The Effects of Public Capital Infusions on Banks' Risk-Shifting to the Deposit Insurance System in Japan

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Abstract

Using option pricing based models, we compute the actuarially fair deposit insurance premium and the market value of assets and asset volatility for Japanese banks as implied by their stock prices. The findings based on these variables suggest that banks shift risks to the deposit insurer who charges them risk insensitive premiums. Well-designed regulatory policies in response to the crisis, however, effectively restrain banks' risk-shifting. Not only did the introduction of the prompt corrective action discipline insured banks, but large-scale public capital infusions successfully deleveraged banks whose assets are risky. This effectively mitigated banks' risk-shifting.

Keywords: actuarially fair deposit insurance premium, blanket deposit insurance, risk-shifting, prompt corrective action, public capital

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1. Introduction

In Japan, amid the financial crisis of the late 1990s, the deposit insurance coverage cap at 10 million yen per depositor per institution was abandoned in June 1996, transforming the deposit insurance system from a limited to an unlimited insurance until March 2002 when the cap was reinstated.

As the financial crisis became more evident, the Japanese government decided to inject public capital into the banks, first in March 1998 and again in March 1999. Under 1998 and 1999 programs, which targeted primarily systematically important major banks, the amounts infused into the banking system totaled 1.8 trillion yen and 7.5 trillion yen, respectively.

A more rigorous regulatory action framework known as the Prompt Corrective Action (PCA) that mandates regulatory interventions into a poorly capitalized bank became effective in March 1998. The application of the PCA to domestic banks that are barred from international businesses was deferred for one year until March 1999.

The more generous insurance protection offered during a crisis is aimed at calming the fears of depositors who might otherwise panic and start a run on their viable banks to withdraw their deposits.[1] There is, however, a broad consensus that the negative side effect of the publicly run deposit insurance system is the problem of moral hazard, that is, the propensity for insured banks to take excessive risks because the deposit insurance insulates insured banks from the risk of losing deposits when they lose their bets and

[1] See Diamond and Dybvig (1983) for the classical discussion on the problem of an inefficient bank run 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) find, 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.

become distressed.[2] [3]

The design of the modern day deposit insurance is characterized as a "flat" premium design. The risk profile of the premium per unit of insured deposits that the public insurer charges banks is flatter than that of the actuarially fair premium that the private insurer would charge in the absence of a public insurer. Consequently, insured banks are willing to take greater risks to pursue higher returns as their greater risk taking does not cost them a larger insurance premium. This is a classic example of moral hazard.[4]

Some authors argue that an insured bank's moral hazard incentive is restrained by a strict regulator (a tougher enforcer of regulations) who successfully disciplines the banks (Grossman, 1992; Duan et al., 1992; Hovakimian & Kane, 2000). Although public capital infusions and the expansion of the deposit insurance protection are the widely employed prudential policy package to contain a financial crisis, the impact of public capital infusions on the moral hazard of banks, which is likely fueled by a more generous deposit insurance protection, is overlooked in the literature.[5]

[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).

[3] "Core Principle for Effective Deposit Insurance Systems" published in June, 2009 by the BCBS 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).

[4] The studies that examine the impact of the deposit insurance on banks' moral hazard include Keeley (1990), Duan et al. (1992), Grossman (1992), Brewer and Mondschean, (1994), Brewer (1995), Wheelock and Wilson (1995), Karels and McClatchey (1999), Hovakimian and Kane (2000), Demirguc-Kunt and Detragiache (2002), Hooks and Robinson (2002), Hovakimian et al. (2003), Gropp and Vesala (2004), Wagster (2007, 2009), and Ioannidou and Penas (2010). Among them, only Keeley (1990), Grossman (1992) and Karels and McClatchey (1999) present evidence against insured banks' moral hazard.

[5] According to Laeven and Valencia (2012b), 17 out of 23 countries studied incurred the fiscal cost of bank recapitalization and other restructuring costs, whereas 21 of these countries expanded the deposit protection during the years 2007 to 2009. According to Laeven and Valensia (2012a), in 8 of 42 historical financial crises, banks were recapitalized and deposits were protected under the blanket guarantee. More recently, Demirguc-Kunt et al. (2015) report the main findings from the IMF's comprehensive cross country database covering 189 IMF countries and Liechtenstein. Based on the database, which is publicly accessible, among 112 countries where relevant information is collected, from 2008 through 2013, the deposit insurance system had been introduced in 14 countries and the statutory insurance coverage had been raised in 59 countries.

Using Japanese bank data, we examine whether the (generous) deposit insurance induced (accelerated) banks' moral hazard and whether the tougher PCA regulatory framework restrained banks from excessive risk-taking. Our unique contribution to the literature, however, is to examine the impacts of public capital infusions on the risk- taking of insured banks. Public capital reduces a recipient bank's leverage, thereby making a bank less susceptible to insolvency. Consequently, the deposit insurance becomes less valuable to the bank. Thus, public capital potentially mitigates the moral hazard of a bank that is insured by flat-rate based deposit insurance.

Based on the model developed by Duan et al. (1992), we test how policy measures influence the banks' risk-shifting, that is, an insured bank passes its risks on to the deposit insurer who is liable for the losses incurred by depositors if the bank fails. 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 the value of the deposit insurance to an insured bank per unit of deposits. Our 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 an increase in a bank's asset risk increases the value of the deposit insurance to the bank but does not increase the premium that the bank pays to the publicly run insurer.

Our major findings are fourfold: First, banks that are insured by the flat-rate based deposit insurance are engaged in risk-shifting regardless of whether or not the insurance coverage is unlimited. Second, in aggregate, fully insured banks that were not subject to the PCA did not accelerate risk-shifting. Third, the PCA was effective in restraining insured banks' risk-shifting incentives. Fourth and most importantly, the 1999 public capital infusion program was effective in restraining the banks' risk-shifting through curbing leverage, whereas the 1998 public capital infusion program was ineffective. Under the 1999 program, the amount of public capital injected into each bank was linked to its capital adequacy. As a consequence, the more greatly a bank increased its asset risk, the more public capital the bank received and the less leveraged it became because an increase in asset risk was generally associated with a decrease in capital adequacy. On the other hand, under the 1998 program the amount of capital received by each bank was not linked to its capital adequacy. To the best of our knowledge, we are the first to identify the mechanism through which properly designed public recapitalization affects not only the quantity of a bank loans as discussed in the literature but also its overall risk-taking behavior (quality of assets held by the bank).[6]

The remainder of the paper is organized as follows: Section 2 discusses the related literature. Section 3 introduces the institutional background, Section 4 discusses the empirical methodology, Section 5 discusses the data and empirical results. Section 6 concludes.

2. The Related Literature

Two studies using our empirical framework find that introducing tougher regulatory reforms mitigates the banks' moral hazard. Duan et al. (1992) find that banks in the United States became more restrained from risk-shifting after the introduction of numerical

[6] For the review of the literature about effects of public recapitalization on the banking behavior, please see Section 2.

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 linked to a bank's capital adequacy and the PCA.

Moreover, using a sample of banks in Milwaukee and Chicago in the 1930s, Grossman (1992) finds that insured thrifts held fewer foreclosed loans than uninsured thrifts and that the risk reducing effect of the deposit insurance was less pronounced in Chicago where regulation was lenient than in Milwaukee where regulation was strict; the evidence is consistent with demanding regulation's disciplinary effect on insured banks.

Regarding two rounds of pubic capital infusions in Japan targeting primarily major banks, Hoshi and Kashyap (2010) discuss that the 1998 capital infusion program was insufficient for most of the banks to restore their capital, whereas the 1999 program was sufficient because the regulator checked sufficiency of the amount of public capital for each recipient bank. Several studies examine public capital infusions on bank lending and/or borrowers of banks that received public capital. Montgomery and Shimizutani (2009) find that public capital under the 1999 program increased total loans and loans to small and medium enterprises (SMEs) by international banks, but public capital under the 1998 program did not. Allen et al. (2011) find that public capital under the 1999 program or later programs increased the banks' total loans and corporate and industrial loans while public capital under the 1998 program decreased total loans. Giannetti and Simonov (2013) find that firms that borrowed from public capital recipient banks under the 1999 program increased loans whereas those that borrowed from public capital recipient banks under the 1998 program did not.

The literature on the effect of public capital on banks' risk-taking outside of Japan is mixed. While Bayazitova and Shivdasani (2012) find that banks that received TARP public capital increased total loans, corporate and industrial loans and real estate loans, Duchin and Sosyura (2010) find that TARP recipients did not increase the probability of loan approval as much as TARP non-recipients did. While Duchin and Sosyura (2010) further present the evidence that TARP recipients made riskier loans and their overall level of (bank level) risk-taking was higher, Black and Hazelwood (2013) find that TARP capital made the lending of large banks riskier but that of small banks less so. Using the German data, Berger et al. (2010) find that the capital injection into a bank by a bankers association not only contributed to reducing the bank's ratio of non-performing loans to total loans in the short run (because more NPLs were written off against injected capital) but also did so in the long run (after five years), suggesting that capital infusions made the banks' lending less risky (because less loans turned out to be non-performing ex-post). Using the data of banks in 15 OECD countries, Klomp (2013) finds that recapitalization into a bank reduces the CDS premium for it.

As Bayazitova and Shivdasani (2012) mention, most of TARP recipients applied for and received three percent of their risk weighted assets, the maximum under the program, so that each individual bank's capital needs were ignored when determining the amount of capital to be injected.

What is yet to be answered is whether the virtue of the design to infuse the needed amount of capital into each recipient bank is only to save the fiscal cost or if this type of design has some perceived desirable influence on banks' lending or risk-taking behavior. We make an attempt to address this unanswered question.

3. Institutional Background

The Deposit Insurance Corporation of Japan (DICJ) was established in July 1971. 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 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 one million yen per depositor per institution so that deposits in excess of one million yen were not covered by the insurance protection. In July 1986, the cap was finally raised to ten million yen, which shaped more or less the present system. In 1991, exactly two decades after the establishment of the DICJ, the insurance was paid out for the first time to the 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 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 for time deposits in principal plus accruing interests. This was a dramatic increase in the size of insured deposits. As of the end of May, 1996 -- immediately before the start of the blanket insurance for time deposits, which constituted roughly two thirds of total deposits, 57 percent of time deposits was in excess of 10 million yen in the amount of principal.[7]

As regulatory lead banks' "self assessments" of their assets at the end of fiscal year 1997 (March 1998) were expected to unveil large capital losses, the Japanese government

[7] The data's source is the Bank of Japan. The data on deposits by size are publicly available only for time deposits.

decided to inject a total of 1.8 trillion yen into 21 banks, 18 of which were "major banks" including city, trust and long-term credit banks (the 1998 public capital infusion program). All of the major banks but Nippon Trust Bank received public capital. Interestingly, eight city banks each received an almost identical amount, which was small relative to the size of the recipient banks and unrelated to their capital adequacy positions.[8] The amounts of injected capital under the 1998 program were not only far less than the amounts needed by participating banks, but also failed to reflect the capital needs of individual banks.

The failures of two major banks, the Long-Term Credit Bank of Japan and the Nippon Credit Bank in late 1998 lead to a full-fledged financial crisis. In response, the Government instigated a second round of public capital infusions in March 1999 (the 1999 public capital infusion program), at a total of 7.5 trillion yen, which was far larger than the 1998 program. Fourteen of 15 recipient banks were major banks. This time, however, not only was the scale of the program larger but also the amount injected into each city bank was negatively linked to its capital adequacy.[9]

The new regulatory action framework, the Prompt Corrective Action (PCA) was introduced in April, 1998, about two years after the start of blanket insurance.[10] Domestic banks that are not allowed to operate internationally were granted a one-year moratorium so

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[8] Seven city banks received 100 billion yen and the remaining bank, Daiichi Kangyo Bank, received 99 billion yen.

[9] For the list of public capital recipients under 1998 and 1999 programs and amounts of capital they received, see Allen et al. (2011).

[10] The FSA began its operation in June of 1998, two months after the PCA took in effect. So technically, during the first two months of the first half year of fiscal year 1998, the Ministry of Finance remained as a banking regulator. The organizational change from the MOF to the FSA is meant to move from the convoy system regulation where the regulators have considerable degree of discretion to the rule based regulations where the PCA was the primary regulatory framework. The two month lag should mostly likely reflect the annual job rotations at government ministries and agencies in Japan that take place in June or July after the end of the Parliament sessions. Our guess is that the MOF during these two months was the MOF in name only and acted in the spirit of the yet to be formally established FSA.

that they became subject to the PCA in March 1999.[11] For the first time in Japan, the PCA employed the Basel risk based capital adequacy criteria as a yardstick for regulatory action. Under the PCA, a bank that falls short of the regulatory minimum standard, faces progressively tougher regulatory actions as the shortfall in a bank's capital adequacy widens.[12]

In April 2002, the unlimited coverage was narrowed to only payable deposits that are non-interest bearing, payable on demand and providing settlement services, which effectively ended the blanket insurance protection.[13]

4. The Empirical Methodology

4.1. 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 (expected) payoff of the flat rate deposit insurance to an insured bank can be viewed as a put option on the bank's assets with a value of its insured liabilities as an exercise price. The value of the put obtained using the Black-Scholes formula, which represents the value of the insurance to an insured bank, is an increasing function of the bank's leverage and asset volatility (partial derivatives of the value of the put with respect to the leverage and the asset volatility are both positive).

In practice, we follow the empirical strategy of Duan et al. (1992), which is built on Merton's theory. They give the formula for the insurance premium per unit of deposits,

[11] International banks adhere to an eight percent minimum standard for the risk based capital adequacy ratio whereas domestic banks adhere to a more lenient standard of four percent.
[12] For the details of the PCA in Japan, see Allen et al. (2011).
[13] A JPY10 million deposit insurance cap on demand deposits was reinstated in 2005.

IPP, as follows.[14]

$$IPP = N\left(y + \sigma_V \sqrt{T}\right) - \frac{(1-\delta)^n V}{B} N(y) \qquad (1)$$

Where:

$$y \equiv \frac{\ln\left[\dfrac{B}{V(1-\delta)^n}\right] - \sigma_V^2 T/2}{\sigma_V \sqrt{T}}$$

B ≡ a bank's total liability

V ≡ the market value of a bank's assets

σ_V ≡ the instantaneous standard deviation of the return on V.

N(.) ≡ the cumulative standard normal distribution.

δ ≡ the dividends per monetary unit of assets.

n ≡ the number of times per period the dividend is paid.

T ≡ the maturity date of the deposit insurance contract

Following the literature (Ronn & Verma,1986; Giammarino et al., 1989; and Duan et al.,1992), we set T to be one year.[15] We assume that dividends are paid once each half-year period because under the Japanese commercial code, a company is allowed to pay

[14] See Appendix for the derivation of IPP.
[15] The real world counterpart to T is the length of the interval between the regulator's examination of a bank. The assumption made in the U.S. literature is justified by the FDIC's rule to examine healthy banks that are not small in total assets annually. As for bank examinations in Japan, "major" banks including city and trust banks are examined and graded annually whereas smaller banks are generally examined and graded less frequently under the Financial Institutions Examination and Grading System, which became effective in April 2007 after a three month testing period starting in January of that year. As for the publicly available frequency of bank examinations in years prior to the start of the System -- except for one year periods from July, 1999 to June, 2000, and from July, 2000 to June, 2001 when approximately half of the banks were examined -- almost all banks were examined every July - June one-year period. This implies that our assumption of T=1 is in line with the actual regulatory practices in Japan.

dividends to shareholders only once during a fiscal year other than at its closing. Thus, n in equation (1) is equal to one.[16]

The valuation of IPP requires estimating two unobservable variables, V and σ_V. Following the methodology of Duan et al. (1992), we obtain values for V and σ_V by solving the system of two non-linear equations with these two variables as unknowns that involve not only the above mentioned B and T but also the bank's shareholder value E and the instantaneous standard deviation of the return on a bank's shareholder value, σ_E.[17]

4.2. Empirical Methodology

We adopt the empirical methodology developed by Duan et al. (1992) and Hovakiman and Kane (2000), which are later employed by Hovakimian et al. (2003) and Wagster (2007, 2009). Thinking of IPP in equation (1) as a function of asset risk (σ_V) and leverage (B/V), we take a total derivative of IPP and approximate marginal changes in IPP and σ_V by discrete changes in the same variables observable in the data. Thus, we obtain the following formula for a discrete change in IPP.

$$\Delta IPP \cong \left[\frac{\partial IPP}{\partial \sigma_V}\right]\Delta\sigma_V + \left[\frac{\partial IPP}{\partial (B/V)}\frac{d(B/V)}{d\sigma_V}\right]\Delta\sigma_V \tag{2}$$

Denoting $\alpha_1 = \left[d(B/V)/d\sigma_V\right]$, equation (2) can be rewritten as follows:

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[16] 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.

[17] σ_E is calculated using the following formula.

$\sigma_E = \sqrt{252\,\mathrm{var}\left(\frac{S_t}{S_{t-1}}\right)}$, where S_t is the daily closing price of a bank's stock price at date t. We thank Ehud Ronn for clarifying this point.

$$\Delta IPP \cong \beta_1 \Delta\sigma_V \tag{3}$$

Where

$$\beta_1 \equiv \frac{\partial IPP}{\partial \sigma_V} + \frac{\partial IPP}{\partial (B/V)}\alpha_1 \tag{4}$$

The risk-shifting exists if β_1 is positive. This is because a positive β_1 means that a bank takes asset risk so as to increase the value of IPP. As discussed in the previous subsection, $\frac{\partial IPP}{\partial \sigma_V}$ and $\frac{\partial IPP}{\partial (B/V)}$ are both positive. If α_1 is negative, β_1 becomes smaller so that risk-shifting is restrained. In an extreme case, β_1 could be negative when α_1 is sufficiently negative.[18]

As Duan et al. (1992) and Hovakimian and Kane (2000) discuss, the major restraints could be regulatory pressures. The very spirit of the Basel risk based capital requirements is to request riskier banks to hold more capital and reduce leverage.

Our empirical strategy will be based on the above-mentioned analysis and equations. 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, 2009). The two equations are;

$$\Delta \frac{B_{it}}{V_{it}} = \alpha_0 + \alpha_1 \Delta\sigma_{Vit} + \varepsilon_{it} \tag{5}$$

$$\Delta IPP_{it} = \beta_0 + \beta_1 \Delta\sigma_{Vit} + \xi_{it} \tag{6}$$

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[18] This means that even though IPP is defined by equation (1), which implies a positive partial derivative of IPP with respect to σ_V by construction, a change in IPP is not necessarily positively associated with a change in σ_V in the actual data.

In equations (5) and (6), *i* represents the *i*'th bank and *t* represents financial statement reporting date. ε and ξ are error terms.[19]

We also consider the effects of public capital infusions on banks' risk-shifting because public capital is injected into banks that are poorly capitalized, which are likely inherently risky lenders, reducing their leverage. To this end, we modify equations (5) and (6) so as to make slope parameters α_1 and β_1 vary across different regulatory regimes and sensitive to different types of public capital infusions in different ways. More specifically, equations (5) and (6) become,

$$\Delta \frac{B_{it}}{V_{it}} = \alpha_0 + \left(\alpha_1 + \sum_{j=2}^{J} \alpha_j D_{jit} + \sum_{k \in K} \alpha_k PUBINJ_{ikt} \right) \Delta \sigma_{Vit} + \varepsilon_{it} \tag{7}$$

$$\Delta IPP_{jt} = \beta_0 + \left(\beta_1 + \sum_{j=2}^{J} \beta_j D_{ijt} + \sum_{k \in K} \beta_k PUBINJ_{kit} \right) \Delta \sigma_{Vijt} + \xi_{it} \tag{8}$$

In equations (7) and (8), *j*, *J*, *k* and *K* represent the *j*'th regulatory regime, the number of regimes, public capital infusions under program *k* and the set of different public capital infusion program types, respectively. We assume that the effects of public capital infusions of different designs to have differential effects on banks' risk-shifting. D_{ijt} is a dummy variable that indicates the *j*'th regulatory regime for bank *i* at date *t*. $PUBINJ_{kit}$ is a measure for public capital infusions under program type *k* for bank *i* at date *t*. In practice, we use the remaining balance of public capital under program *k* divided by the market value of total assets, V, as of date *t* as $PUBINJ_{kit}$, and the set of programs K consists

[19] As Jurado et al. (2013) discuss, the risk is countercyclical. This means that σ_V and V may be negatively associated so that the negative effect of regulatory pressures and the positive effect of the countercyclical risk may offset each other, which may result in an ambiguous sign of α_1. The sign of α_1 is ultimately an empirical question.

of the 1998 program as represented by k = 98, the 1999 program as represented by k = 99 and any other capital infusions as represented by k = other.[20] [21]

The coefficients of equations (7) and (9) are estimated using the seemingly unrelated regression (SUR) methodology where two equations for leverage and IPP are treated as a system and the error terms for the two equations are assumed correlated because of the fact that 1998 and 1999 capital infusions occur on the same calendar dates for all of the respective recipient banks in our sample, which may cause the cross-sectional correlation in the error terms, and may reduce the power of statistical tests.

4.3. Hypotheses to Be Tested

As it was briefly mentioned in Introduction, we attempt to test the following three hypotheses:

H1. The flat-premium based deposit insurance system in Japan incites banks to shift their risk to the Deposit Insurance Corporation of Japan. The blanket insurance accelerates banks toward risk-shifting.

H2. The PCA mitigates the risk-shifting induced by the deposit insurance.

H3. A public capital infusion affects a bank's risk-shifting behavior either negatively (mitigates a bank's risk-shifting) or positively (accelerates its risk-shifting) depending on whether it is implemented under the 1998 program where the amount of public capital is

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[20] Allen et al. (2011) used similar variables for public capital infusions. In their study, public capital infusions were grouped in two, those implemented under the 1998 program and al the others. In their study, a variable for each program type (infusions under the 1998 program or other infusions) is the amount of capital infusion divided by book based total assets. Our measure is the remaining balance over market based total assets, which we believe is an improved measure for the relative size of public capital on a bank's balance sheet, because it takes the dynamic effect of public capital infusions on a bank's risk-shifting into account.

[21] The balance of the public capital infused into a bank decreases when the government (the DICJ) sells a bank's shares back to the bank. We calculate the balance for each public capital recipient bank using the information about the DICJ's sales of the bank's shares reported on the DICJ's website.

independent of a bank's needs or it is implemented under the 1999 program where it is determined based on its needs.

5. Data and Empirical Results

5.1. Data

We need total liabilities and dividend payouts reported in the banks' financial statements and their daily stock prices of banks to compute V, the market value of bank assets, and σ_v, the instantaneous standard deviation of the return on V. The banks' financial statements were collected from the "Financial Statements of All Banks" published semi-annually by the Japanese Bankers' Association, "Financial Statements of All Mutual Banks" published by the National Mutual Bank Association and the Nikkei NEEDS databank.[22] The numbers for total liabilities at interim closings before September 1997 were hand collected from hard copy versions of the "Financial Statements of All Banks" and the "Financial Statements of All Mutual Banks".[23] As for the data on semiannual dividend payouts, we assume that for each fiscal year the payouts are split by half between two half-year periods because under the Japanese commercial code, a company is allowed to pay dividends to shareholders only once during a fiscal year other than at its closing. The data on daily stock prices and the number of shares at interim and fiscal closings, which are used to calculate E and σ_E, are extracted from the Nikkei NEEDS databank.

The banks included in our original sample are 123 banks that are listed in at least one

[22] 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 are contained in the "Financial Statements of All Mutual Banks" rather than in the "Financial Statements of All Banks".

[23] When necessary, the data are supplemented by financial statement reports, which are disclosure reports required by the law of listed firms. These are regarded as the Japanese counterparts to the U.S. SEC filings.

of Japan's four stock exchanges: the Tokyo Stock Exchange, the Osaka Stock Exchange, the Nagoya Stock Exchange and the Fukuoka Stock Exchange. Our semiannual sample is selected to cover the period from the second half of the 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, 2008) although the data needed to compute V, σ_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 a 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 during an entire half-year period.

Following Hovakimian et al. (2003), five banks that were in the sample no longer than three consecutive years were dropped, reducing the number of sample banks to 118. In addition, again following Hovakimian et al. (2003), observations below the first or above the ninety-ninth percentiles for at least one of the three estimated variables -- V, σ_v and IPP -- were dropped. This sample trimming allows us to neutralize the effects of extreme values. As a result, we are left with a total of 4018 bank-date observations for our baseline sample. 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 was the largest at 104 and cover 35.3 percent as of March 2006 when it was the smallest.[24] Our sample size for equations (7) and (8) with first differenced variables is further reduced to 3909.

[24] The share of our sample banks is very small as of March 2006 because most of the major banks were dropped from the sample as they became unlisted subsidiaries of listed holding companies and some of their data had been discontinued. In our empirical analyses, we will test using this base sample and the sample augmented by bank holding companies as well as the sample augmented by hypothetically consolidated banks.

5.2. Descriptive Statistics and Stylized Facts

Table 1 summarizes the descriptive statistics of the variables used in computing V, σ_V and IPP, computed V, σ_V and IPP as well as variables for measuring the remaining balance of public capital as a share of the market value of total assets, V, namely, $PUBINJ_{98}$ for the 1998 public capital infusion program, $PUBINJ_{99}$ for the 1999 program and $PUBINJ_{OTHER}$ for any other capital infusions.[25] The summary of our sample closely resembles that of the U.S. sample used in Hovakimian and Kane (2000), the only difference being banks in our sample are on average larger. Table 2 is a frequency table for sample banks with a positive balance of public capital for the 1998 and 1999 programs and for any other programs.

Figure 1 depicts aggregate trends of IPP and leverage, B/V. As a reference, the trends of the official deposit insurance premium rate set by the DICJ are also displayed. Both IPP and leverage are aggregated over the sample banks with V as a weight date by date.[26] The aggregate IPP has almost always greatly exceeded the DICJ's premium rate, suggesting that DICJ substantially subsidizes Japanese banks by its flat rate insurance. While leverage had been consistently on an upward trend until it peaked out at the second half of

[25] Since 1998 and 1999 programs were implemented at ends of FY 1997 (March, 1998) and FY 1998 (March, 1999), respectively, $PUBINJ_{98}$ and $PUBINJ_{99}$ are measured after all the stock market based data used to calculate IPP, the market value of a bank's assets, V, and a bank's asset volatility, σ_V for the second half of respective year are observed. We are examining whether public capital affects the bank's risk-taking behavior as illustrated by these stock market based variables. Thus, one may wonder if this timing of measurements results in the reverse causality from the bank's behavior to the policy. The government announced the 1998 program in December 1997 and the program was signed into law in February 1998. Thus, we cannot rule out the possible reverse causality regarding our test of the 1998 program. On the other hand, the 1999 program was signed into law in October 1998 and its details were finalized about two weeks before public capital was injected at the end of March 1999. Trends of stock prices of public capital recipients under the 1999 program are universally upward from the beginning of the half-year period in October, 1998. Thus, as for the 1999 program, the reverse causality is of little concern.

[26] The two variables are drawn only until the first half of fiscal year 2000 because it was up until this date that all the major 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.

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 at a rate of one percent of the amount of deposits, stands more than six times as high as the value at the previous date and more than ten times as high as the DICJ's premium.

Apparently, Japan entered a serious financial crisis at the second half of fiscal year 1997 as both aggregate leverage and IPP reached their respective peaks.[27] Essentially, IPP is a cover of the amount of loss incurred by a bank that would be borne by a depositor without 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, a sharp increase in Japanese banks' borrowing rates in international credit markets, emerged (Peek & Rosengren, 2001). As Figure 2 shows, the Japan premium and IPP keep track each other remarkably well. This fact lends support to the credibility of our method for computing IPP.[28]

5.3. Empirical Results

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

[28] A credit default swap (CDS) is another publicly traded instrument that insures against a firm's default. The data about reference rates of CDS are publicly available through the Tokyo Financial Exchange. The historical data of CDS rates are available from late March, 2004. We calculated the correlation coefficient of IPP of Sumitomo Mitsui Financial Group, a bank holding company (BHC) of Sumitomo Mitsui Bank and the CDS rate for Sumitomo Mitsui Bank over the period from FY 2004 to FY 2010. The period was extended to include more recent dates to increase the sample size. We do not think extending our sample period for our regressions in the same manner as this would include the period of the global financial crisis when stock prices of Japanese banks as well as their CDS rates were exogenously influenced by the volatile financial markets although they were least exposed to financial instruments that incited the crisis and these market based prices were less likely to correctly imply banks' secular risk-taking. We chose Mitsui Sumitomo Bank because CDS rates for only three banks are available and two other banks are ones of multiple commercial banks held by their BHCs whereas Mitsui Sumitomo is its BHC's sole commercial bank. The correlation coefficient is 0.931, which is another proof in favor of our calculations.

Preliminary results

Table 3 presents the regression results for leverage B/V and for the actuarially fair insurance premium IPP. Columns 1 and 2 report the results of the regressions without the three cross products between regulatory regime dummies and σ_V as independent variables, whereas columns 3 and 4 report the results of the regressions with these cross products. For each pair of columns for the same SUR estimation, the first column reports the results for the leverage equation, whereas the second reports the results for the IPP equation.

As for a choice of three regimes, we loosely follow Duan et al. (1992) and Hovakimian and Kane (2000) who employ dummy variables to indicate tougher regulatory regimes based on capital requirements and Wagster (2007) who employs a dummy variable to indicate a regime with an explicit deposit insurance (a regime with enhanced deposit protection).[29] The three regime dummies are: 1) a dummy variable for the period of blanket insurance without the PCA (D_2); 2) a dummy variable for the blanket insurance with the PCA (D_3); and, 3) a dummy variable for the post blanket insurance period (D_4). The descriptions of these regime dummies are summarized in Table A. One advantage to using the Japanese data is that the PCA was applied to international banks one year earlier (in April, 1998) than it was for domestic banks so that we are able to identify the (pure) effect of transforming the deposit insurance from limited to unlimited insurance (without the PCA's effect) and the PCA's effect on disciplining the fully insured banks from any aggregate effect.[30] [31] Based on H1 and H2, we predict that the coefficients of the cross

[29] Using data of banks in the United States, Duan et al. (1992) employ a dummy variable to indicate a regime with numerical guidelines for capital requirements, whereas using the more recent data from the same country, Hovakimian and Kane (2000) create dummy variables based on the same regime with numerical guidelines and another regime after the PCA took in effect. Using the data of Canadian banks, Wagster (2007) employs a dummy variable to indicate the period after the deposit insurance system was established.

[30] The regulatory regime for the blanket insurance without the PCA ended at the second half of fiscal year 1997 and at the second half of fiscal year 1998 for international banks and domestic banks,

products with D_2, D_3 and D_4 are positive, negative and negative, respectively.

A negative and weakly statistically significant coefficient of σ_V in column 1 and a positive and significant coefficient of σ_V in column 2 of Table 3 show that, under the flat rate based deposit insurance system, although banks were engaged in substantial risk-shifting, those with riskier assets did deleverage to some extent. The sums of the coefficient of $\Delta\sigma_V$ and the cross product of a dummy variable to indicate a regulatory regime in column 4 are all positive and statistically significant, suggesting that under any regulatory regime, insured banks are engaged in some degree of risk-shifting.

A negative and significant coefficient of a cross product between $\Delta\sigma_V$ and D_3 in columns 3 and 4 show that the PCA disciplined riskier banks not to seek greater leverage, which may have had some effect in mitigating insured banks' moral hazard incentives. Indeed, the coefficients of the cross product of $\Delta\sigma_V$ and D_3 are statistically significantly smaller than the coefficients of the cross product of $\Delta\sigma_V$ and D_2 for both leverage and IPP regressions as reported at the bottom of the table (α_3-α_2 and β_3-β_2 are both negative and significant), suggesting that the PCA had a strong disciplinary effect on restraining the fully insured banks' risk-shifting.[32] [33]

A positive and significant coefficient of the cross product between $\Delta\sigma_V$ and D_2, implies that fully insured banks that are yet to be subject to the PCA accelerated risk-shifting.

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respectively. Likewise, the regulatory regime for the blanket insurance with the PCA began at the first half of fiscal year 1998 and at the first half of fiscal year 1999, respectively.

[31] Forty-two out of 103 banks were international banks as of the second half of fiscal year 1997.

[32] 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.

[33] We also find that β_4-β_3 is positive and statistically insignificant, suggesting that the end of the blanket insurance actually encouraged banks' risk-shifting (for brevity, results are not reported).

The effects of public capital infusions on banks' risk-shifting

Table 4 presents the results of the regressions with cross products with PUBINJs as independent variables.[34] The coefficients of the cross product with $PUBINJ_{99}$ are negative and statistically significant for both leverage and IPP equations, whereas the coefficient of the cross product with $PUBINJ_{98}$ is positive and significant for the IPP equation. These findings show that, while the 1999 public capital program was effective not only in reducing leverage of riskier banks but also in restraining banks' risk-shifting, the 1998 program was unsuccessful not only in reducing leverage of riskier banks and mitigating the banks' risk-shifting but rather it actually accelerated banks' risk-shifting. The recent literature on the efficacy of TARP public capital presents the evidence that banks, which received TARP capital, made riskier loans (Duchin & Sosyura, 2010, Black & Hazelwood, 2013). It so happens that the design of TARP is similar to that of the 1998 program in that the amount of injected capital was independent of each recipient's capital needs and that the TARP program may have driven risky banks into more risk-taking because of its risk insensitive design.[35]

The failure of the 1998 public capital program and the success of the 1999 program may be attributable to sharp differences in their designs. As mentioned earlier, under the

[34] None of the infusions that occurred at any time other than March 1998 and March 1999 preceded the 1999 program. When capital infusions were grouped into two, namely those under the 1998 program and others, as done in Allen et al. (2011), the results found are largely consistent with the results reported in subsequent tables. When $PUBINJ_{99}$ is dropped, the results are virtually unchanged for remaining coefficients. Distinguishing three types of infusions as we do allows us not only to exemplify 1998 and 1999 programs as policies targeting major banks at the peak of the system wide crisis but also to take into account of the different designs of the two programs. For a complete list of banks that received public capital, see Allen et al. (2011).

[35] Note that most banks received a fixed proportion of their risk assets so that the amount of injected capital reflected the recipient's risk provided that its risk assets accurately measured its risk. We do not believe that the recipient banks' risk assets correctly measured their risk-taking because it was the regulatory arbitrage to make loans and engage in transactions that cost them less risk charges than would actual risks, such as subprime mortgages and off balance transactions, more heavily, which lead to the financial crisis.

1999 program, the amount of public capital injected into each recipient bank was determined on its needs. That is, the more poorly capitalized a bank was, the more public capital the government granted to it. During the crisis period, relatively poorly capitalized banks, which were more likely to experience a larger increase in their asset risk, received a larger public capital (relative to their size) and reduced their leverage more greatly than relatively adequately capitalized banks did. Therefore, the 1999 program had the effect of strengthening the negative association between bank risk and leverage, which further moderated the positive relationship between bank risk and IPP. Under the 1998 program, on the other hand, the amount of public capital injected into each bank was not determined in accordance with its need for capital so that pre-recapitalization level of leverage (capital adequacy) was not positively (negatively) associated with the size of public capital (relative to the size of assets).[36] As far as its effect on reducing the banks' moral hazard incentives is concerned, the design to efficiently allocate public capital by infusing more capital into poorly capitalized banks than into relatively well capitalized banks was important.[37] [38]

[36] The correlation coefficients between the leverage immediately before the date of public recapitalization and the amount of public capital received relative to V as of the date of recapitalization are -0.163 and 0.272 for 1998 and 1999 programs, respectively. Likewise, as of the date of public recapitalization, the correlation coefficients between a change in σ_V and the amount of public capital received relative to V are 0.300 and 0.555 for 1998 and the 1999 programs, respectively. These facts support our interpretations of the results in favor of the 1999 program over the 1998 program.

[37] We also find that the effect of the 1999 program on reducing a bank's risk-shifting had an effect beyond the date of capital infusion. When the regressions are run on the sample that excludes observations for the second half of fiscal year 1998 (the period of the 1999 program's execution) the negative coefficient of the cross product of σ_V and $PUBINJ_{99}$ remains significant for both leverage and IPP regressions though the magnitude of the estimated coefficient for the IPP regression is substantially smaller than the estimated coefficient reported in Table 4 and significant only at the ten percent significance level (results are not reported). This is because banks were requested by the regulator to submit a Management Strengthening Plan and had to periodically report to what extent they had fulfilled the conditions of the submitted plan. Under the 1999 program, the law allowed the regulator to take formal actions when the bank's execution of the plan was insufficient. Under the 1998 program, there was no legal framework to allow the regulator to take such actions, which may have contributed to the differential policy effects of 1998 and 1999 programs.

[38] 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 σ_V in leverage and IPP regressions between banks that were enforced the PCA and those that were not. Regarding our

The positive coefficient of the cross product of $\Delta\sigma_V$ and $PUBINJ_{98}$ in the IPP equation may imply that the 1998 program drove banks into lending to wrong borrowers, thereby, contributing to their accelerated moral hazard. These coefficients may, however, simply indicate that, as discussed in the literature (Peek & Rosengren, 2005; Caballero et al., 2008; Watanabe, 2010), banks that had received public capital under the 1998 program were relatively poorly capitalized and had already engaged in misallocation of credits rather than the received capital enabled them to misallocate credits. Either way, these results show that the 1998 program did not help the banks to discipline themselves.

Alternatively, in light of the discussion by Montgomery and Shimizutani (2009), the banks who applied for the same small amount of capital under the 1998 program had outed themselves to the market as being capital deficient hence experiencing an increase in risk. However, the reduction in risk attributable to the second infusion program was probably because most of the banks were the same as those receiving capital under the 1998 program. After outing themselves in 1998 as being capital deficient in return for a very small capital injection, receiving a larger capital injection was well received by the market.

As for coefficients of the other independent variables, the results remain qualitatively the same as those from Table 3 where the results of regressions without public capital

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sample, Hokkaido Bank (from May, 1999), Tokyo Sowa Bank (May, 1999), Senshu Bank (September, 1999), Chiba Kyogyo Bank (April, 2000), Fukushima Bank (December, 2001) and Howa Bank (April, 2006) were enforced the PCA. We assume that the FSA continued to enforce the PCA on the Hanwa Bank for one year and that it continued to enforce the PCA on all the other banks for three years, because it is in December 2002 that the FSA shortened the time for the improvement of capital adequacy in enforced banks from three years in principle to one year in principle. We added the cross product of σ_V and a dummy variable to indicate that a bank was under the PCA enforcement to the regressions whose results are reported in Table 4. The coefficients of this added cross product for leverage and IPP regressions are both positive and statistically significant. We decided not to report the results because the results by themselves suggest that enforced banks accelerated risk-shifting, which is puzzling. One explanation to this finding is that the fact that banks became subject to the regulatory intervention were perceived as an evidence that they were financially unhealthier than those that did not so that prices of these banks' stocks became very volatile when the PCA was enforced. For example, Tokyo Sowa Bank failed shortly after it was enforced the PCA so that the price of its stocks dropped to the lowest possible value (1 yen or 2 yen) very rapidly.

variables as independent variables are reported.

Testing the disciplinary effect of the franchise value

In his seminal study, Keeley (1990) presents evidence that not only prudential regulations -- such as the capital requirements -- discipline banks but also their willingness to retain their franchise (charter) value disincentivizes them from increasing their risks and shifting them to the deposit insurer.[39] This is because a bank's franchise value is retained as long as it stays in business. Therefore, although the value of the deposit insurance payoff itself increases to the extent of an insured bank's risk-taking, the true value of the deposit insurance to the bank may not necessarily increase with greater risk-taking, because the bank takes into account not only the values of the insurance payoff but also the cost of losing the franchise value at the time of the bank's failure.

One may suspect that our results about prudential policy measures are spurious and that it is the franchise value that drives our results. In order to allay this suspicion, we augment regression equations for leverage and IPP by adding the cross product of the measure for the franchise value and $\Delta\sigma_V$. Following Keeley (1990), we use the sum of the book value of a bank's liabilities, B, and its shareholders' value, E, divided by the book value of its total assets -- a so-called Tobin's q -- as a measure for the franchise value.[40] Table 5 demonstrates the results. As it turns out, the effect of the cross product with respect to the franchise value on both leverage and IPP are negative and significant, while

[39] For the extensive discussion of the literature, both theoretical and empirical, see Jimenez et al. (2013). Demsetz et al. (1996) define the franchise value as the present value of future profits that a firm (bank) is expected to earn as a going concern. Demsetz et al. further discuss that the franchise value stems from either less competitive lending environments a bank is operating in or the factors unique to the bank such as the branch network and the bank's informational advantage over other lenders as a relationship lender.

[40] Demsetz et al. (1996) show that a bank's Tobin's q is mathematically equivalent to its franchise value as measured by the bank's market value less its replacement cost, which is divided by the book value of its assets if the bank's market value is proxied by the sum of a bank's shareholders' value, E, and its liabilities.

the results on regulatory regimes and public capital infusion programs remain qualitatively unaltered.[41]

Examining the effects of delisted banks

Recall that our data lack recent observations on the banks whose business structure was reorganized into the bank holding company system when operating banks became subsidiaries of newly established holding companies and the parent companies' shares were publicly traded while shares of the banks themselves had halted trading. Our main results regard the effects of public capital infusions on the banks' risk-shifting. Because most of banks that participated either in the 1998 program or the 1999 program had exited the sample when they were delisted, we are unable to observe the recent behaviors of such banks.[42] Because most recipient banks under 1998 and 1999 programs disappeared from the sample by the second half of FY 2000, the data on the banks after they received public capital existed only for a few years and about seven years of the most recent data are missing. This may cause a serious sample selection bias, especially if risk-taking behaviors of publicly recapitalized banks have recently changed.

To resolve our concerns, we elaborate in order to reconstruct missing observations. In practice, we added the parent bank holding companies of those banks with recent

[41] As for Japanese banks, Konishi and Yasuda (2004) and Gan (2007) examine banks' risk-taking (lending) behavior using the same q as ours as the measure for the franchise value. Konishi and Yasuda (2004) find that the relationship between q and the bank risk is either negative or positive depending on the measure for the bank risk. Finding that q does not have a statistically significant effect on bank lending, Gan (2007) argues that q is not only an indicator of a bank's franchise value having a negative effect on a bank's risk-taking but also an indicator of a bank's future investment opportunity having a positive effect on risk-taking and concludes that these two opposing effects offset each other.

[42] As for 21 recipient banks under the 1998 program, only two banks can be observed until the end of the sample period. Among the remaining 19 banks, 17 banks became subsidiaries of their holding companies and thus disappeared from the sample. As for 15 recipient banks under the 1999 program, only one bank continues to be observable until the end of the sample period.

missing observations to the base sample and reexamined the results.[43] [44] Table 6 shows the regression results that replicate Table 4 using the data augmented by those on bank holding companies. The results found in Table 4 remain almost unchanged except that the coefficient of the cross product of $\Delta\sigma_V$ and $PUBINJ_{98}$ in the IPP equation is now insignificant.

One may be skeptical about the results reported in Table 6 as bank holding companies are treated as new entities, losing continuity between the banks before and after the formation of the holding companies. Thus, we construct a sample of banks that is consistent throughout the sample period by using the data for hypothetical bank holding companies before their formations and hypothetically consolidated banks before their consolidations. Balance sheet based variables are easy to consolidate as we simply sum up values for them across merging banks (subsidiary banks under holding companies).[45]

Constructing the data of stock prices of hypothetical consolidated banks (bank holding companies) is a little more challenging. When consolidating prices of stocks of merging banks before a merger, we divide the sum of shareholders' values of merging banks by the number of shares that a hypothetical bank would have issued. In doing so, we convert the pre-merger number of shares of each merging bank into the number of shares of a continuing entity (a bank or a bank holding company) after a merger using the share exchange ratio. For instance, if shareholders' values of an acquirer (a continuing bank) and the acquired bank are E_1 and E_2, before a merger respectively, the numbers of shares of

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[43] We treat these parent bank holding companies not as direct successors of the disappearing banks but as new entities different from their corresponding banks because the earlier data on an operating bank and the recent data on its parent are not consistent.

[44] As we did for listed banks, we added 10 listed bank holding companies that had or have been listed at least for three consecutive years. Only one bank holding company, Ashigin Holding, which had been listed for less than three consecutive years, has been dropped from the sample.

[45] One bank, Ashikaga Bank, did not consolidate with any other bank but was reorganized into a subsidiary of Ashigin Holdings.

these two banks are N_1 and N_2, respectively, and the share exchange ratio is e:1 so that 1 share of an acquired bank is exchanged with e shares of an acquirer. Then, a hypothetical stock price before a merger can be calculated by the following formula:

$$S = \frac{E_1 + E_2}{N_1 + eN_2}$$

Table 7 reports the results for the sample of banks including hypothetically consolidated banks constructed as above.[46] The results are qualitatively the same as the results reported Table 4.[47]

<u>Testing another source of regulatory discipline: Takenaka's Financial Revival Program</u>

There may have been other sources of regulatory discipline during our sample period. One of the most famous potential sources is the Financial Revival Program. In October, 2002, the Minister for Financial Services, Heizo Takenaka, took a leadership role in implementing the Financial Revival Program, which required major banks, including city, trust, and long-term credit banks, to halve their ratio of non-performing loans to total loans by the end of fiscal year 2004 (March, 2005). The Program successfully concluded by reaching its aims.

Table 8 reports the results of the regressions with a cross product of $\Delta\sigma_V$ and $D_{takenaka}$,

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[46] For this sample, in principle, we dropped a hypothetical bank from the sample if data of its stocks are unavailable for merging banks. Mitsui Sumitomo Financial Group and Resona Bank are kept in the sample although the stock data of small regional 2 banks that consolidated into bank holding companies are unavailable (Wakashio Bank for Mitsui Sumitomo Financial Group and Nara Bank for Resona Bank). We used the balance sheet data of Resona Bank rather than those of its holding company, Resona Holdings, which is listed, because Resona Holdings consolidates both Resona Bank and Resona Trust Bank.

[47] The insignificant coefficient of the cross product of $\Delta\sigma_V$ and $PUBINJ_{98}$ is now negative. Another minor change is that the estimated coefficient of the cross product of $\Delta\sigma_V$ and D_3 is not significantly smaller than that of the cross product of $\Delta\sigma_V$ and D_2.

a dummy variable to indicate that a bank is subject to the Financial Revival Program (a major bank during the period of the Program's implementation). We use the sample of banks including hypothetically consolidated banks found in the regressions whose results are reported in Table 7, because the Program was implemented after the consolidation wave of major banks, most of which had received public capital. Looking at the IPP regression results reported in column 2, the coefficient of this added cross product is negative and significant, suggesting some disciplinary effect of the Program. Our result that the 1999 program was effective in mitigating banks' risk-shifting remains robust.[48]

Additional robustness tests

We conducted a number of additional regressions to confirm our findings, particularly the 1999 public capital program's effect to restrain banks' risk-shifting, whose results will not be reported for reasons of brevity.

First, we run the same regressions using the shorter sample period beginning in the second half of 1991. We omitted the period until the first half of 1991 because the IPP is relatively low for the period before that time. We suspect that the low IPP results from the fact that banks' stock prices were steady (kept rising with little volatility) during the bubble period of the late 1980s, which lead to low values of the deposit insurance to banks. As Jimenez et al. (2006) discuss, it is during the boom time that banks engage in risky lending by loosening lending standards. It may be misleading to view the bubble era as a period of little risk-taking. The effect of the 1999 public capital program estimated using the shorter sample period remains the same after dropping bank-year observations of the

[48] We also ran the regressions including the cross product of $\Delta\sigma_V$ and $D_{takenaka}$ as an independent variable using the sample including bank holding companies as separate entities used in Table 6 and found the results consistent with the results reported in Table 8. The results are consistent with those reported in Table 8 except that the effect of the 1998 program is positive and significant (results are not reported).

bubble period.

Second, we modified PUBINJs so that they take a positive value only at the date of infusion and zeros at all other dates. Remember that the strong risk-shifting restraining effect of the 1999 program lies in its design to replenish more capital for more capital depleted banks. Publicly recapitalized banks restored their capital immediately after receiving public capital so that the effect of the 1999 program itself emerges right at the time of capital infusion. The results of the regressions with modified PUBINJs remain qualitatively unaltered. As we discussed in footnote 37 the tougher regulatory stance against recapitalized banks under the 1999 program than those under the 1998 program may explain partially the presence of the effect to mitigate banks' risk shifting under the former program and its absence under the latter program. This finding, however, shows that the regulatory stance is not the sole reason for the differential effectiveness in mitigating banks' risk shifting between the two programs because the regulator's tougher discipline began as a follow up policy after the capital infusion had been implemented. The presence of the contemporaneous effect to mitigate risk-shifting is the evidence that a decrease in leverage caused by public capital itself has a strong effect of mitigating banks' risk-shifting.

Third, we included the cross product of σ_V and the dummy variable to indicate the second half of fiscal year 1998 (the date at which the 1999 program was executed) so as to check whether the negative and significant coefficient of $\Delta\sigma_V$ and $PUBINJ_{99}$ captures the unobservable shock affecting all banks' risk-taking that coincides the 1999 program. The 1999 program results remain intact though its point estimates are smaller in magnitude. The coefficients of an added cross product are negative and statistically significant, suggesting that the bank's risk-shifting is universally curbed .[49]

Fourth, we used the lagged $PUBINJ_{98}$ rather than the contemporaneous $PUBINJ_{98}$ as a variable to interact with σ_V in order to confirm that the possible reverse causality due to timing of the policy announcement of the 1998 program discussed in footnote 25 is of little concern. The results that an insignificant coefficient of the cross product with $PUBINJ_{98}$ and a negative and significant coefficient of the cross product with $PUBINJ_{99}$ for the IPP equation remain unchanged.

Fifth, when we add the cross product of the ratio of bank capital to total assets, as a measure for a bank's financial health, and σ_V, the results remain unaltered. This suggests that our finding is not solely caused by the positive association between IPP and PUBINJs that could be both proxies for a bank's financial health.

Sixth, when PUBINJs in isolation as independent variables are added, their coefficients are statistically insignificant and our findings remain unaltered, confirming that the effects of the cross products with PUBINJs do not simply capture the independent effects of PUBINJs on IPP per se.

Finally, when time fixed effects are added, our results remain unchanged, implying that the results are not caused by regulatory changes and/or (negative) events that coincided with capital infusions such as the Asian crisis and the Russian default.[50]

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[49] We thank Masami Imai for suggesting these additional robustness tests.

[50] One wonders whether the flat-rate deposit insurance induced banks to take risks in an economically significant manner. In order to show that banks indeed took excessive levels of risk, we present the results using alternative market and accounting risk measures. More specifically, we run the regressions of the ratio of non-performing loans to total assets and z-score as conventionally used bank-specific risk measures and CoVaR as a systemic risk measure and run the regressions on regulatory regime dummies, D_2 through D_4 and $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINB_{other}$ directly without interacting with any variable (results are not reported). We find, a) the blanket insurance reduced a bank's managerial stability as measured by a z-score but decreased a systemic risk as measured by a bank's

6. Conclusion

In this paper, using the data of Japanese banks that became subject to three policy measures in response to the financial crisis of the late 1990s: the blanket deposit insurance, the Prompt Corrective Action (PCA) framework and public capital infusions, we examined whether banks under the fixed (flat) premium based deposit insurance system engaged in moral hazard: excessive risk-taking by shifting their asset risk to the deposit insurer. Using the option pricing based model for valuing the deposit insurance, we examined whether banks took risks so as to increase the value of the insurance for themselves.

The deposit insurance system in Japan does induce banks' moral hazard irrespective of its coverage limit. The PCA was effective in restraining risk-shifting by insured banks under the blanket (full) insurance. Most importantly, it was the large scale public capital infusion program of March 1999, which was executed when deposits were fully insured, that mitigated the banks' risk-shifting because this program was designed such that the more poorly capitalized a bank was, the larger amount of public capital the bank received.

These findings suggest that moral hazard incentives that are induced by publicly run deposit insurance can be mitigated by well-designed public capital infusions. In the context of the more recent global financial crisis, unlike in the case of the Japanese financial crisis of the late 1990s, the expansion of the deposit insurance cap in major countries was not only legally explicit but also real, which implies that banks may have been engaged in accelerated risk-shifting under the enhanced deposit protection.

The world has recently experienced a financial crisis of unprecedented magnitude. In

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CoVaR, b) the PCA mitigated the effect of the blanket insurance to decrease the z-score c) the PCA is associated with the greater NPLs presumably because a bank is required to realize more NPLs under the PCA.

response, large amounts of public capital were injected into the distressed banking system. In October 2008, just one month after the Lehman Brothers' demise, eight of the largest financial institutions in the United States were bailed out by public capital infusions under the Capital Purchase Program of the Troubled Asset Purchase Program (TARP). According to various newspaper reports, large-scale capital infusions took place in major European countries during the same month, too.

Another immediate response by the regulators was to expand the government's protection of deposits. The Federal Deposit Insurance Corporation of the United States raised the deposit insurance cap from 100 thousand dollars to 250 thousand dollars per depositor per institution. The Financial Stability Board's "Exit from extraordinary financial sector support measures" published in November 2010 reported that 46 jurisdictions adopted some form of enhanced deposit protection such as the increased insurance cap and the establishment of the deposit insurance system per se, the bulk of which was concentrated during three months from September, 2008.

International discussions promoting tougher regulations, on the other hand, lead to the fundamental reforms of current capital requirements. In September 2010, the Basel Committee for Banking Supervision (BCBS) published the draft of the Basel III, which substantially tightens capital requirements.

As Hoshi and Kashyap (2010) discuss, we can draw parallels to policy measures employed in Japan in response to the financial crisis of the late 1990s.

Our findings also suggest that the TARP public capital infusion program which is designed not to reflect a recipient's capital adequacy on the amount of public capital it received may not have mitigated the moral hazard of banks whose deposits were covered by the expanded insurance.

Appendix: The Derivation of the IPP

In this Appendix, we derive the IPP following the model of Duan et al. (1992).

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 a 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.

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

Where

FV(.): 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. This is the value of the deposit insurance to the bank.

$$\max\left\{0, FV(B_1) - \frac{V_T B_1}{B_1 + B_2}\right\} \qquad (2)$$

Following Merton (1977), the present value of the insurance payment expressed by equation (2), IP, is,[51]

[51] 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.

$$IP = B_1 N\left(y + \sigma_V \sqrt{T}\right) - \frac{(1-\delta)^n V B_1}{B} N(y) \qquad (3)$$

Where

$$y \equiv \frac{\ln\left[\frac{B}{V(1-\delta)^n}\right] - \sigma_V^2 T/2}{\sigma_V \sqrt{T}}$$

$B \equiv B_1 + B_2$

$\sigma_V \equiv$ the instantaneous standard deviation of the return on V.

N(.) ≡ the cumulative standard normal distribution.

$\delta \equiv$ the dividends per monetary unit of assets.

n ≡ the number of times per period the dividend is paid.

Scaling down both sides of the equation (3) by B_1, the premium *per unit of* insured deposits, IPP, can be expressed as follows:

$$IPP = N\left(y + \sigma_V \sqrt{T}\right) - \frac{(1-\delta)^n V}{B} N(y)$$

When computing V and σ_V, we follow Ronn and Verma (1986), Giammarino et al. (1989) and Duan et al. (1992), and use the following system of equations:

$\boldsymbol{E = VN(x) - \rho BN\left(x - \sigma_V \sqrt{T}\right)}$ and

$$\sigma_E = \frac{VN(x)}{E}\sigma_V, \text{ where } \quad x \equiv \frac{\ln\left(\frac{V}{\rho B}\right) + \sigma_V^2 T/2}{\sigma_V \sqrt{T}}.$$

The first equation is based on the discussion of Black and Scholes (1973) in which the value of the equity of a firm (bank) is 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. The second equation is derived by using the Ito's lemma.

Note, we assume that the deposit insurer will declare a bank bankrupt when the value of the bank's assets falls below ρB rather than immediately after it is undercapitalized. The parameter ρ reflects what Ronn and Verma (1986) refer to as the *bail-out effect*; an insurer does not liquidate a bank immediately when its net worth (V-B) turns negative. Following the abovementioned studies, we set ρ to be 0.97.

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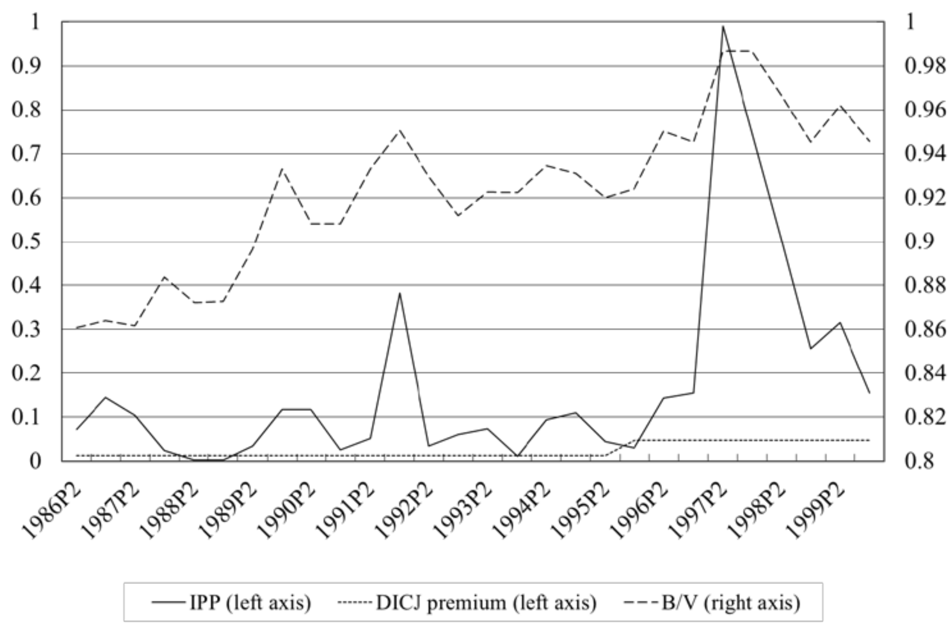
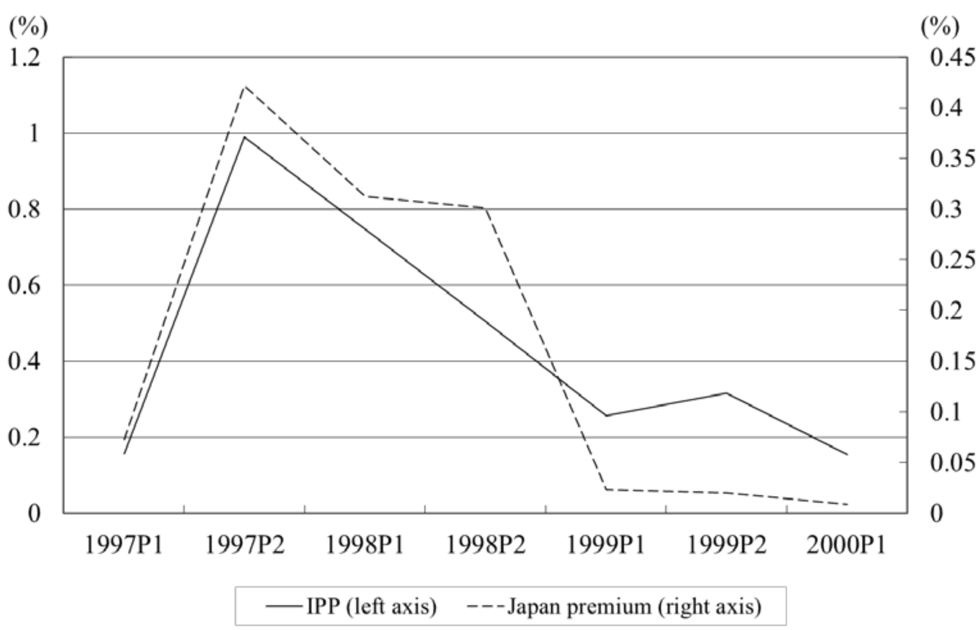
Figure 1. Trends of IPP, the DICJ's Premium Rate and B/V



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

Figure 2. The Japan Premium and aggregate IPP



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

Table 1. Descriptive Statistics

	N	mean	median	standard deviation	min	max
Total liabilities, B (100 million yen)	4018	60,644	23,616	113,486	1,942	988,861
Market value of equity, E (100 million yen)	4018	5,487	1,410	12,958	85	113,178
Annualized standard deviation of rate of return on equity, σ_E (%)	4018	32.4	30.3	13.2	5.0	104.5
Annualized standard deviation of rate of return on assets, σ_V (%)	4018	2.15	1.72	1.44	0.2	11.24
Market value of assets, V (100 million yen)	4018	64,309	24,479	121,970	1,969	1,005,734
Leverage ratio, B/V (%)	4018	96.4	97.1	3.2	82.5	101.6
IPP	4018	0.1548	0.0463	0.2772	0.0000	2.9029
Public capital infused in March 1998 as a share of V, $PUBINJ_{98}$ (%)	4018	0.0223	0	0.1557	0	2.5419
Public capital infused in March 1999 as a share of V, $PUBINJ_{99}$ (%)	4018	0.0393	0	0.2913	0	4.5378
Public capital infused at time any other than in March 1998 and in March 1999 as a share of V, $PUBINJ_{OTHER}$ (%)	4018	0.0562	0	0.3583	0	3.5932

Table 2. Frequency Table for the Number of Banks That Received Public Capital Injections in Each Half-Fiscal-Year Period

	- 1997P1	1997P2	1998P1	1998P2	1999P1	1999P2	2000P1	2000P2	2001P1	2001P2	2002P1
A positive balance of public capital for the 1998 program	0	15	18	20	17	18	16	13	8	7	6
A positive balance of public capital for the 1999 program	0	0	0	15	14	15	13	10	5	4	3
A positive balance of public capital for any other programs	0	0	0	0	4	5	6	7	9	10	8
N	2061	98	104	105	98	100	100	97	90	86	82

	2002P2	2003P1	2003P2	2004P1	2004P2	2005P1	2005P2	2006P1	2006P2	2007P1	2007P2	Total
A positive balance of public capital for the 1998 program	4	2	0	1	1	1	0	1	1	2	2	153
A positive balance of public capital for the 1999 program	3	2	1	0	0	0	0	0	0	0	0	85
A positive balance of public capital for any other programs	7	7	6	7	5	5	4	5	5	5	5	110
N	83	82	81	82	80	80	79	79	80	81	81	3909

The 1998 and 1999 programs are public capital infusion programs in March 1998 and in March 1999, respectively.

Table 3. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes

	(1) The leverage equation			(2) The IPP equation			(3) The leverage equation			(4) The IPP equation		
	coefficient	standard error		coefficient	standard error		coefficient	standard error		coefficient	standard error	
constant	0.0013	0.0002	***	0.0000	0.0001		0.0013	0.0002	***	0.0000	0.0001	***
$\Delta\sigma_V$	-0.1872	0.0173	***	0.0244	0.0043	***	-0.1161	0.0197	***	0.2598	0.0049	***
$\Delta\sigma_V D_2$							0.1817	0.0718	**	0.0641	0.0179	***
$\Delta\sigma_V D_3$							-0.4780	0.0555	***	-0.1316	0.0138	***
$\Delta\sigma_V D_4$							-0.3607	0.0610	***	-0.0647	0.0152	***
	3909						3909					
R-squared	0.0292			0.4515			0.0565			0.4684		
Breusch-Pagan statistic	1327.044(0.0000)						1272.868(0.0000)					
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$							0.0656	0.0690		0.3239	0.0172	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$							-0.5941	0.0519	***	0.1282	0.0129	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$							-0.4768	0.0577	***	0.1951	0.0144	***
$\alpha_3-\alpha_2$ / $\beta_3-\beta_2$							-0.6597	0.0864	***	-0.1957	0.0215	***

The coefficients are estimated using the seemingly unrelated regression methodology where two equations for leverage and IPP are treated as a system and the error terms for the two equations are assumed correlated. Columns 1 and 2 and columns 3 and 4 report the results for the regressions with the cross products between $\Delta\sigma_V$ and dummy variables and those without, respectively, where, for each pair of columns, the first reports the results for the leverage equation and the second reports the results for the IPP equation. 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. α_1 and β_1 are the coefficients of $\Delta\sigma_V$ under regime 1 for the leverage equation and and for the IPP equation, respectively, where regime 1 is the period from the second half of fiscal year 1986, the beginning of our sample period, through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. α_i and β_i for i = 2, 3 or 4 are the coefficients of the cross products between $\Delta\sigma_V$ and D_i, for the leverage equation and the IPP equation, respectively. Thus, $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i* for the leverage equation and the IPP equation, respectively. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. The number inside the parenthesis beside the Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table 4. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes

	(1) The leverage equation coefficient	(1) standard error		(2) The IPP equation coefficient	(2) standard error	
constant	0.0013	0.0002	***	0.0000	0.0001	***
$\Delta\sigma_V$	-0.1159	0.0196	***	0.2599	0.0049	***
$\Delta\sigma_V D_2$	0.1719	0.0719	**	0.0593	0.0178	***
$\Delta\sigma_V D_3$	-0.3971	0.0661	***	-0.1079	0.0164	***
$\Delta\sigma_V D_4$	-0.3489	0.0642	***	-0.0518	0.0159	***
$\Delta\sigma_V PUBINJ_{98}$	8.2758	6.3138		4.0759	1.5658	**
$\Delta\sigma_V PUBINJ_{99}$	-26.3078	5.6057	***	-9.0460	1.3901	***
$\Delta\sigma_V PUBINJ_{OTHER}$	-6.8129	5.8744		-5.4727	1.4568	***
N			3909			
R-squared		0.0622			0.4759	
Breusch-Pagan statistic			1259.003(0.0000)			
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$	0.0560	0.0692		0.3192	0.0172	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$	-0.5130	0.0631	***	0.1520	0.0157	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$	-0.4648	0.0611	***	0.2081	0.0152	***
$\alpha_3-\alpha_2$ / $\beta_3-\beta_2$	-0.5690	0.0916	***	-0.1673	0.0227	***

The coefficients are estimated using the seemingly unrelated regression methodology where two equations for leverage and IPP are treated as a system and the error terms for the two equations are assumed correlated. Columns 1and 2 report the results for the leverage equation and for the IPP equation, respectively. The sample covers from the second half of fiscal year 1986 through the first 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. α_1 and β_1 are the coefficients of $\Delta\sigma_V$ under regime 1 for the leverage equation and and for the IPP equation, respectively, where regime 1 is the period from the second half of fiscal year 1986, the beginning of our sample period, through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i*. The coefficients of $\Delta\sigma_V$ themselves are those of $\Delta\sigma_V$ under regime 1 from the second half of fiscal year 1986 through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINJ_{OTHER}$ are the remaining amount of the public capital injection that was received in March 1998, in March 1999 and at any other time, respectively, divided by V, the market value of total assets. α_i and β_i for i = 2, 3 or 4 are the coefficients of the cross products between $\Delta\sigma_V$ and D_i, for the leverage equation and the IPP equation, respectively. Thus, $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i* for the leverage equation and the IPP equation, respectively. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. The number inside the parenthesis beside the Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table 5. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes: Robustness Test of the Franchise Value Effect.

	(1) The leverage equation			(2) The IPP equation		
	coefficient	standard error		coefficient	standard error	
constant	0.0015	0.0002	***	0.0001	0.0001	***
$\Delta\sigma_V$	6.4055	0.4051	***	3.6987	0.0879	***
$\Delta\sigma_V D_2$	-0.0858	0.0715		-0.0766	0.0155	***
$\Delta\sigma_V D_3$	-0.5806	0.0650	***	-0.2047	0.0141	***
$\Delta\sigma_V D_4$	-0.5508	0.0634	***	-0.1582	0.0138	***
$\Delta\sigma_V PUBINJ_{98}$	4.7841	6.1178		2.2347	1.3278	
$\Delta\sigma_V PUBINJ_{99}$	-29.4746	5.4318	***	-10.7159	1.1789	***
$\Delta\sigma_V PUBINJ_{OTHER}$	-2.7726	5.6939		-3.3422	1.2359	***
$\Delta\sigma_V q$	-6.1692	0.3828	***	-3.2531	0.0831	***
N	3909					
R-squared	0.1206			0.6235		
Breusch-Pagan statistic	1098.401(0.0000)					
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$	6.3196	0.3943	***	3.6221	0.0856	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$	5.8249	0.3980	***	3.4940	0.0864	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$	5.8546	0.3965	***	3.5405	0.0861	***
$\alpha_2-\alpha_3$ / $\beta_2-\beta_3$	-0.4947	0.0888	***	-0.1281	0.0193	***

The coefficients are estimated using the seemingly unrelated regression methodology where two equations for leverage and IPP are treated as a system and the error terms for the two equations are assumed correlated. Columns 1and 2 report the results for the leverage equation and for the IPP equation, respectively. The sample covers from the second half of fiscal year 1986 through the first 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. q is the ratio of the sum of liabilities and shareholders' value to total assets. $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINJ_{OTHER}$ are the remaining amount of the public capital injection that was received in March 1998, in March 1999 and at any other time, respectively, divided by V, the market value of total assets. α_1 and β_1 are the coefficients of $\Delta\sigma_V$ under regime 1 for the leverage equation and and for the IPP equation, respectively, where regime 1 is the period from the second half of fiscal year 1986, the beginning of our sample period, through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. α_i and β_i for i = 2, 3 or 4 are the coefficients of the cross products between $\Delta\sigma_V$ and D_i, for the leverage equation and the IPP equation, respectively. Thus, $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i* for the leverage equation and the IPP equation, respectively. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. The number inside the parenthesis beside the Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table 6. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes: the Sample Including Bank Holding Companies

	(1) The leverage equation			(2) The IPP equation		
	coefficient	standard error		coefficient	standard error	
constant	0.0012	0.0002	***	0.0000	0.0001	
$\Delta\sigma_V$	-0.1123	0.0197	***	0.2625	0.0049	***
$\Delta\sigma_V D_2$	0.1562	0.0723	**	0.0479	0.0179	**
$\Delta\sigma_V D_3$	-0.4149	0.0654	***	-0.1165	0.0162	***
$\Delta\sigma_V D_4$	-0.3710	0.0625	***	-0.0613	0.0155	***
$\Delta\sigma_V PUBINJ_{98}$	19.6133	9.8835	**	11.3477	2.4446	***
$\Delta\sigma_V PUBINJ_{99}$	-28.0218	4.8613	***	-10.0157	1.2024	***
$\Delta\sigma_V PUBINJ_{OTHER}$	-1.5527	3.7835		-4.2956	0.9358	***
N	3978					
R-squared	0.0707			0.4753		
Breusch-Pagan statistic	1285.214(0.0000)					
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$	0.0439	0.0695		0.3105	0.0172	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$	-0.5272	0.0624	***	0.1461	0.0154	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$	-0.4833	0.0594	***	0.2012	0.0147	***
$\alpha_3-\alpha_2$ / $\beta_3-\beta_2$	-0.5711	0.0909	***	-0.1644	0.0225	***

The coefficients are estimated using the seemingly unrelated regression methodology where two equations for leverage and IPP are treated as a system and the error terms for the two equations are assumed correlated. Columns 1and 2 report the results for the leverage equation and for the IPP equation, respectively. The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007 and includes observations for bank holding companies. 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. α_i and β_i for i = 2, 3 or 4 are the coefficients of the cross products between $\Delta\sigma_V$ and D_i, for the leverage equation and the IPP equation, respectively. Thus, $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i* for the leverage equation and the IPP equation, respectively. α_1 and β_1 are the coefficients of $\Delta\sigma_V$ under regime 1 for the leverage equation and and for the IPP equation, respectively, where regime 1 is the period from the second half of fiscal year 1986, the beginning of our sample period, through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINJ_{OTHER}$ are the remaining amount of the public capital injection that was received in March 1998, in March 1999 and at any other time, respectively, divided by V, the market value of total assets. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. The number inside the parenthesis below the Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table 7. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes: the Sample Including Hypothetically Consolidated Banks

	(1) The leverage equation			(2) The IPP equation		
	coefficient	standard error		coefficient	standard error	
constant	0.0008	0.0003	***	-0.0001	0.0001	
$\Delta\sigma_V$	-0.2795	0.0269	***	0.2066	0.0104	***
$\Delta\sigma_V D_2$	0.0609	0.1028		-0.0202	0.0396	
$\Delta\sigma_V D_3$	-0.2723	0.0841	**	-0.0550	0.0324	
$\Delta\sigma_V D_4$	-0.1557	0.0727	*	0.0278	0.0280	
$\Delta\sigma_V PUBINJ_{98}$	-27.4222	30.1059		-9.3090	11.6127	
$\Delta\sigma_V PUBINJ_{99}$	-37.0757	9.9257	***	-11.2288	3.8287	***
$\Delta\sigma_V PUBINJ_{OTHER}$	8.1926	4.9378		-1.9372	1.9047	
N	3175					
R-squared	0.0796			0.1420		
Breusch-Pagan statistic	1606.794(0.0000)					
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$	-0.2186	0.0992	**	0.1864	0.0382	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$	-0.5518	0.0798	***	0.1516	0.0308	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$	-0.4352	0.0675	***	0.2344	0.0260	***
$\alpha_3-\alpha_2$ / $\beta_3-\beta_2$	-0.3332	0.1257	***	-0.0348	0.0485	

The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007 and includes observations for hypothetically consolidated banks. 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i*. The coefficients of $\Delta\sigma_V$ themselves are those of $\Delta\sigma_V$ under regime 1 from the second half of fiscal year 1986 through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINJ_{OTHER}$ are the remaining amount of the public capital injection that was received in March 1998, in March 1999 and at any other time, respectively, divided by V, the market value of total assets. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. The number inside the parenthesis below the Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table 8. Tests of the Risk-shifting Hypothesis under Different Regulatory Regimes: Examining the Takenaka Financial Revival Program's Effect, the Sample Including Hypothetically Consolidated Banks

	(1) The leverage equation			(2) The IPP equation		
	coefficient	standard error		coefficient	standard error	
constant	0.0007	0.0003	***	-0.0001	0.0001	
$\Delta\sigma_V$	-0.2795	0.0269	***	0.2065	0.0103	***
$\Delta\sigma_V D_2$	0.0580	0.1027		-0.0217	0.0396	
$\Delta\sigma_V D_3$	-0.2785	0.0841		-0.0582	0.0324	*
$\Delta\sigma_V D_4$	-0.0947	0.0789		0.0604	0.0304	**
$\Delta\sigma_V D_{takenaka}$	-0.2974	0.1505		-0.1584	0.0580	***
$\Delta\sigma_V PUBINJ_{98}$	-27.6468	30.0876		-9.4287	11.5992	
$\Delta\sigma_V PUBINJ_{99}$	-32.7945	10.1535	***	-8..9482	3.9143	**
$\Delta\sigma_V PUBINJ_{OTHER}$	9.9169	5.0111		-1.0186	1.9319	
N	3175					
R-squared	0.0807			0.11440		
Breusch-Pagan statistic	1604.867 (0.0000)					
$\alpha_1+\alpha_2$ / $\beta_1+\beta_2$	-0.2215	0.0991	**	0.1848	0.0382	***
$\alpha_1+\alpha_3$ / $\beta_1+\beta_3$	-0.5581	0.0798	***	0.1483	0.0308	***
$\alpha_1+\alpha_4$ / $\beta_1+\beta_4$	-0.3743	0.0742	***	0.2669	0.0286	***
$\alpha_3-\alpha_2$ / $\beta_3-\beta_2$	-0.3366	0.1256	***	-0.0365	0.0484	

The sample covers from the second half of fiscal year 1986 through the second half of fiscal year 2007 and includes observations for hypothetically consolidated banks. 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 after the deposit insurance cap was reinstated; from the first half of fiscal year 2002 through the second half of fiscal year 2007, the end of the sample period. $D_{takenaka}$ is a dummy variable to indicate that a bank is subject to the Financial Revival Program (a major bank during the period of the Program's implementation, from the second half of FY 2002 through the second half of FY 2004) $\alpha_1+\alpha_i$ and $\beta_1+\beta_i$ are the coefficients of $\Delta\sigma_V$ under regime *i*. The coefficients of $\Delta\sigma_V$ themselves are those of $\Delta\sigma_V$ under regime 1 from the second half of fiscal year 1986 through the first half of fiscal year 1996, which is before the instatement of the blanket deposit insurance coverage. α_3-α_2 and β_3-β_2 measure how larger the coefficient of $\Delta\sigma_V$ is under regime 3 than under regime 2. $PUBINJ_{98}$, $PUBINJ_{99}$ and $PUBINJ_{OTHER}$ are the remaining amount of the public capital injection that was received in March 1998, in March 1999 and at any other time, respectively, divided by V, the market value of total assets. *, ** and *** indicate that values are statistically significant at ten percent, five percent and one percent significance levels, respectively. Breusch-Pagan statistic is the p value for the statistic against the null of residuals being independent for the corresponding system of two regression equations.

Table A. The Summary of Regime Dummy Variables

	Blanket deposit insurance	Prompt Correction Action (PCA)	International banks	Domestic banks
	No	No	-1996:1	
$D_2 = 1$	Yes	No	1996:2 - 1997:2	1996:2 - 1998:2
$D_3 = 1$	Yes	Yes	1998:1 - 2001:2	1999:1 - 2001:2
$D_4 = 1$	No	Yes	2002:1 -	

International banks and domestic banks are the banks that are allowed to operate internationally and those that are not allowed to do so, respectively. “Yes“ means a corresponding policy is in operation. “No” means a corresponding policy is not in operation. For each date, a fiscal year and a half year period are in order. The fiscal year for Japanese banks begins on April 1st and ends on March 31st of the following calendar year.