. (2003), five banks that stay in the sample no longer than three years are dropped, reducing the number of

\(^{20}\) Most mutual banks, which were licensed under the Mutual Bank Act, switched to banks licensed under the Banking Act in 1989. Thus, financial statements of former mutual banks until fiscal year 1988 are contained in “Financial Statements of All Mutual Banks” rather than “Financial Statements of All Banks”.

\(^{21}\) There is a minor difference between the pre blanket coverage system and the post blanket coverage system in that the former covers only principals up to 10 million yen whereas the latter covers both principals and accruing interests up to 10 million yen.
sample banks to 118. The sample banks cover 96.6 percent of all domestically licensed banks in terms of total assets as of March 1995 when the number of sample banks is the largest at 104 and cover 35.3 percent as of March 2006 when it is the smallest. In addition, following Hovakimian et al. (2003) again, observations below the first or above the ninety-ninth percentiles for at least one of the three variables of our interest, $V$, $\sigma_v$ and IPP are dropped. This sample trimming allows us to neutralize the effects of extreme values. As a result, we are left with a total of 3979 bank-date observations for our baseline sample. Our sample size for equations (12) and (13) with first differenced variables is further reduced to 3788.

4.2. Descriptive Statistics and Stylized Facts

Table 1 summarizes descriptive statistics of the variables used in computing $V$, $\sigma_v$ and IPP as well as computed $V$, $\sigma_v$ and IPP. The summary of our sample closely resembles that of the U.S. sample used in Hovakimian and Kane (2000), the only exception being banks in our sample are on average larger.

Figure 1 depicts aggregate trends of IPP and leverage, $B/V$. As a reference, the trends of the official deposit insurance premium set by DICJ are also displayed. Both IPP and leverage are aggregated over the sample banks with $V$ as a weight date by date. The aggregate IPP has almost always greatly exceeded the DICJ’s premium rate, suggesting that DICJ substantialy subsidizes Japanese banks by its flat rate

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22 The share of our sample banks is very small as of March 2006 because most of large banks were dropped from the sample as they became unlisted subsidiaries of listed holding companies and their data had been discontinued.

23 The two variables are drawn only until the first half of fiscal year 2000 because it was until this date that all the large banks, which constituted 69.7 percent of our sample in terms of $V$ as of the end of fiscal year 2000, remained in the sample.
insurance. While leverage had been consistently on an upward trend until it peaked out at the second half of fiscal year 1997, there are two spikes in IPP; the first relatively modest one at the first half of fiscal year 1992, and the second sharpest one at the second half of fiscal year 1997. The level of IPP at the second spike, almost one percent of the amount of deposits, stands more than six times as high as the value at the previous date as well as more than ten times as high as the DICJ’s premium.

The stylized facts that both leverage and IPP see their peaks at the second half of fiscal year 1997 are suggestive of Japanese banks in a crisis at this time. Shareholders valued the flat premium based deposit insurance extremely highly when banks were in severe distress. As equation (2) shows, IPP is a cover of the amount of a loss incurred by a bank that would be borne by a depositor without the deposit insurance. Roughly speaking, IPP is a market based measure for a bank’s credit risk implied from the stock markets. It was at the second half of fiscal year 1997, particularly in November, 1997, that what is known now as the Japan premium, sharp increases in Japanese banks’ borrowing rates in international credit markets emerged (Peek and Rosengren, 2001). As Figure 2 shows, the Japan premium and IPP keep track of each other remarkably. This fact lends support to our method to compute IPP.

4.3. Empirical Results

Preliminary results

24 There is a broad consensus that large capital losses, which lead to the severe credit crunch, occurred at that time (Woo, 2003; Watanabe, 2007).

25 The credit default swap (CDS) is another publicly traded measure for a cover of a cost of a default of a firm.
Table 2 presents the baseline regression results for leverage, B/V, in columns 1 and 2 and the actuarially fair insurance premium, IPP, in columns 3 and 4, respectively. For each dependent variable, the first of the two columns is the results for the equation without cross products of $\sigma_V$ and a dummy variable for the blanket coverage period (the second half of fiscal year 1996 through the second half of fiscal year 2001) when deposits were entirely fully insured ($D_2$), and a dummy variable for the post blanket coverage period when the blanket coverage is lifted except for certain deposit types ($D_3$), and the second is the results for the equation with these cross products. The coefficient of each cross product represents to what extent the sensitivity of a dependent variable to $\sigma_V$ changed during the period indicated by the corresponding dummy variable in comparison to the pre blanket coverage period.

The negative and significant coefficient of $\sigma_V$ in column 1 shows that banks deleverage in response to a greater asset risk, thereby restrain their risk-shifting incentive. The positive and significant coefficient of $\sigma_V$ in column 3 shows that, during the sample period, banks have significant incentives for risk-shifting. As shown in column 2, the negative and significant coefficient of the cross product with $D_3$ demonstrates that, after the insurance cap was reinstated, banks became more cautious in increasing leverage. As shown in column 4, none of the coefficients of the cross products in the $\Delta$IPP regression is significant. On balance, these results appear to suggest that the blanket coverage of the deposit insurance had not accelerated banks’ risk-shifting beyond the degree under the limited insurance coverage.

The blanket coverage and the prompt corrective action

Table 3 shows the results with cross products of $\sigma_V$ and three dummy variables for
regulatory regimes, a dummy variable for the regime of the blanket coverage without
the prompt corrective action (D2), a dummy variable for the regime of the blanket
coverage with PCA (D3) and a dummy variable for the regime after the end of the
blanket coverage for time deposits (D4). D2 takes a value of one from the second half
of fiscal year 1996 to the second half of fiscal year 1997 for international banks as of
the second half of fiscal year 1997 and from the same date to the second half of fiscal
year 1998 for domestic banks as of the second half of fiscal year 1997.26 Accordingly,
D3 takes a value of one until the second half of fiscal year 2001 but begins to do so at
the first half of fiscal year 1998 for international banks and at the first half of fiscal year
1999 for domestic banks. D4 begins to take a value of one at the first half of fiscal
year 2002 for all the sample banks.

The studies that employ the same empirical framework as ours represented by
equations (12) and (13), which was surveyed in 3.3, use period dummies within a
country to represent regulatory regimes. In other words, if there are macroeconomic
developments or policy changes other than the considered regulatory regimes that affect
banks’ risk taking during the same period, we are unable to isolate the effects of the
considered regulatory regimes on banks’ risk taking. Our use of Japanese episodes
overcome this problem of identification as a year of the start of the PCA, a major
regime switching point, differs across banks depending on their regulatory status.

In column 1, the positive and statistically significant coefficient of the cross
product with D2 more than offsets the negative coefficient of $\sigma_v$ itself, thus, under the
regime of the blanket coverage without PCA, greater asset risks do not restrain banks’
pursuit for leverage. On the other hand, the negative and significant coefficient of the

\[ 26 \text{ of 103 banks were international banks as of the second half of fiscal year 1997.} \]
cross product with $D_3$ implies that, even in the presence of the blanket coverage, banks subject to the PCA deleveraged even more aggressively than those before the blanket coverage period when they were not subject to the PCA. Negative and significant coefficients of cross products with $D_3$ and with $D_4$, whose magnitudes are similar each other, suggest that the PCA’s disciplinary effect was so strong that it neutralized the force of the blanket coverage which had previously wiped out a riskier bank’s restraint on increasing leverage. A negative and significant coefficient of the cross product with respect to the post blanket coverage period suggests that the disciplinary effect of the PCA remains strong under the deposit insurance generally more generous by law than the one before the lift of the cap.\footnote{There was no exception to the 10 million yen cap before the start of the blanket coverage. Certain types of payable deposits are still fully insured even after the end of the blanket coverage, although all term deposits became subject to the cap. Some contend to our argument that implicitly deposits were fully guaranteed although there was an explicit 10 million cap under the formal system.}

In column 2, the coefficient of the cross product of $\sigma_V$ with $D_3$ is positive and statistically significant. Its point estimate (0.1414) relative to the point estimate for $\sigma_V$ (0.0889) means that the risk-shifting incentive as measured by the sensitivity of IPP to the volatility of asset return jumped up by 160 percent when blanket coverage policy was introduced. However, the negative and insignificant coefficient of the cross product with $D_3$ implies that the effect of the PCA was strong enough to offset the risk-shifting effect of the introduction of the blanket coverage. The negative and insignificant coefficient of the cross product with $D_4$ implies that the deposit insurance reform of April 2002 that limited the coverage of time deposits was negligible to banks subject to the PCA. It is the PCA that primarily disciplines banks regardless of the insurance coverage. This suggests that Japanese banks were disciplined not only by
partially insured depositors after the end of the blanket insurance as argued by Imai (2006) and Fueda and Konishi (2007) but also by the stringent regulatory framework based on the PCA.

**Capital adequacy and risk-shifting**

Marcus (1984) discusses that poorly capitalized banks undertake the go-for-broke policy by increasing asset risk in order to increase the value of the deposit insurance. Following Hovakimian and Kane (2000) in spirit, 28

As for the results on the regressions for leverage reported in columns 1 and 2 of Table 4, two findings are worth mentioning. First, regardless of the regulatory regime, poorly capitalized banks tend to be no less restrained from seeking leverage than well capitalized banks. Second, the coefficient of $\sigma_V$ and the cross product with respect to the regime of blanket insurance with the PCA is larger and more significant for banks with higher leverage (reported in column 2) than those with lower leverage (reported in column 1). This implies that as anticipated the PCA played a stronger disciplinary role for poorly capitalized banks than for well capitalized banks.

Poorly capitalized banks generally have a greater extent of risk-shifting incentive than well capitalized banks as demonstrated in columns 3 and 4 of Table 4. Before the instatement of the blanket coverage, the coefficient of $\sigma_V$ is nearly twice as large for poorly capitalized banks as for well capitalized banks. This trend is maintained under any regime but the regime of the blanket coverage with the PCA. The sum of the

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28 Hovakimian and Kane (2000) interact dummy variables to indicate whether a bank’s leverage in the previous quarter is below or above the median at that quarter with independent variables. We decided to split the sample because it is less straightforward to interpret coefficients of many resulting cross products. Both the method of Hovakimian and Kane (2000) and our methods produce qualitatively the same results.
coefficients of $\sigma_V$ and the cross product of $\sigma_V$ and the dummy variable remains nearly twice as large for poorly capitalized banks as the corresponding value for well capitalized banks except under the regime of the blanket coverage with PCA. Surprisingly, under the regime of the blanket coverage with PCA, unlike under other regimes, well capitalized banks have a statistically significant risk-shifting incentive whereas poorly capitalized banks do not. No doubt that there was a stronger effect of the PCA on poorly capitalized banks than well capitalized peers contributed to this fact. The negligible difference in the deleveraging effect between poorly and well capitalized banks, however, suggests that the PCA’s disciplinary force functioned through means other than deleveraging The smaller risk-shifting incentive by poorly capitalized banks suggests that, under the PCA based on capital adequacy, poorly capitalized banks felt more regulatory pressures than well capitalized banks. The PCA effectively restrained poorly capitalized banks from further risk taking.

The literature agrees that poorly capitalized Japanese banks in the late 1990s to early 2000s had a perverse incentive of making rescue lending to practically defaulted firms, thus made their assets riskier (Peek and Rosengren, 2005; Caballero et al, 2008; Watanabe, 2010). This is because, as firms were able to service preexisting debt by new loans, lending banks were able to do away with classifying loans to these firms as non-performing. What is accused of driving banks to what is known as “evergreening” in the literature is the loophole of the risk based capital adequacy standard, namely, the risk weight assigned to corporate loans used to calculate the risk based capital adequacy ratio that was independent of credit risk. This created an opportunity for the regulatory arbitrage between risky and safe corporate loans. Our finding that the deposit insurance drove poorly capitalized banks into risky lending suggests that the deposit
insurance is another institution to induce banks’ perverse incentives.

5.4. Robustness Checks

**Shorter sample period**

We test whether the underrepresentation of large banks at recent dates caused by delisting of many of them as an independent bank biases our estimates. As we did for drawing Figure 1, we end the sample period at the first half of fiscal year 2000. Table 5 replicates the results reported in Table 3 using this shorter panel. As this sample period ends before the reinstatement of the insurance cap at the first half of fiscal year 2002, the cross product with respect to the post blanket coverage period is dropped from each regression equation. Except for the coefficients of this dropped cross product, the results in Table 5 remain the same as in Table 3.

**Controlling for public capital infusions**

Allen et al. (2010) discuss that public capital infusions in Japan affected bank lending. There have been two major waves of public capital infusions in Japan. The first wave took place in March 1998, the end of fiscal year 1997 (the 1998 wave). The public capital was aimed at 19 large banks and 3 regional banks including Yokohama Bank, the largest regional bank. The amounts of public capital injected into banks were arguably independent of banks’ capital positions. In fact, the 10 largest banks (9 city banks and Industrial Bank of Japan) received almost the equal amount. The total

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29 The results reported in Tables 2 and 4 also remain unchanged with a shorter panel (results are not reported).

30 Among the 10 largest banks, all but Daiichikangyo Bank received 10 billion yen of public capital. The amount received by Daiichikangyo Bank was 9.9 billion yen.
amount of public capital was modest at 18.156 trillion yen. The second wave came in March 1999, when 74.593 trillion yen was received by 14 large banks and Yokohama Bank (the 1999 wave). This time, the amount of public capital was determined based on each bank’s capital adequacy. According to Allen et al. (2010), the 1998 wave reduced total bank lending whereas the 1999 wave increased it. Their results suggest that public infusions affect recipient banks’ risk taking.

Regarding the influences of public recapitalization on banks’ risk taking, there is another issue. Under the relevant laws, publicly recapitalized banks have to submit a business revitalization plan that primarily aims at restoring their financial health. The plan under the 1999 wave included measures for “smoothing lending”, which effectively meant increasing lending to bank dependent small and medium enterprises that were likely victims of the credit crunch. The 1999 wave may have induced recipient banks’ risk taking not only through increasing lending but also through forcing banks to tilt toward high risk borrowers (SMEs).

These discussions lead us to check our results’ robustness after controlling for public capital infusions. Following Allen et al. (2010), we group public capital infusions in Japan into three types, the 1998 wave, the 1999 wave and all the others. We divide the remaining amounts of public capital initially infused into a bank in March 1998, March 1999 and any other time by V to construct PUBLIC98, PUBLIC99 and PUBLICOTHER, respectively. The results reported in Table 6 are consistent with those reported in Table 3. As for the coefficients of the three variables for public

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31 Legally speaking, some public capital infusions that occurred after April 1999, which are represented by PUBLICOTHER rather than PUBLIC99, are based on the Early Strengthening Law that stipulates all the capital infusions in March 1999. So, technically, the business revitalization plan to call for “smoothing lending” binds these banks that received public capital after April 1999.
capital infusions, none of them is statistically significant.32

The sample of domestic banks only

One way to look at our results is that the PCA is not driving our results but just the type of banks. For example, international banks may have more risk-shifting opportunities than domestic banks. Thus, the FSA would be more vigilant in policing risk exposures of international banks with or without the PCA. In order to test this alternative view, we run the regressions on the sample of domestic banks. Notice, as is evident, this way of subsampling inevitably nullifies our methodological advantage that the dummy variables for the PCA are not indicators for time series variations. The results for the IPP regression remain qualitatively unaltered. Regarding the leverage regression, however, neither the encouraging effect of blanket insurance without the PCA nor the discouraging effect of blanket insurance with the PCA is statistically significant, although the signs remain unaltered (column 1 of Table 7). On balance, our results that the PCA restrained perfectly insured banks from engaging in moral hazard remain robust.

32 Peek and Rosengren (1995) find that banks that were subject to formal regulatory actions, which were based on the leverage ratio requirement, reduced lending faster than those that were not. In light of their finding, we examined whether there was any difference in the coefficients of $\sigma_V$ in leverage and IPP regressions between banks that were enforced the PCA and those that were not. Regarding our sample, Hokkaido Bank (from May, 1999), Sowa Bank (May, 1999), Namihaya Bank (June, 1999), Senshu Bank (September, 1999), Chiba Kyogyo Bank (April, 2000), Fukushima Bank (December, 2001) and Howa Bank (April, 2006) were enforced the PCA. We assumed that the Financial Services Agency continued to enforce Howa Bank the PCA for one year and that it continued to enforce all the other banks the PCA for three years, because it is in December 2002 that the FSA shortened the time to the improvement of capital adequacy of enforced banks from three years in principle to one year in principle. We added the cross product of $\sigma_V$ and a dummy variable to indicate that a bank is under the PCA enforcement to the regressions whose results are reported in Table 6. None of the coefficients of this cross product was statistically significant (results are not reported). These findings imply that it is the existence of the action framework rather than its enforcement that disciplined banks.
5. Conclusion

In this paper, utilizing temporary blanket coverage in Japan as a natural experiment, we examined whether the fixed (flat) premium based deposit insurance system, particularly unlimited insurance drives banks to engage in the moral hazard, excessive risk taking by shifting their asset risk to the deposit insurer. Using the option pricing based model of valuing the deposit insurance, we examined whether banks take risks so that the value of the insurance to their shareholders increases under different regulatory regimes.

The blanket coverage when unaccompanied by a stringent regulatory framework of the prompt corrective action did encourage banks further risk-shifting. The blanket coverage when accompanied by the PCA, on the other hand, did not. These findings suggest that moral hazard incentives accelerated by expanded insurance coverage can be mitigated by the strong regulatory discipline. We additionally find that poorly capitalized banks are engaged in risk-shifting to the greater degree than well capitalized banks but such tendency is not found during the period when both the blanket coverage and the PCA were in action, suggesting that the PCA effectively restrained poorly capitalized banks from further risk taking.
Reference


Bailouts: Micro-Evidence from Japan,” mimeo, Stockholm School of Economics and Michigan State University.


Figure 1. Trends of IPP, the DICJ’s Premium Rate and B/V

IPP and B/V are aggregated over sample banks each period using the value of V as a weight.

Figure 2. The Japan Premium and aggregate IPP

IPP is aggregated over sample banks each period using the value of V as a weight. The Japan premium is the differential between the interbank borrowing rate of Tokyo-Mitsubishi Bank and UK/US banks.
Table 1. Descriptive Statistics

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Table 2. Tests of the Risk-shifting Hypothesis, the Three Regime Model

\[
\Delta \frac{B_i}{V_{jt}} = \alpha_0 + \left( \alpha_i + \sum_{i=2}^{3} \alpha_i D_{ijt} \right) \Delta \sigma_{vj} + \varepsilon_{jt} \quad \Delta IPP_{jt} = \beta_0 + \left( \beta_i + \sum_{i=2}^{3} \beta_i D_{ijt} \right) \Delta \sigma_{vj} + \xi_{jt}
\]

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*, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.
The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007.
Dummy variables, D_2 and D_3 are variables that indicate regulatory regimes 2 and 3, respectively. D_2 takes a value of 1 from the second half of fiscal year 1996 through the second half of fiscal year 2001 when the deposit insurance coverage was unlimited. D_3 takes a value of 1 from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. \( \alpha_i+\alpha_i \) is the coefficient of \( \Delta \sigma_v \) under regime \( i \). The coefficient of \( \Delta \sigma_v \) itself is the coefficient of \( \Delta \sigma_v \) under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage.
Table 3. Tests of the Risk-shifting Hypothesis, the Four Regime Model

\[ \Delta \bar{B}_{ijt} = \alpha_0 + \left( \alpha_1 + \sum_{i=2}^4 \alpha_i D_{ijt} \right) \Delta \sigma_{ijt} + \epsilon_{ijt} \]

\[ \Delta \bar{P}_{ijt} = \beta_0 + \left( \beta_1 + \sum_{i=2}^4 \beta_i D_{ijt} \right) \Delta \sigma_{ijt} + \xi_{ijt} \]

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* *, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.

The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007.

Dummy variables, D_2, D_3 and D_4 are variables that indicate regulatory regimes 2, 3 and 4, respectively. D_2 takes a value of 1 when the deposit insurance coverage was unlimited and the prompt corrective action (PCA) was yet to begin; from the second half of fiscal year 1996 through the second half of fiscal year 1997 for banks that the regulator allows to operate internationally (international banks) and from the second half of fiscal year 1996 through the second half of fiscal year 1998 for banks that the regulator allows to operate only domestically (domestic banks). D_3 takes a value of 1 when the deposit insurance coverage is unlimited and PCA is in effect; from the first half of fiscal year 1998 through the second half of fiscal year 2001 for international banks and from the first half of fiscal year 1999 through the second half of fiscal year 2001 for domestic banks. D_4 takes a value of 1 from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. \( \alpha_i + \alpha_i \) is the coefficient of \( \Delta \sigma_V \) under regime \( i \). The coefficient of \( \Delta \sigma_V \) itself is the coefficient of \( \Delta \sigma_V \) under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage.
Table 4. Tests of the Risk-shifting Hypothesis, the Three Regime Model: Lower Leverage versus Higher Leverage

\[ \Delta \frac{B}{V^p} = \alpha_0 + \left( \alpha_1 + \sum_{i=2}^{4} \alpha_i D_i \right) \Delta \sigma_{V_i} + \epsilon \]

\[ \Delta IPP^p = \beta_0 + \left( \beta_1 + \sum_{i=2}^{4} \beta_i D_i \right) \Delta \sigma_{PP^p} + \xi \]

<table>
<thead>
<tr>
<th>lower leverage</th>
<th>higher leverage</th>
<th>lower leverage</th>
<th>higher leverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>0.0029</td>
<td>-0.0006</td>
<td>0.0002</td>
</tr>
<tr>
<td>( \Delta \sigma_V )</td>
<td>-0.4072</td>
<td>-0.4828</td>
<td>0.0680</td>
</tr>
<tr>
<td>( \Delta \sigma_V D_2 )</td>
<td>0.5120</td>
<td>0.3875</td>
<td>0.0894</td>
</tr>
<tr>
<td>( \Delta \sigma_V D_3 )</td>
<td>-0.2821</td>
<td>-0.3505</td>
<td>0.0129</td>
</tr>
<tr>
<td>( \Delta \sigma_V D_4 )</td>
<td>-0.2638</td>
<td>-0.2645</td>
<td>-0.0057</td>
</tr>
</tbody>
</table>

R-squared 0.1320 0.2391 0.2752 0.2883

N 1910 1878 1910 1878

\( \alpha_{1+\alpha_2} \) 0.1049 0.2214 -0.0953 0.0896

\( \alpha_{1+\alpha_3} \) -0.689 0.1447 *** -0.8333 0.1015 ***

\( \alpha_{1+\alpha_4} \) -0.6709 0.0947 *** -0.7473 0.0917 ***

\( \beta_{1+\beta_2} \) 0.1575 0.0346 *** 0.2919 0.0423 ***

\( \beta_{1+\beta_3} \) 0.0809 0.0230 *** 0.0475 0.0367

\( \beta_{1+\beta_4} \) 0.0623 0.0079 *** 0.1231 0.0223 ***

*, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.

The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007.

For the column labeled “lower leverage”, the sample consists of bank-date observations whose leverage at the previous date is below the median at that date, whereas for the column labeled “higher leverage”, it consists of the sample of bank-date observations whose leverage is above the median at that date.

Dummy variables, \( D_2 \), \( D_3 \) and \( D_4 \) are variables that indicate regulatory regimes 2, 3 and 4, respectively. \( D_2 \) takes a value of 1 when the deposit insurance coverage was unlimited and the prompt corrective action (PCA) was yet to begin; from the second half of fiscal year 1996 through the second half of fiscal year 1997 for banks that the regulator allows to operate internationally (international banks) and from the second half of fiscal year 1996 through the second half of fiscal year 1998 for banks that the regulator allows to operate only domestically (domestic banks). ** \( D_3 \) takes a value of 1 when the deposit insurance coverage is unlimited and PCA is in effect; from the first half of fiscal year 1998 through the second half of fiscal year 2001 for international banks and from the first half of fiscal year 1999 through the second half of fiscal year 2001 for domestic banks. ** \( D_4 \) takes a value of 1 from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. \( \alpha_{1+\alpha_i} \) is the coefficient of \( \Delta \sigma_V \) under regime \( i \). ** The coefficient of \( \Delta \sigma_V \) itself is the coefficient of \( \Delta \sigma_V \) under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage.
Table 5. Tests of the Risk-shifting Hypothesis for a Shorter Sample Period

\[
\Delta \frac{B_v^{jt}}{\sigma_v^{jt}} = \alpha_0 + \left( \alpha_1 + \sum_{i=2}^{3} \alpha_i D_{ij} \right) \Delta \sigma_v^{jt} + \epsilon_j \quad \Delta IPP_j = \beta_0 + \left( \beta_1 + \sum_{i=2}^{3} \beta_i D_{ij} \right) \Delta \sigma_v^{jt} + \xi_j
\]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.0014</td>
<td>0.0003 ***</td>
<td>0.0001</td>
</tr>
<tr>
<td>Δσ_v</td>
<td>-0.4420</td>
<td>0.0485 ***</td>
<td>0.0887</td>
</tr>
<tr>
<td>Δσ_vD_2</td>
<td>0.4550</td>
<td>0.1209 ***</td>
<td>0.1420</td>
</tr>
<tr>
<td>Δσ_vD_3</td>
<td>-0.3505</td>
<td>0.1252 ***</td>
<td>-0.0325</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.1545</td>
<td>0.2960</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2577</td>
<td>2577</td>
<td></td>
</tr>
<tr>
<td>α_1+α_2</td>
<td>0.0130</td>
<td>0.1103</td>
<td>0.2307</td>
</tr>
<tr>
<td>α_1+α_3</td>
<td>-0.7925</td>
<td>0.1159 ***</td>
<td>0.562456</td>
</tr>
<tr>
<td>β_1+β_2</td>
<td>0.2307</td>
<td>0.0236291 ***</td>
<td></td>
</tr>
<tr>
<td>β_1+β_3</td>
<td>0.0562456</td>
<td>0.0201 **</td>
<td></td>
</tr>
</tbody>
</table>

*, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.

The sample covers from the second half of fiscal year 1986 through the first half of fiscal year 2000.

Dummy variables, D_2 and D_3 are variables that indicate regulatory regimes 2 and 3, respectively. D_2 takes a value of 1 when the deposit insurance coverage is unlimited and the prompt corrective action (PCA) is yet to begin; from the second half of fiscal year 1996 through the second half of fiscal year 1997 for banks that the regulator allows to operate internationally (international banks) and from the second half of fiscal year 1996 through the second half of fiscal year 1998 for banks that the regulator allows to operate only domestically (domestic banks). D_3 takes a value of 1 when the deposit insurance coverage is unlimited and PCA is in effect; from the first half of fiscal year 1998 through the first half of fiscal year 2000 for international banks and from the first half of fiscal year 1999 through the first half of fiscal year 2000 for domestic banks. α_1+α_i is the coefficient of Δσ_v under regime i. The coefficient of Δσ_v itself is the coefficient of Δσ_v under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996.
Table 6. Tests of the Risk-shifting Hypothesis when Controlling for Public Capital Infusions

\[
\Delta \frac{B_j}{V_{jt}} = \alpha_0 + \left( \alpha_1 + \sum_{i=2}^{3} \alpha_i D_{ijt} \right) \Delta \sigma_{Vjt} + \theta_{98} \text{PUBLIC98} + \theta_{99} \text{PUBLIC99} + \theta_{\text{other}} \text{PUBLICOTHER} + \varepsilon_{jt}
\]

\[
\Delta \text{IPP}_{jt} = \beta_0 + \left( \beta_1 + \sum_{i=2}^{3} \beta_i D_{ijt} \right) \Delta \sigma_{Vjt} + \xi_{jt} + \theta_{98} \text{PUBLIC98} + \theta_{99} \text{PUBLIC99} + \theta_{\text{other}} \text{PUBLICOTHER} + \varepsilon_{jt}
\]

<table>
<thead>
<tr>
<th>coefficient</th>
<th>standard error</th>
<th>coefficient</th>
<th>standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>0.0012</td>
<td>0.0002 ***</td>
<td>0.0001</td>
</tr>
<tr>
<td>\Delta \sigma_{V}</td>
<td>-0.4432</td>
<td>0.0484 ***</td>
<td>0.0890</td>
</tr>
<tr>
<td>\Delta \sigma_{V}D_{2}</td>
<td>0.4560</td>
<td>0.1090 ***</td>
<td>0.1412</td>
</tr>
<tr>
<td>\Delta \sigma_{V}D_{3}</td>
<td>-0.3190</td>
<td>0.0835 ***</td>
<td>-0.0210</td>
</tr>
<tr>
<td>\Delta \sigma_{V}D_{4}</td>
<td>-0.2776</td>
<td>0.0351</td>
<td>-0.0043</td>
</tr>
<tr>
<td>PUBLIC98</td>
<td>0.0963</td>
<td>0.2305</td>
<td>-0.0076</td>
</tr>
<tr>
<td>PUBLIC99</td>
<td>-0.1512</td>
<td>0.1106</td>
<td>-0.0382</td>
</tr>
<tr>
<td>PUBLICOTHER</td>
<td>-0.0351</td>
<td>0.0476</td>
<td>-0.0009</td>
</tr>
</tbody>
</table>

| R-squared          | 0.1711         | 0.2616       |
| N                  | 3788           | 3788         |
| \alpha_1 + \alpha_2 | 0.0128         | 0.1103       |
| \alpha_1 + \alpha_3 | -0.7622        | 0.0979 ***   |
| \alpha_1 + \alpha_4 | -0.7208        | 0.0679 ***   |
| \beta_1 + \beta_2  | 0.2302         | 0.0324 ***   |
| \beta_1 + \beta_3  | 0.0680         | 0.0186 ***   |
| \beta_1 + \beta_4  | 0.0847         | 0.0099 ***   |

*, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.

The sample covers from the second half of fiscal year 1986 through the first half of fiscal year 2000.

The dummy variables, D_2 and D_3 are variables that indicate regulatory regimes 2 and 3, respectively. D_2 takes a value of 1 when the deposit insurance coverage is unlimited and the prompt corrective action (PCA) is yet to begin; from the second half of fiscal year 1996 through the second half of fiscal year 1997 for banks that the regulator allows to operate internationally (international banks) and from the second half of fiscal year 1996 through the second half of fiscal year 1998 for banks that the regulator allows to operate only domestically (domestic banks). D_3 takes a value of 1 when the deposit insurance coverage is unlimited and PCA is in effect; from the first half of fiscal year 1998 through the first half of fiscal year 2000 for international banks and from the first half of fiscal year 1999 through the first half of fiscal year 2000 for domestic banks. \alpha_i + \alpha_i is the coefficient of \Delta \sigma_{V} under regime i. The coefficient of \Delta \sigma_{V} itself is the coefficient of \Delta \sigma_{V} under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996.

PUBLIC98, PUBLIC99 and PUBLICOTHER are the remaining amounts of public capital infused in March 1998, March 1999 and any other time, respectively, divided by V.
Table 7. Tests of the Risk-shifting Hypothesis for the Sample of Domestic Banks

\[
\Delta \frac{B_{jt}}{V_{jt}} = \alpha_0 + \left( \alpha_1 + \sum_{i=2}^{4} \alpha_i D_{ijt} \right) \Delta \sigma_{vjt} + \varepsilon_{jt} \quad \Delta IPP_{jt} = \beta_0 + \left( \beta_1 + \sum_{i=2}^{4} \beta_i D_{ijt} \right) \Delta \sigma_{vjt} + \xi_{jt}
\]

<table>
<thead>
<tr>
<th></th>
<th>coefficient</th>
<th>standard error</th>
<th>coefficient</th>
<th>standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>0.0009</td>
<td>0.0002 ***</td>
<td>0.0001</td>
<td>0.0000 ***</td>
</tr>
<tr>
<td>\Delta \sigma_V</td>
<td>-0.3901</td>
<td>0.0476 ***</td>
<td>0.1179</td>
<td>0.0090 ***</td>
</tr>
<tr>
<td>\Delta \sigma_V D_2</td>
<td>0.1189</td>
<td>0.1367</td>
<td>0.0920</td>
<td>0.0472 *</td>
</tr>
<tr>
<td>\Delta \sigma_V D_3</td>
<td>-0.2100</td>
<td>0.1675</td>
<td>0.0064</td>
<td>0.0412</td>
</tr>
<tr>
<td>\Delta \sigma_V D_4</td>
<td>-0.3297</td>
<td>0.0755 ***</td>
<td>-0.0145</td>
<td>0.0182</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.1741</td>
<td>0.3094</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2182</td>
<td>2182</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \alpha_1 + \alpha_i \) is the coefficient of \( \Delta \sigma_V \) under regime \( i \). The coefficient of \( \Delta \sigma_V \) itself is the coefficient of \( \Delta \sigma_V \) under regime 1. The coefficient \( \Delta \sigma_V \) itself is the coefficient of \( \Delta \sigma_V \) under regime 1 from the second half of fiscal year 1986 to the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage.

\*, ** and *** indicate that values are statistically significant at the 10 percent, 5 percent and 1 percent significance levels, respectively.

The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007 and the sample banks are domestic banks only.

Dummy variables, \( D_2, D_3 \) and \( D_4 \) are variables that indicate regulatory regimes 2, 3 and 4, respectively. \( D_2 \) takes a value of 1 when the deposit insurance coverage was unlimited and the prompt corrective action (PCA) was yet to begin; from the second half of fiscal year 1996 through the second half of fiscal year 1998. \( D_3 \) takes a value of 1 when the deposit insurance coverage is unlimited and PCA is in effect; from the first half of fiscal year 1999 through the second half of fiscal year 2001. \( D_4 \) takes a value of 1 from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period.