Government guarantees of loans to small businesses: Effects on banks' risk-taking and non-guaranteed lending

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ARTICLE INFO

ABSTRACT

We analyzed the loan guarantees that the Japanese government provided for banks' loans to small and medium-sized enterprises (SMEs). We modeled and estimated how much and under what conditions loan guarantees affected banks' risk-taking and banks' non-guaranteed lending.

In the presence of controls for bank capital and other factors that might affect supplies of bank credit, our estimates supported our model's implications that loan guarantees increased banks' risk-taking.

Consistent with our model, our estimates imply that, when banks initially had fewer guaranteed loans and then got more guaranteed loans, guaranteed loans were complements to, rather than substitutes for, non-guaranteed loans. As complements, loan guarantees could be "high-powered" in that they generated increases not only in guaranteed loans, but also increases in non-guaranteed loans that were a multiple of the increases in guaranteed loans. In addition, banks' having more capital was associated with doing more non-guaranteed lending.

1. Introduction

We present a model of a value-maximizing bank's adjustments of its risk-taking and of its non-guaranteed lending when a government program increases the supply of guarantees for bank loans. Not surprisingly, our model predicts that a larger supply of loan guarantees encourages a bank to take more risk. More surprising, perhaps, are the model's predictions about when, and how much, guaranteed loans would displace or would stimulate banks' non-guaranteed lending. Our model and estimates indicate the banks' conditions for more, government-promoted, guaranteed lending to lead to more non-guaranteed lending by banks.

Governments around the world provide credit guarantees to banks for loans that they make to small and medium-sized enterprises (SMEs). (See Cressy, 2000, 2002.) Udell (2015) notes that, while the welfare effects of these guarantees are an unsettled issue, one of the consensus motivations for loan guarantees are imperfections in markets for SME loans. Among the benefits of loan guarantee programs, however, Udell (2015) cites several studies that concluded that guarantees of SME

loans tended to offset some of the procyclicality of SME lending and offset some of the procyclicality of SMEs' real economic activities.

In response to the global financial crisis of the late 2000s, many countries expanded their supplies of guarantees for the small business loans made by commercial banks. For example, the U.S. Small Business Administration (SBA) reduced its fees and increased the fraction of each small business loan that its credit guarantees would cover. The Japanese government added its Emergency Guarantee Program, which sharply increased the total supply of guarantees, i.e., the total amount of SME loans held by banks that could be covered by government loan guarantees. And, the U.K. government began a large program to provide guarantees on SME loans.

Guarantees on SME loans were not new to Japan. Concerns in the late 1990s about declining flows of bank loans and their adverse repercussions on the Japanese macroeconomy led the government to dramatically increase the size of its programs that supplied guarantees of repayments to banks on their small-business loans. Fig. 1 shows that national aggregates of business loans by loan size of Japanese banks declined noticeably in the late 1990s. (In all of our figures, tables, and
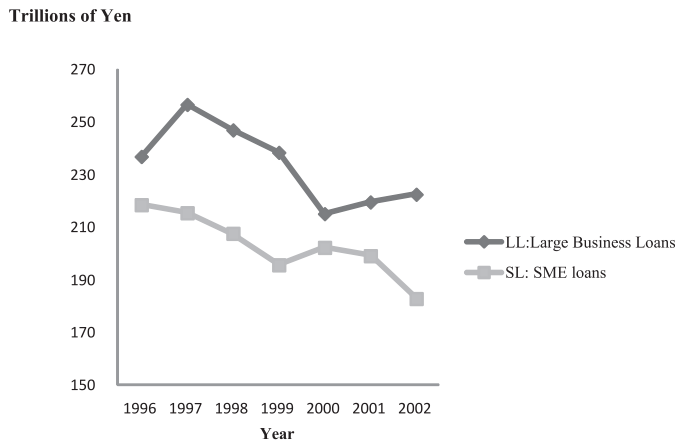

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Trillions of Yen

Fig. 1. Bank loans to small and medium-size enterprises and to large businesses (All Japanese banks, 1996–2002).

text, "year" refers to March 31 of that calendar year. Thus, 1999 refers to March 31, 1999, which is the end of fiscal year 1998 in Japan.) Fig. 1 also shows that the amount in Japanese yen of bank loans outstanding to small and medium-size enterprises (or, small business loans) fell as much as it did for banks' large loans. Given their smaller amount in yen, the percentage decline in SME loans was even larger in the late 1990s than it was for large loans.

In response to the financial exigency in the late 1990s, Japan launched the very large Special Credit Guarantee Program (SCGP). The effects of the SCGP on banks' risk-taking and on non-guaranteed lending is the focus of our empirical analysis. In response to the re-percussions on the Japanese economy of the Fall 2008 "Lehman shock," Japan launched another guarantee program, the Emergency Guarantee Program (EGP). Due to guaranteed-loan data by bank not being disclosed after 2002, our sample period did not include the years when the EGP operated.

Somewhat in contrast to the U.S., in Japan, SME borrowers often had both non-guaranteed and guaranteed loans outstanding. While being denied a non-guaranteed loan is a requirement for getting a guaranteed loan in the U.S., there is no such requirement in Japan. Indeed, banks sometimes originated both at the same time to a business. Further, despite the guarantees, Japanese banks often had credit po-licies (if not stated rates of interest) for guaranteed loans that were the same as they had for non-guaranteed loans.

Both the SCGP and the EGP loan guarantee programs distinctly in-creased the supply of loan guarantees and had the goal of increasing the supply of bank credit to SMEs. Legislation specified that a cumulative total of up to 30 trillion yen in loans to SMEs were eligible to be covered by the SCGP. Fig. 2 shows the outstanding stock of guaranteed loans to
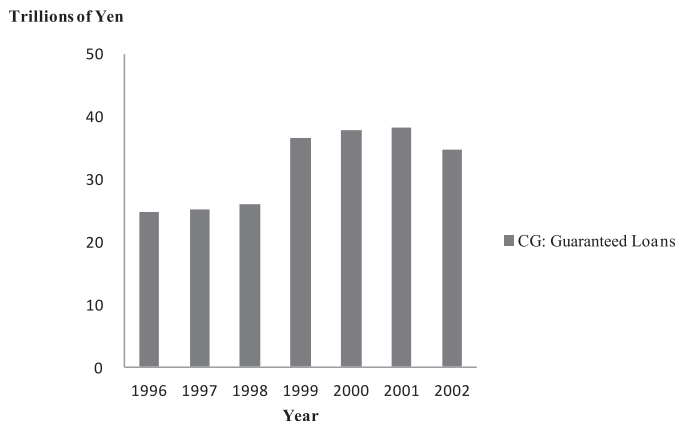
Trillions of Yen

Fig. 2. Guaranteed small business loans (All Japanese banks, 1996–2002).
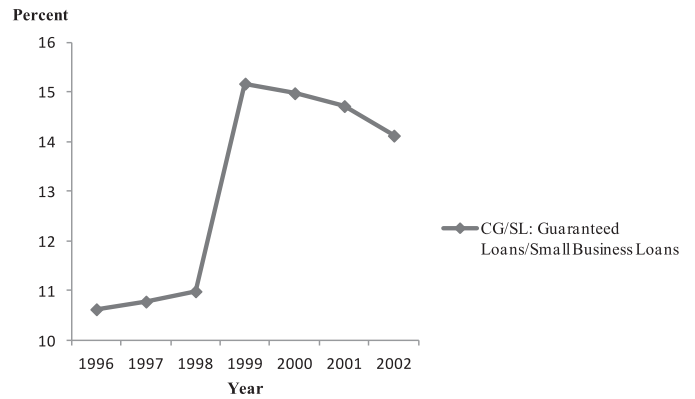
Percent

Fig. 3. Percent of small business loans that were guaranteed (All Japanese banks, 1996–2002).

SMEs at all Japanese banks in the years before the enactment of the SCGP was about 25 trillion yen. Fig. 2 also shows that the volume of guaranteed loans rose abruptly, as intended, right after the SCGP began, soon cresting at nearly 40 trillion yen in 2001. Fig. 3 provides another view of the importance of the SCGP by showing the percent of all bank loans outstanding to SMEs that were guaranteed. That percentage also rose abruptly after 1998, from about 11 to about 15 percent.

A salient feature of both the earlier SCGP and the later EGP loan guarantee programs was that the bank was guaranteed that 100 percent of the loan balance (plus all accrued interest) would be repaid, either by the borrower, or the guarantee program, or both. The insurance pre-miums for the loan guarantees were fixed and thus were completely insensitive to the risk of a loan or of a borrower. Thus, banks bore none of the credit risk associated with guaranteed loans that they extended to eligible SMEs.[1] Nor did banks or borrowers bear any higher guarantee fees for riskier loans.

Of course, completely insulating banks from credit losses might well raise banks' lending to SMEs. Complete insulation from losses might also encourage banks to extend loans to lower-quality borrowers, or even to "zombies", businesses that were still in operation and were economically insolvent. Thus, while total guaranteed lending might rise, that was no guarantee that the extra loans would be used only to assist solvent businesses. Nor was there any guarantee that the new, guaranteed loans that were made to solvent businesses were applied to socially-productive uses. At the same time, however, presumably some discipline, however weak, arose from the loan guarantors' having to review and approve the guarantee for each loan.

The few studies of Japanese loan guarantee programs provide some evidence on how the programs affected bank loans to SMEs. Naturally, the studies typically concluded that the guarantees increased the amounts of guaranteed loans outstanding. In practice, as is often the case in the U.S., the entire supply of SME loan guarantees was com-pletely used. But, the studies provide conflicting evidence about whe-ther the guarantees boosted the sum of guaranteed plus non-guaranteed loans outstanding. The studies reported either negligible, substantial, or even complete substitution (perhaps via re-financings) of guaranteed for non-guaranteed loans. Thus, the prior studies differ considerably about whether loan guarantees raised total SME lending by a lot, a little, or not at all.

Our results stand in contrast to the evidence in prior studies. Not surprisingly, our estimates indicate that banks became riskier, cet. par., when they took on more credit-guaranteed loans. Surprising, perhaps, is that we also found that, in general, additional loan guarantees tended to raise, rather than reduce, banks' non-guaranteed lending, particularly

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[1] Wilcox and Yasuda (2008) and Uesugi et al. (2010) provide more institu-tional details on the Japanese loan guarantee programs.

at banks that started with relatively few guaranteed loans. That is, we found that non-guaranteed loans tended to complement guaranteed loans, rather than guaranteed loans' substituting for non-guaranteed loans.

Being complements means that the late 1990s' loan guarantees may have been "high-powered" in that, by raising guaranteed loans, total loans rose more than the guaranteed loans that were added. Such a "pump-priming" effect would presumably be music to the ears of policymakers.

Less comforting to policymakers, however, would be that both our model and our estimates implied that the "multiplier effects" on total loans of guaranteed loans dwindled as the outstanding stock of loan guarantees grew larger. Although we estimated that non-guaranteed loans often, but not always, were complementary to guaranteed loans, the size of the complementarity tapered off as banks had more and more guaranteed loans. Thus, "guarantee fatigue" eventually cumulated in that larger or later guarantee programs had smaller effects per guarantee amount than programs that added less or were added to a smaller initial stock of guarantees.

Section II surveys some of the literature on loan guarantees, as well as that on deposit guarantees. Section III presents our model of a profit-maximizing, risk-taking bank. We show the implications for a bank's risk-taking and for its non-guaranteed lending when the government supplies more guarantees for SME loans. Then, based on panel data for Japanese banks, Section V presents estimates (including IV-based estimates) of the effects of loan guarantees and other factors on banks' risk-taking and on their non-guaranteed lending. Section VI summarizes our findings and their implications.

2. Literature review

In comparison with the numerous studies of the effects of (mispriced) deposit insurance on banks' choices of assets and liabilities, very little attention has been directed at the effects of loan guarantees. One reason for the disparity surely is that deposit insurance typically pertains directly to so much more of banks' balance sheets than loan guarantees do. Another reason is that loan guarantee programs are relatively newer than the more common explicit and implicit deposit insurance programs. In addition, loan guarantees often are typically restricted to small loans made to small businesses and data for individual, small firms is usually scarce. Below, we note a few of the recent studies of deposit insurance. We then describe some pertinent studies of loan guarantees, particularly those of Japanese loan guarantees.

Any number of studies have noted that mispriced deposit insurance encourages banks to take more risks. Anginer et al. (2014) is one recent example. They examined the relation between deposit insurance and bank risk in the years leading up to and during the recent financial crisis. Their conclusions were that financial safety nets led banks to take more risks in the years before the financial crisis. Then, during the crisis, the presence of deposit insurance, on balance, lowered risks to banks by maintaining confidence of the banks' creditors, including their depositors. In another study, Marques et al. (2013) used data from before and from during the financial crisis for listed, credit-rated banks in countries worldwide. They concluded that government guarantees, in particular in the form of deposit insurance, increased bank's risk-taking.

Lambert et al. (2017) used the cross-sectional variation in the increase in insured deposits that resulted from the increase in the per-account ceiling in the U.S. during the financial crisis from $100,000 to $250,000. They found that the larger a bank's increase in insured deposits due to the ceiling increase, the more risky commercial real estate loans that a bank held and the more risky a bank became relative to banks that gained fewer insured deposits as a result of the higher ceiling.

Earlier studies of deposit insurance came to similar conclusions.

Ioannidou and Penas (2010) reported that, after controlling for changes in macroeconomic conditions and competition in the local loan markets, adding deposit insurance led banks to make riskier loans, charge higher loan interest rates, and incur more delinquent and defaulting loans. They also concluded that, although the existing empirical evidence has been mixed, most studies found that deposit insurance led to more risk-taking by banks.

One of the very few empirical studies of the effects of loan guarantees on banks' risk-taking was done by Cowan et al. (2015). They used data for individual firms to estimate the effects of loan guarantees on guaranteed and on total bank credit extended to SMEs. They found that SMEs with both guaranteed and non-guaranteed loans were no more likely to default on guaranteed than on their non-guaranteed loans. They also found that firms with guaranteed loans were one percent more likely to default on their loans than similar firms only non-guaranteed loans, a difference that they attributed to adverse selection, with the firms getting guaranteed loans generally being weaker. Indeed, since being turned down for a non-guaranteed loan is often a requirement for getting a guaranteed loan (as it is in the U.S., but not in Japan), that selection seems virtually intentional.

Gropp et al. (2014) analyzed the effects of a judicial decision in 2001 that suddenly removed government guarantees on loans at German (savings) banks. In contrast to banks that did not have guaranteed loans before the decision, banks that lost their access to loan guarantees reduced the amounts of credit that they extended to their riskiest borrowers, shifted their liabilities away from more rate-sensitive categories, and saw yields on their bonds rise.

No consensus has emerged from studies of guarantees on small business loans in Japan. Some studies found that SME loans rose, but by much less than guaranteed SME loans rose. Others reported negligible increases in the total of banks' loans to small and to large businesses.

Matsuura and Takezawa (2001) conducted one of the first studies of the effects of Japanese government loan guarantees on bank lending. Based on their panel of annual data by prefecture for the fiscal years 1998 and 1999, they found no statistically significant effect of loan guarantees on banks' total lending to SMEs.[2] One possible explanation for their not detecting significant effects of loan guarantees on lending to SMEs is that their sample period included only the very beginning part of the time when the SCGP was in operation and had guaranteed loans outstanding. We note that, given that guaranteed SME lending surely rose then, the failure of total SME lending to rise implied that nonguaranteed lending to SMEs declined by about the same amount. Results like these fueled the view that banks were, in effect, adding guarantees to pre-existing loans, perhaps by providing guaranteed loans to pay off prior, non-guaranteed loans that banks had made to the same firms.

Konishi and Hasebe (2002) then estimated nearly the same specifications that Matsuura and Takezawa had used with data that extended through 2001. However, Konishi and Hasebe (2002) also included in their data the lending done not only by city and regional banks but also by credit banks and credit cooperatives. Based on their panel of data (annually, by prefecture), they estimated an elasticity of total SME loans to guaranteed SME loans of about three-quarters. Converting that estimated elasticity to units suggests that total lending to SMEs rose by a large multiple of the increase in guaranteed SME loans. For example, based on an estimated share of guaranteed SME loans in total SME loans of about 10 percent, their estimates suggest that each additional unit of guaranteed SME loans was associated with an increase of about 7½ units of total SME loans (and thus an increase in nonguaranteed loans of about 6½ units).

Sui (2004) used data for individual city and regional banks over a longer period. Based on data for the 1990s, he found a very small

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[2] Matsuura and Takezawa (2001) did find that higher land prices stimulated lending and loan loss rates reduced lending.

elasticity (about 0.025) of total SME loans to guaranteed SME loans. That elasticity suggests that total SME loans rose by much less than the increase in guaranteed SME loans and that, as a result, nonguaranteed SME loans declined when guaranteed loans rose.

Uesugi et al. (2010) showed that, relative to a control group, loan balances at Japanese businesses that participated in SCGP did rise, suggesting that guaranteed loans did not merely replace nonguaranteed loans. Their data were not suited, however, to answering how much, if at all, total lending rose as a result of the SCGP.

Thus, evidence from prior studies about the effects of guaranteed SME loans in Japan is limited and mixed: One study implied very large effects on nonguaranteed and, thus, total loans at the prefecture level when credit banks and cooperatives were included, but two other studies, which were based on data only for individual commercial banks, found very small effects on total SME loans.

3. A model of banks' risk-taking and guaranteed and non-guaranteed loans

We model the lending and risk-taking of a risk-neutral, value-maximizing bank that faces changes in government loan-guarantee programs, in its own equity capital, and in other factors. Our model adds (credit-) guaranteed loans to the structure of the well-known bank models in Blum (1999, 2002), Boyd and De Nicolo (2003, 2005, 2007), and Martinez-Miera and Repullo (2010). In our model, a bank chooses the amounts and riskiness of its non-guaranteed loans, as well as the amounts of its guaranteed loans, while recognizing that more (credit) risk raises both the stated returns and the default probability of non-guaranteed loans. The model also specifies that a bank takes into consideration that amounts that it expects to recover when non-guaranteed loans default. A bank expects complete recovery of its amounts of guaranteed loans, regardless of whether they default. Our model also includes the possibility that defaults are costly enough to render a bank insolvent, as well as the case where defaults are not that costly.

The liability side of the bank's balance sheet is structured as follows. Deposits are fully covered by government-provided deposit insurance, whose premiums and fees are completely insensitive to risk. Thus, neither the interest costs to depositors nor the costs of deposit insurance that the bank incurs respond to a bank's risks. For simplicity, we assume that depositors earned no interest on their fully-insured deposits. Thus, deposits pay a gross rate of return of one.[3] We assume that the (implicit plus explicit) costs connected with deposit insurance are low enough and deposits are elastically supplied so that banks use insured deposits as their only liabilities. Given exogenous equity, E, a bank then chooses simultaneously how many non-guaranteed and how many guaranteed loans to make and how many (insured) deposits to acquire. Thus, the leverage and the size of the bank are determined within the model.

The asset side of the bank's balance sheet is structured as follows. The bank holds two types of loans: non-guaranteed loans (L_n) and guaranteed loans (L_g). We assume that the all-in costs of the government's loan guarantees are low enough that banks in the aggregate make as many guaranteed loans as the government-determined size of the guarantee program can cover. Experiences across time and across countries point toward banks' virtually always opting for deposit insurance and for the entire allotments of loan guarantees that are available to them. While the (the volume of) guaranteed loans may be exogenous in the aggregate, typically being determined by statute, the amount of guaranteed loans at individual banks is endogenous, which we take into consideration when we estimate the effects of those guarantees on non-guaranteed lending.

In addition to choosing how much of each category of loans to hold, the bank also chooses the (default) riskiness of its loans, which we

denote by X. For simplicity, we assumed that non-guaranteed and guaranteed loans had the same risk of default, X. As we have noted, Japanese banks often applied the same credit standards to both categories of loans. A key difference between the loan categories, of course, is that losses on non-guaranteed loans are borne by the bank—as long as it survives. Losses on guaranteed loans are always borne by the government's loan-guarantee program.

We assume that the bank's loans had a two-point distribution of gross rate of return, R. That is, after choosing its loan amounts and riskiness, the bank encounters either a good state or a bad state. The probabilities of the good and the bad states are $p(X)$ and $1 - p(X)$. We assumed that the probability that loans would default, $1 - p(X)$, and the stated, gross returns on loans, R, rose with their risk, X. Thus, $p'(X) < 0$. We also assumed that the probability of loans defaulting accelerated with risk, i.e., $p''(X) < 0$. In the good state, the loan technology produces a gross return $R = X$ on non-guaranteed loans. In the bad state, the non-guaranteed loans produce a gross return $R = \rho X$, where ρ is the expected, net, average recovery rate on non-guaranteed loans.

Compared with non-guaranteed loans, due to their lower loss-given-default, guaranteed loans might carry lower gross interest rates, even after adjusting those rates for whatever extra fees and nonpecuniary costs accompany loan guarantees. Below, we specify the adjusted, stated, gross return on guaranteed loans to be no greater than the stated gross return on non-guaranteed loans. Specifically, we assumed that the adjusted, stated, gross returns on guaranteed loans equal θX, where $1/X < \theta \leq 1$. The more complete the loan guarantees are, and thus the lower the losses to banks in the event of defaults, the more that we expect θ to be below one.

On these assumptions, a value-maximizing bank solves:

$$max_{\{X,L_n\}} EV = p(X)\{X(L_n + \theta L_g) - D\} + (1 - P(X))\max\{X(\rho L_n + \theta L_g) - D, 0\} - C(L_n)$$

(1)

$$L \equiv L_n + L_g = D + E \tag{2}$$

Eq. (2) imposes the bank's balance sheet constraint that assets (here, only loans) equal liabilities (here, only deposits) plus equity (i.e., bank capital).

The first term in Eq. (1) is the expected (gross) return from the entire loan portfolio (guaranteed loans plus non- guaranteed loans) minus the bank's only liabilities, its deposits (D). The second term is the (expected, gross) return from the entire loan portfolio in the bad state, which occurs with probability $1 - p(X)$. ρ is the expected recovery rate on defaulting, non-guaranteed loans. As usual, the bank may directly recover some or even all of the outstanding amounts of its defaulted loans by receiving cash from borrowers or by selling whatever collateral had been posted for the defaulting, non-guaranteed loans. Absent any loss-sharing provisions in the loan guarantee program, the recovery rate on guaranteed loans is one. The bank gains when its guaranteed loans are successful, but the bank does not suffer any of the losses on defaulting, guaranteed loans when the loan guarantee program fully compensates the bank for any losses on guaranteed loans. In Eq. (1), the first term in the $max\{ . \}$ expression is the bank's return if it remains solvent. If the resulting asset value in the bad state is not sufficient to completely pay all of the depositors, then the bank's limited liability prevents its gross return from going below zero.

The last term in Eq. (1), $C(L_n)$, reflects the (present value of the) costs to the bank of administering, monitoring, and enforcing its non-guaranteed loans. We assumed that guaranteed loans impose negligible costs on the bank. We assume that $C'(\cdot) > 0$ and $C''(\cdot) > 0$.

3.1. Effects on bank risk-taking of guaranteed loans

We first consider the effects of an exogenous increase in the

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[3] Coincidentally, deposit rates were often very close to zero during our sample period.

government's supply of loan guarantees, and thus in guaranteed loans, on a bank's risk-taking.

The bank's optimal lending decisions will depend on ρ. Given the bank's optimal choices for the amount and riskiness of its non-guaranteed loans, L_n^* and X^*, we can define ρ* as the value of ρ that satisfies $X(\theta L_g + \rho L_n) - D - C(L_n) = 0$. Thus, if the recovery rate is high enough, i.e., if ρ > ρ*, then the bank remains solvent in the bad state. On the other hand, if ρ < ρ*, then the bank becomes insolvent in the bad state.

In cases where ρ > ρ*, Eq. (1) becomes:

$$max_{\{X,L_n\}}EV = p(X)\{X(L_n + \theta L_g) - D\} + (1 - p(X))\{X(\rho L_n + \theta L_g) - D\} - C(L_n) \quad (3)$$

Then, the bank's first-order condition with respect to risk-taking, X, is given by Eq. (4):

$$\frac{\partial EV}{\partial X} = 0 \Leftrightarrow \{p'(X)X + p(X)\}(XL_n + \theta L_g) - p'(X)X(\rho L_n + \theta L_g) + (1 - p(X))(\rho L_n + \theta L_g) = 0 \quad (4)$$

Eq. (4) can be rewritten as Eq. (5):

$$p'(X)X + p(X) + \frac{\rho L_n + \theta L_g}{(1 - \rho)L_n} = 0 \quad (5)$$

When ρ is above ρ*, then Eq. (5) shows that the bank's choices about risk-taking and non-guaranteed lending are affected by the value of ρ. Adding loan guarantees and adding a recovery rate on non-guaranteed loans adds the third term to the first-order condition in Eq. (5). In the third term, the second term in the numerator arises from the presence of guaranteed loans. The recovery rate on non-guaranteed loans appears in both the numerator and the denominator. The more loan guarantees there are, i.e., the larger L_g is, the larger the numerator of the third term is.

If a bank had no guaranteed loans (L_g=0), then, because $p''(X) < 0$, Eq. (5) has an interior maximum at $X = X^S$, the socially-optimal level of risk-taking, as shown in Fig. 4. The dashed line in Fig. 4 shows that the function for value maximization is concave in X. It also follows from Eq. (5), when ρ is above ρ*, that larger recovery rates, ρ, raise the socially-optimal level of risk-taking, i.e., the concave value function in Fig. 4 shifts rightward as ρ rises. Just as higher recovery rates provide more protection for the bank, so too do loan guarantees. The solid line in Fig. 4 shows how adding loan guarantees shifts a bank's opportunities rightward, thereby raising the bank's privately-optimal riskiness of its non-guaranteed and guaranteed loans, X^*.

However, in the case where the bad state renders the bank insolvent, i.e., where ρ < ρ*, how far ρ is below ρ* does not affect the bank's decisions. When ρ < ρ*, the bank's maximization function becomes:

Expected Value
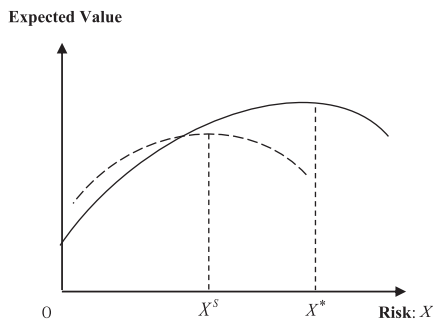
X^S is the socially-optimal level of risk-taking.

X^* is the privately-optimal level of risk-taking.

Fig. 4. Effect of loan guarantees on a bank's risk-taking.

$$max_{\{X,L_n\}}EV = p(X)\{X(L_n + \theta L_g) - D\} - C(L_n) \quad (6)$$

Its first-order condition with respect to X becomes:

$$\frac{\partial EV}{\partial X} = 0 \Leftrightarrow \{p'(X)X + p(X)\}(XL_n + \theta L_g) - p'(X)D = 0 \quad (7)$$

Eq. (7) can be rewritten as:

$$p'(X)X + p(X) - \frac{Dp'(X)}{L_n + \theta L_g} = 0 \quad (8)$$

Eq. (8) can then be rewritten as:

$$p'(X)X + p(X) - \frac{(L_n + L_g - E)p'(X)}{L_n + \theta L_g} = 0 \quad (9)$$

In contrast to Eq. (5), in Eq. (9) the recovery rate, ρ, does not appear. When recovery rates are below ρ*, the bank does not factor in how far below ρ* the recovery rate is, because the bank will be insolvent for any value of ρ below ρ*. When ρ < ρ*, then the numerator in the third term in Eq. (9) includes a factor that reflects deposit insurance and the bank's limited liability if it defaults (Blum, 1999; Cordella and Yeyati, 2003). In contrast, for the case when ρ > ρ*, Eq. (5) does not contain the deposit insurance factor since the bank will not fail.

3.2. Effects on non-guaranteed loans of guaranteed loans

We next analyze how guaranteed loans affect a bank's optimal amount of non-guaranteed loans.

For ρ > ρ*, the first-order condition with respect to non-guaranteed loans is:

$$\frac{\partial \Pi}{\partial L_n} = 0 \Leftrightarrow p(X)X + (1 - p(X))X\rho - 1 - C'(L_n) = 0 \quad (10)$$

Eq. (10) implies that the optimal amount of non-guaranteed loans L_n^* satisfies:

$$p(X)X + (1 - p(X))X\rho - 1 = C'(L_n^*) \quad (11)$$

Eq. (11) shows that, given the amount of guaranteed loans and the bank's optimal level of risk, L_n and X^* from Eq. (5), the bank then equates the expected marginal benefit to the marginal cost, $C'(L_n^*)$ of a non-guaranteed loan. When ρ < ρ*, on the other hand, the first-order condition becomes:

$$\frac{\partial \Pi}{\partial L_n} = 0 \Leftrightarrow p(X)X - p(X) - C'(L_n) = 0 \quad (12)$$

Eq. (12) implies that the optimal amount of non-guaranteed loans, L_n^*, satisfies:

$$p(X)(X - 1) = C'(L_n^*) \quad (13)$$

Totally differentiating Eqs. (5) and (11) for the case where ρ > ρ* (and differentiating Eqs. (9) and (13) for the case of ρ < ρ*) leads to Propositions 1 and 2. (See the Appendix for proofs of these propositions and for the derivation of Δ and of $\widetilde{\Delta}$.

Proposition 1. Increasing the amount of guaranteed loans raises a bank's risk-taking:

$$\left.\frac{dX}{dL_g}\right|_{X=X^*} = \frac{\theta}{\Delta}C''(L_n) > 0 \quad (14)$$

Proposition 2. If ρ > ρ*, then additional guaranteed loans <u>substitute</u> for non-guaranteed loans. Guaranteed loans are also substitutes for non-guaranteed loans if ρ < ρ* and a bank's guaranteed loans sufficiently exceed its equity. Non-guaranteed loans are complements to guaranteed loans if ρ < ρ* and a bank's guaranteed loans are not sufficiently greater than its equity.

When ρ > ρ*, then guaranteed and non-guaranteed loans are

substitutes:

$$\left.\frac{dL_n}{dL_g}\right|_{X=X^*} = \frac{\theta}{\Delta}B(X^*) < 0 \tag{15}$$

where $B(X^*) = \{(p'(X^*)X^* + p(X^*))(1 - \rho) + \rho\}$

When $\rho < \rho^*$, then guaranteed and non-guaranteed loans may be either substitutes or complements, depending the how large a bank's guaranteed loans are relative to its equity:

$$\left.\frac{dL_n}{dL_g}\right|_{X=X^*} = -\frac{\theta}{\widetilde{\Delta}}G(X^*)\left[\left(1 - \frac{\theta D}{L_n + L_g}\right)p'(X^*)\right] < 0 \quad if \ (1-\theta)L_g > E \tag{16}$$

$$\left.\frac{dL_n}{dL_g}\right|_{X=X^*} = -\frac{\theta}{\widetilde{\Delta}}G(X^*)\left[\left(1 - \frac{\theta D}{L_n + L_g}\right)p'(X^*)\right] > 0 \quad if \ (1-\theta)L_g < E \tag{17}$$

where $G(X^*) = [p'(X^*)(X^* - 1) + p(X^*)] = p'(X^*)\left(\frac{L_n + L_g - E}{L_n + \theta L_g} - 1\right)$

Below we provide estimates that bear on whether Japanese banks conform to Propositions 1 and 2. In particular, we estimate whether individual banks took on more risk when they had access to more loan guarantees. We also estimate whether additional loan guarantees substituted for banks' non-guaranteed loans or complemented (i.e., stimulated more) non-guaranteed loans.

4. Data, variables constructed, and regression specifications

In this section we describe the data, variables, and regression specifications that we used to estimate the effects of guaranteed loans on banks' risk-taking and on their non-guaranteed loans.

4.1. Dataset, data sources, and sample period

For a panel of publicly-traded Japanese banks, we used data as of March 31 for each year during 1996 – 2002.[4] At the end of March 2002, despite the loan-guarantee programs' continuing, the loan-guarantee agencies quit publicly disclosing the amounts of guaranteed loans at individual banks. That forced an end to our sample period then (March 2002). Our sample period began around the time of the announcement of the Japanese "Big Bang", which was a substantial reform of the Japanese banking system.

For each year we had well over 100 banks in our sample. We obtained data for assets, loans, equity capital, and so on from the balance sheets for each bank from the NIKKEI NEEDS database. Data for the amounts of government-guaranteed loans at each bank for each year were hand-collected from the Annual Reports on Credit Insurance Statistics. We calculated the volatility of each bank's equity returns, which we used for *ASSETVOL*, from the banks' equity prices in the Astra Manager database. The remaining data were collected from the NIKKEI NEEDS database.

4.2. Regression specifications

4.2.1. Risk-taking

To investigate the effects of guaranteed loans on banks' risk-taking, we used a panel of data for individual banks (subscript b) for each year in our sample period (subscript t) to estimate versions of the following specification:

$$RISK_{b,t} = \alpha_1 CG_{b,t} + \alpha_2 EQCAP_{b,t} + \alpha_3 BASEL_{b,t} + \alpha_4 ASSETS_{b,t} + \alpha_b + \alpha_t + \varepsilon_{b,t} \tag{18}$$

We used four different measures as indicators of a bank's risk, $RISK_{b,t}$. Because there has long been suspicion about the accuracy of the (book value) accounting statements of Japanese banks, we wanted to minimize our reliance on accounting data. Japanese banks may have had considerable incentives and leeway to not report accurately their loan losses in general and other accounting measures during this period.[5] Thus, for each bank and year, our first measure of its risks is the standard deviation of the daily, delivered, market value of its assets, $ASSETVOL_{b,t}$. We calculated a second measure of a bank's risk, $PAYOUT_{b,t}$, as the ratio to guaranteed loans of payouts to a bank by the government's loan-guarantee agency. Although they may have inaccurately reported about non-guaranteed loans, since the government reimbursed them in full for any losses on guaranteed loans, Japanese banks had considerable incentives to report accurately about losses on their guaranteed loans.

As our third indicator of a bank's risk, we used $WEAKIND_{b,t}$, which is the share of each bank's total loans that were made to the real estate, service, wholesale and retail, and construction industries. Watanabe (2010) identified these industries as unhealthy due to their large volumes of non-performing loans. Our last indicator of a bank's risk, we used the ratio of delinquent to total loans, $DELINQ_{b,t}$.

Eq. (18) shows the explanatory variables in the specification for risk-taking. As our measure of (credit-) guaranteed loans at each bank, $CG_{b,t}$, we used the ratio of each bank's guaranteed loans to its total assets. We also included $EQCAP_{b,t}$ the ratio (in percentage points) of equity capital to total assets. We also included some other control variables in our regression specifications. We included a dummy variable that took the value of one whenever a bank was subject to the Basel capital rules ($BASEL = 1$; zero otherwise). All of the city banks and a few of the larger regional banks tended to be the banks that had sufficiently large international operations to bring them under the Basel rules. Rarely did a bank switch its Basel status, for example, by shedding its international operations. To control for size-related effects on risk-taking and lending, we also included total assets (measured in millions of yen), $ASSETS_{b,t}$, which equaled each bank's total assets (in millions of yen). And, for each specification in each table of estimates, we included a separate dummy variable for each year, as well as a fixed-effect for each bank.

4.2.2. Non-guaranteed loans

Similarly, we analyzed the effects of guaranteed loans on non-guaranteed loans at each bank by estimating the following specification:

$$NGL_{b,t} = \beta_1 CG_{b,t} + \beta_2 EQCAP_{b,t} + \beta_3 SIMPLEQ_{b,t} + \beta_4 BASEL_{b,t} + \beta_5 ASSETS_{b,t} + \beta_b + \beta_t + \varepsilon_{b,t} \tag{19}$$

$NGL_{b,t}$ is the ratio of the amount of non-guaranteed loans at each bank b in each year t to their total assets. Eq. (19) adds another control variable, $SIMPLEQ_{b,t}$, which is the ratio to the book value of a bank's total assets of the sum of the market value of its equity and the book value of its liabilities.[6]

4.3. Instrumental variables

The coefficients shown in column 2 of Table 2 and those shown in Tables 3 and 4 were estimated with instrumental variables (IV). Estimation via instrumental variables may be warranted for one or more

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[4] March 31 is the end of the fiscal year in Japan. Fiscal years end in the March following the end of the calendar year. Thus, FY1996 ended on March 31, 1997. Thus, we used data for fiscal years 1995–2001.

[5] We do note, however, that we detected some effects of reported bank capital on accounting-based measures of risk-taking, such as non-performing loans, charge-offs, and so on. Our concerns about the quality of the data and about simultaneity biases persuaded us to omit those results.

[6] Keeley (1990) used this measure as a proxy for the franchise value of a bank. When we estimate $ASSETVOL$, in Eq. (10), a positive relationship mechanically exits. Thus, we are including $SIMPLEQ$ when we estimate Eq. (11), which will be discussed below.

reasons. Perhaps the most compelling reason for using IV is that some of the omitted variables that are compounded into the disturbance term in Eq. (19) may also affect the volume of guaranteed loans, *CG*, at the same bank. For example, for some unobservable or unmeasured reason, a potential borrower may choose Bank 1 over Bank 2 as a source of loans. If so, then we may observe both more non-guaranteed (for unmeasured reasons) and guaranteed loans at Bank 1. In that case, *CG* rose not because of an exogenous increase in the supply of credit guarantees, but rather from an increase in loan demand at Bank 1. The tendency of such unmeasured, and typically unmeasurable, reasons to increase both *CG* and the disturbance term would render OLS inconsistent. To remove this source of inconsistency, we use IV estimation.

For our IV estimates, we added one instrumental variable to the predetermined variables in the specifications for risk and for non-guaranteed loan in Eqs. (18) and (19). We calculated the additional instrument as the product of (1) the pre-determined, legislated national stock of loans that could be guaranteed under the SCGP and (2) how "guarantee-intensive" each bank's loan portfolio had been before the enactment of the SCGP. More specifically, we calculated the additional instrumental variable, *CGEXOG*, as the product of (1) an estimate of the (exogenous) total national amount of SME loan guarantees outstanding each year under the SCGP and (2) the shares of the total national amount of SME loan guarantees outstanding (arising from prior, long-standing SME loan guarantee programs) that each bank had just prior to the beginning of our sample period, i.e., as of March, 1996. Thus, these shares were based on each bank's guarantee intensity three years before the SCGP began.

Fig. 5 displays the legislated cap on the total gross stock of guaranteed loans (i.e., the cumulated gross flows of SME loan guarantees) available under the SCGP. After first becoming available in late 1998, the total gross stock of guaranteed loan under the SCGP was capped initially at 20 trillion yen. The cap on the total gross stock was then raised in 2000 to 30 trillion yen.

Many of the guaranteed loans, like non-guaranteed loans, were of relatively short maturities. Under the rules of the SCGP, which specified a cap on the cumulated gross flow of loan guarantees, rolling over maturing, short-term loans used more of the available supply of loan guarantees than did a single, longer-term guaranteed loan. As a result of guaranteed loans having short maturities, the outstanding net stock of guaranteed loans made under the SCGP (as well as under the long-standing, standard guarantee program) was typically far below the cumulated gross flow of guarantees that had been used. Based on the annual gross flows of new guarantees and the resulting net stock of guaranteed loans, we estimated that the "depreciation," or "run-off," rate for guaranteed loans was about 50 percent per year. We used a 50 percent depreciation rate, the fact that the SCGP was instituted part way through 1998, and the two legislated caps on the SCGP to estimate
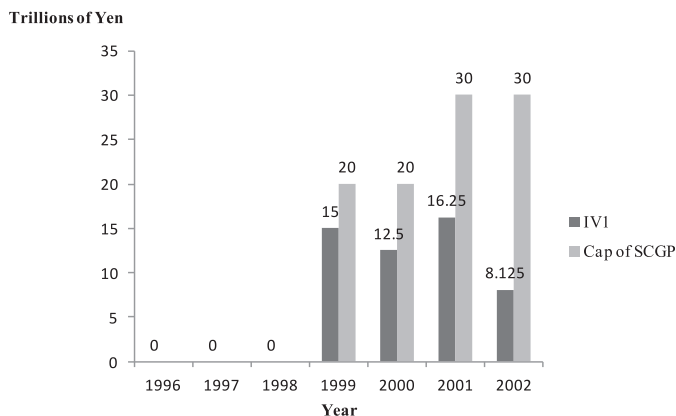
Trillions of Yen

Fig. 5. The legislated, maximum, cumulative amount of guaranteed loans and the maximum amounts of guaranteed loans available by year.

the maximum total national supply of SCGP loan guarantees that were available each year. For each year, this supply is the estimated total of remaining guaranteed loans that could be covered under the SCGP cap.

Fig. 5 shows that the legislated SCGP cap, which is the, maximum, cumulative amount of guaranteed loans available under the SCGP, rose from 20 to 30 trillion yen. IV1 in Fig. 5 shows each year's remaining maximum volume of loans that could be covered under the prevailing SCGP cap. The large volumes of maturing loans each year kept the maximum flow supply of guarantees below the legislated caps. And, even when the SGCP cap was unchanged from year to year, the ongoing flows of maturing loans also reduced the remaining, maximum flow supply of guarantees that were available. Thus, in Fig. 5, by 2001, when the cap rose to 30 trillion yen, the remaining supply was 16.25 trillion yen. Then, because many guaranteed loans matured, by 2002, the remaining supply of guarantees could only cover 8.125 trillion yen of guaranteed loans.

4.4. Descriptive statistics

Before presenting regression results, we show some descriptive statistics in Table 1 for our variables over our entire 1996–2002 sample period and over two sub-periods: 1996–1998, which covered the years before the introduction of the SCGP and 1999–2002, the years in our sample period when the SCGP provided guarantees. In addition to showing the means and standard deviations for each of the variables that we used, column 4 of Table 1 shows *t*-statistics for tests that each variable's means were the same in the two sub-periods.

The mean of *ASSETVOL*, which is the volatility of the market-value returns on banks' assets, was about one-fourth lower after the SGCP was in operation. On the other hand, payouts by the SCGP on defaulted guaranteed loans (*PAYOUT*) and the overall loan delinquency rate (*DELINQ*) were noticeably and statistically-significantly higher during the SCGP sub-period. Those increases might suggest that banks took more credit risk on loans under the SCGP. Apparently, the government injections of capital, which were significantly higher in the later sub-period, boosted capital ratios. In addition, although the mean share of banks' loans that were guaranteed (*CG*) rose by about two percentage points after the SCGP was in operation, the mean share of non-guaranteed loans declined by about twice as much. Taken together, the means in Table 1 do not clearly signal whether banks took more risks or whether guaranteed loans were substitutes or complements to non-guaranteed loans.

5. Regression results

5.1. Effects on risk-taking

Table 2 shows estimates of Eq. (18) for each of our four indicators of risk-taking. Column 2 shows the IV (two-stage least squares) estimates when we use *ASSETVOL* as an indicator of risk-taking. The first-stage results in column 1 shows our exogenous measure of credit guarantees, *CGEXOG*, was strongly related to *CG*. Coupled with the significant association of *CG* with *EQCAP* and *BASEL*, the first-stage regression had an adjusted R^2 of 0.72, which reduced concern about having weak instruments. The IV estimates in column 2 show that banks' asset volatilities were significantly higher when they had more loan guarantees. In column 3, we show OLS results when the exogenous guarantee variable, *CGEXOG*, replaced *CG*. Given that its estimated coefficient in column 1 was about one-third, it is not surprising that the statistically-significant estimated coefficient on *CGEXOG* was about one-third as large as the *CG* estimate in column 2. In general, Table 2 also shows that the other, control variables that we included were not significantly related to our indicators of risk-taking.

Columns 4 through 7 show the results of estimating Eq. (18) with other indicators of banks' risk-taking. Columns 4 and 5 use the one- and two-year ahead payouts by the SCGP for defaulted guaranteed loans as

Table 1
Descriptive statistics (All Japanese banks).

			Before SCGP	After SCGP	*t*-statistics for tests of equality of means across sub-periods
		1996–2002 (1)	1996–1998 (2)	1999–2002 (3)	(4)
1	ASSETVOL (%)				
	Mean	0.11	0.12	0.09	−5.36***
	Standard deviation	0.06	0.06	0.05	
2	PAYOUT (%)				
	Mean	1.70	1.34	1.98	8.33***
	Standard deviation	1.10	0.80	1.21	
3	WEAKIND (%)				
	Mean	50.00	51.21	49.07	−4.49***
	Standard deviation	7.00	6.64	2.58	
4	DELINQ (%)				
	Mean	0.80	0.71	0.91	3.92***
	Standard deviation	0.74	0.61	0.82	
5	NGL (%)				
	Mean	63.64	65.91	61.84	−8.95***
	Standard deviation	6.50	6.23	6.14	
6	CG (%)				
	Mean	6.03	4.77	7.03	−13.14***
	Standard deviation	2.68	1.96	2.75	
7	CGEXOG (%)				
	Mean	1.44	0.00	2.58	39.74***
	Standard deviation	1.62	0.00	1.33	
8	EQCAP (%)				
	Mean	4.10	3.63	4.47	11.12***
	Standard deviation	1.14	0.09	1.16	
9	BASEL				
	Mean	0.36	0.55	0.21	−10.22***
	Standard deviation	0.41	0.50	0.41	
10	SIMPLEQ				
	Mean	1.01	1.02	1.00	−6.19***
	Standard deviation	0.04	0.02	0.05	
11	ASSETS				
	Mean	6.11	6.08	6.13	0.52
	Standard deviation	1.32	1.29	1.33	

Note: *** Significant at the 1% level.

risk-taking indicators. Row 1 shows that that having more guaranteed loans was, naturally, associated with more payouts. The estimated coefficients on *CG* in columns 4 and 5 suggest that losses on guaranteed loans may have been quite high, since future payouts on them rose by about 0.04 and then 0.08 per additional unit of guaranteed loans. Column 6 then shows that the more guaranteed loans that a bank had, the more loans that a bank had outstanding to the commonly-identified weak industries at that time (real estate, construction, wholesale and retail, and services).

On the other hand, column 7 shows the somewhat-surprising finding that having more guaranteed loans was associated with banks' having lower overall loan delinquency rates. One possibility for this finding is that the increases in banks' guaranteed loans coincided with their "evergreening" more non-guaranteed loans, which would have lowered reported delinquency rates. It may also have been that, even if guaranteed loans defaulted more often than non-guaranteed loans, the delinquency rates on guaranteed loans, and thus on all loans, were kept

low by the loan guarantee agency's making sufficiently rapid payouts, which then would have removed defaulting loans from delinquent status. Neither from the available data nor from the estimates in column 7 can we discern whether more guaranteed loans were associated with more delinquencies of non-guaranteed loans. Taken together, however, the estimated coefficients on *CG* in Table 2 generally point to more guaranteed loans being associated with more risk-taking.

5.2. Effects on non-guaranteed lending

The effects of guaranteed loans on banks' <u>non</u>-guaranteed loans are of considerable interest. If guaranteed lending "crowds out" non-guaranteed lending by having borrowers and lenders agree to merely substitute the former for the latter, then total lending would be unaffected and presumably the guarantee program would not achieve its goal of boosting total lending. Our model suggested the conditions under which guaranteed loans would be substitutes, or would be complements.

Tables 3 through 5 provide IV estimates about whether and when guaranteed loans were substitutes or were complements. For the estimates in Tables 3 through 5, as instruments for guaranteed loans (*CG*), we used the current and the one-year lagged values of each of the right-hand-side variables, the one-year lagged values of non-guaranteed loans (*NGL*), as well as the current-year value of *CGEXOG*.

Table 3 shows the IV-estimated effects on non-guaranteed loans of guaranteed loans and of the other, control variables. After starting with a pared-down specification in column 1, columns 2 through 4 successively add additional control variables. For each of columns 1 through 4, we detected significant positive effects of guaranteed on non-guaranteed loans. These estimated coefficients imply that a bank's having more guaranteed loans was generally associated with its also having more non-guaranteed loans. Thus, these estimates imply that the two loan categories were complements, rather than substitutes. Instead of crowding out non-guaranteed loans, guaranteed loans crowded in non-guaranteed loans.

According to Eq. (17), their being complements implies that the recovery rate on non-guaranteed loans in the bad state, ρ, was low enough for banks to become insolvent and that banks' guaranteed loans were not too large relative to banks' equity. Based on our finding of loan complementarity, our model implies that banks would be expected, in the bad state, to recover too little on defaulting loans to remain solvent. That an important share of the Japanese banking system encountered the bad state during our sample period and that their loan recovery rates might be low enough to cause bank insolvencies should not be controversial. That Japanese banks continued operations or merged with other banks, just like in the U.S., did not mean that they were continuously solvent.

In columns 1 through 4 of Table 3, the estimated effects on non-guaranteed loans of guaranteed loans were about two. A coefficient of two implies a "three-fer" for total loans, in that non-guaranteed loans rose by two when guaranteed loans rose by one. Thus, guaranteed loans appear to have been "high-powered" in that they not only raised guaranteed loans (of course), but they also led to increases in non-guaranteed loans that were a sizable multiple of the increase in guaranteed loans.[7]

Conforming to one of the predictions of our model, the estimates in Column 5 show that the effect of an additional unit of guaranteed loans, *CG*, tended to fall as the amount of guaranteed loans already on banks' balance sheets rose. That shrinking effect is the implication of the significantly negative estimated coefficient on the square of *CG*. We

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[7] These complementary effects recall the multiple effects on the money supply of the monetary base, which was often referred to as "high-powered money." Although the multiplier effects are similar, the mechanisms are quite different.

Table 2
Effects on risk-taking of loan guarantees (All Japanese Banks, 1996–2002, year and bank fixed-effects).

	Independent variables	First stage OLS	Second stage IV	OLS				
		CG (1)	ASSETVOL (2)	ASSETVOL (3)	PAYOUT (t + 1) (4)	PAYOUT (t + 2) (5)	WEAKIND (6)	DELINQ (7)
1	CG		0.022 (2.66)***		0.041 (1.64)*	0.082 (2.81)***	0.179 (2.14)**	−0.054 (−2.03)**
2	CGEXOG	0.360 (5.72)***		0.007 (2.22)**				
3	EQCAP	−0.161 (−2.42)**	0.003 (0.85)	0.002 (0.96)	−0.029 (−0.73)	−0.111 (−2.33)**	−0.075 (−0.62)	−0.456 (−11.71)***
4	BASEL	0.004 (2.47)**	0.000 (0.55)	0.000 (1.57)	−0.001 (−1.38)	−0.001 (−1.60)	0.010 (3.62)***	0.000 (0.26)
5	ASSETS	0.003 (0.85)	−0.919 (−0.44)	0.368 (0.19)	−0.004 (−0.44)	−0.003 (−1.06)	−0.007 (−7.31)***	0.000 (0.12)
	F-statistic	20.3	3.01	2.97	13.71	13.14	52.68	1.73
	Adjusted R^2	0.72	0.05	0.52	0.79	0.81	0.93	0.37
	Overidentification test (p-value)		0.55					
	Observations	503	503	597	635	522	744	742

Note: t-statistics are in parentheses below estimated coefficients.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 3
Effects on non-guaranteed loans of guaranteed loans (All Japanese Banks, 1996–2002, year and bank fixed-effects, IV estimates).

	Independent variables	NGL (1)	NGL (2)	NGL (3)	NGL (4)	NGL (5)
1	CG	2.202 (4.64)***	1.778 (3.59)***	1.784 (3.59)***	2.163 (4.69)***	3.899 (3.81)***
2	CG²					−7.589 (−2.04)**
3	EQCAP	1.099 (5.31)***	1.243 (5.94)***	1.304 (6.14)***	0.945 (4.12)***	0.997 (3.95)***
4	SIMPLEQ		0.157 (1.30)	0.176 (1.46)	−0.014 (−0.11)	−0.038 (−0.27)
5	BASEL			−0.010 (−1.97)**	−0.011 (−2.16)**	−0.013 (−2.29)**
6	ASSETS				−0.008 (−5.50)***	−0.008 (−5.02)***
	F-statistic	22.85	25.28	24.04	10.92	17.32
	Adjusted R^2	0.83	0.84	0.84	0.83	0.78
	Overidentification test (p-value)	0.99	0.85	0.78	0.80	0.84
	Observations	635	591	591	591	591

Note: t-statistics are in parentheses below estimated coefficients.
** Significant at the 5% level.
*** Significant at the 1% level.

investigate this declining marginal effect further in Table 4.

Row 3 shows a small (i.e., about 1), significant, positive, estimated effect of bank equity capital on non-guaranteed loans. Compared with estimates of similar effects based on U.S. data that were in the range of three, one is a relatively small estimated effect (Peek and Rosengren, 1995; Hancock and Wilcox, 1994). The vast mis-measurement of Japanese banks' capital during this period likely attenuated the estimated effects of their capital.

5.2.1. High- vs. low-guarantee banks, substitutes vs. complements

Another way to see whether our model's implications in Proposition 2 about when these two loan categories were substitutes or complements was to split our panel dataset by whether banks had many or few guaranteed loans. In line with the conditions in Eqs. (16) and (17), we designated banks as high-guarantee banks if they had guaranteed loans that exceeded 125% of their equity capital. Low-guarantee banks were those banks that had guaranteed loan amounts that were less than 80% (i.e., 100/125) of their capital. Thus, we omitted from both subsamples

those banks that had medium-sized amounts of guaranteed loans, i.e., between 80 and 125 percent of their equity capital.

Eq. (16) states that banks are more likely to reduce their non-guaranteed loans when they already have more guaranteed loans (relative to their capital). Table 4 shows the IV-based-results of estimating the specification in (19) separately for high-guarantee and for low-guarantee banks. The IV estimates in Table 4 were the same as those used for Table 3.

The results shown in Table 4 further support Proposition 2. Conforming to the implications of our model, high-guarantee banks tended to <u>substitute</u> guaranteed for non-guaranteed loans: The significantly-negative estimated coefficient in column 1 suggests that a one-unit increase in guaranteed loans at high-guarantee banks were partially offset decreases (of 0.623) in non-guaranteed loans.[8] Also in concert

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[8] Substitution effects were reported by Uesugi et al. (2010) and Ono et al. (2013).

Table 4
Effects on non-guaranteed loans of guaranteed loans: high-guarantee banks vs. low-guarantee banks (All Japanese Banks, 1996–2002, year and bank fixed-effects, IV Estimates).

	Independent variables	High-guarantee banks NGL (1)	Low-guarantee banks NGL (2)
1	CG	−0.623	3.460
		(−2.70)***	(2.59)***
2	EQCAP	0.798	0.832
		(3.56)***	(1.18)
3	SIMPLEQ	0.236	0.511
		(2.00)**	(1.79)*
4	BASEL	0.002	−0.007
		(0.43)	(−0.69)
5	ASSETS	−0.002	−0.004
		(−4.74)***	(−2.95)***
	F-statistic	27.49	24.65
	Adjusted R^2	0.91	0.95
	OveridentificationTtest (*p*-value)	1.00	0.04
	Observations	350	73

Note: *t*-statistics are in parentheses below estimated coefficients.
  * Significant at the 10% level.
  ** Significant at the 5% level.
  *** Significant at the 1% level.
  High-guarantee Banks: CG > 1.25*EQCAP.
  Low-guarantee Banks: CG < (1/1.25) *EQCAP.

with the model, row 1 in Table 4 shows that, indeed, low-guarantee banks tended to complement their guaranteed loans with a multiple increase (3.460 per unit guaranteed loans) in non-guaranteed loans. Thus, guaranteed loans may well stimulate total lending considerably, providing substantial "bang per buck" in additional bank loans. But, in the case at hand, the marginal effects dwindled quite considerably as the size of the loan guarantee program grew, in that the "multipliers" for non-guaranteed loans at individual banks declined, and eventually became negative, as banks' holdings of guaranteed loans rose: If a guarantee program gets large enough, complementary guaranteed loans became substitutes for non-guaranteed loans.

The estimates in row 2 show that both groups of banks tended to hold more non-guaranteed loans when they had more capital. Although the capital estimates for high- and low-guarantee banks were both about 0.8, only the estimate for high-guarantee banks was statistically significant. Thus, unlike the guaranteed loan coefficient, the capital coefficient showed no sign of being affected by the amounts of guaranteed loans.

5.2.2. Imposing a constraint implied by the model

The specification in column 5 of Table 3, included the square of *CG*. That specification allowed the effect of guaranteed loans on non-guaranteed loans to vary with the amounts of guaranteed loans, which can be expressed as:

$$\beta_1 = \underset{(+)}{\delta_0} + \underset{(-)}{\delta_1} CG \tag{20}$$

Our model implies that $\delta_0 > 0$ and $\delta_1 < 0$. Our model has a further implication. The conditions in Eqs. (16) and (17) implies that β_1 equals zero when $(1 - \theta)CG = EQCAP$. Imposing that constraint on Eq. (20) delivers:

$$\beta_1 = \delta_0 \left\{ \frac{EQCAP - (1 - \theta)CG}{EQCAP} \right\} \tag{21}$$

Substituting Eq. (21) into Eq. (19) produces:

$$NGL_{b,t} = \delta_0 CGN_{b,t} + +\beta_2 SIMPLEQ_{b,t} + \beta_3 BASEL_{b,t} + \beta_4 ASSETS_{b,t} + \beta_b$$
$$+ \beta_t + \varepsilon_{b,t} \tag{22}$$

Table 5
Effects on non-guaranteed loans of guaranteed loans: extended specifications (All Japanese Banks, 1996–2002, year and bank fixed-effects, OLS).

	Independent variables	NGL (1)	NGL (2)
1	CGN	0.063	
		(2.20)**	
2	CG		0.912
			(1.52)
3	CG^2		−13.68
			(−1.85)*
4	CG^3		45.93
			(1.60)
5	EQCAP		0.867
			(5.95)***
6	SIMPLEQ	−0.010	0.212
		(−0.14)	(2.95)***
7	BASEL	−0.002	−0.003
		(−0.77)	(−1.11)
8	ASSETS	−0.008	−0.006
		(−8.49)***	(−6.36)***
	F-statistic	49.13	46.40
	Adjusted R^2	0.91	0.91
	Observations	705	599

Note: *t*-statistics are in parentheses below estimated coefficients.
  * Significant at the 10% level.
  ** Significant at the 5% level.
  *** Significant at the 1% level.

where $CGN_{b,t} = CG_{b,t}((EQCAP_{b,t} - (1 - \theta)CG_{b,t})/EQCAP_{b,t})$.

We estimated Eq. (22) to test whether the coefficient δ_0 was positive and statistically significant. In order to calculate the values of *CGN* by bank by year, we needed to assume a value for θ. For that purpose, we assumed that θ equaled 0.80.

Column 1 of Table 5 shows the estimates when the constraint on Beta1 was imposed. The positive and statistically significant (at the 1% level) coefficient on *CGN* suggests, again, that guaranteed loans were complements to non-guaranteed loans for banks that started with sufficiently-few guaranteed loans.

In addition, we wanted to examine whether our findings that guaranteed loans changed from complements to substitutes when banks had large enough amounts of guaranteed loans would hold up if we allowed for a more flexible specification than Eq. (20). To do so, we added a quadratic term in *CG* to Eq. (20):

$$\beta_1 = \underset{(+)}{\alpha_0} + \underset{(-)}{\alpha_1} CG + \underset{(+)}{\alpha_2} CG^2 \tag{23}$$

Substituting Eq. (23) into Eq. (19) gives:

$$L_n = (\alpha_0 + \alpha_1 CG + \alpha_2 CG^2)CG + \beta_2 EQCAP + \cdots, \tag{24}$$

Eq. (24) can be re-written as:

$$NGL_{b,t} = \alpha_0 CG_{b,t} + \alpha_1 CG_{b,t}^2 + \alpha_2 CG_{b,t}^3 + \beta_2 EQCAP_{b,t} + \beta_3 SIMPLEQ_{b,t}$$
$$+ \beta_4 BASEL_{b,t} + \beta_5 ASSETS_{b,t} + \beta_b + \beta_t + \varepsilon_{b,t} \tag{25}$$

Estimating Eq. (25) produced column 2 in Table 5. The estimated coefficients on *CG* trace out a similar pattern to the split-sample and other results above. When guaranteed loans are sufficiently few, non-guaranteed loans complement them, which is the implication of the positive coefficient on *CG*. Again, as our model and other regression results imply, as *CG* rises, the effects of *CG* on non-guaranteed loans decline, as implied by the negative estimated coefficient on CG^2. Although the estimated coefficient on CG^3 is large and positive, the estimated effects on non-guaranteed loans do not then turn positive (suggesting complementarity) for the values of *CG* in our dataset. We also note that, despite *CG* and CG^2 being statistically significant in column 5 of Table 3, adding CG^3 rendered each of the *CG* terms insignificant. The insignificance of CG^3 led us to prefer the specification in

column 5 of Table 3 over the specification in column 2 of Table 5.

6. Summary and implications

The risk-shifting aspects of deposit insurance have long been recognized. Similarly, the incentives created by substantial, and especially by total, guarantees of loans made by banks have also long been known to researchers, if not always to policymakers.

We examined theoretically and empirically the effects of a very large loan-guarantee program on banks' risk-taking and on their non-guaranteed lending. Both our theory and our evidence suggested that loan-guarantee program in Japan gave banks incentives to take more risk in the late 1990s.

While our model implied that loan guarantee programs always gave banks stronger incentives to take risks, our model delineated the conditions that made guaranteed loans either complements to or substitutes for banks' non-guaranteed loans. Non-guaranteed loans were more likely to act as complements, rather than substitutes, when banks started with fewer guaranteed loans. Thus, our model showed how loan guarantees could be "high-powered," in that they led to a multiple increase in non-guaranteed loans. Our empirical estimates supported the model's implications about when more guaranteed loans resulted in banks' also extending more <u>non</u>-guaranteed loans. Our estimates also suggested that loan guarantees have been "high-powered," thereby stimulating total lending by considerably more than just the additional guaranteed lending.

These results from this experience from long ago and far away may well be helpful when analyzing the financial crisis in the U.S. in the late 2000s. In response to the crisis and ensuing Great Recession, the supply of SBA loan guarantees rose and the associated fees fell. Those changes may then have boosted both U.S. guaranteed and non-guaranteed lending. Prior estimates and conventional wisdom may have underpinned support for those changes to loan guarantees. Our new model and new estimates here add to that support.

Appendix

Proofs of Propositions 1 and 2. To find the effects on bank risk-taking, X, and on non-guaranteed loans, L_n, of additional guaranteed loans, L_g, when $\rho > \rho^*$, we totally differentiated Eqs. (5) and (11) to get:

$$A(X)dX + B(X)dL_n + \theta dL_g = 0 \text{ (based on equation (5))} \tag{A1}$$

and

$$B(X)dX - C''(L_n)dL_n = 0 \text{ (based on equation (11))} \tag{A2}$$

where

$$A(X) \equiv [\{p''(X)X + 2p'(X)\}(1 - \rho)L_n] \tag{A3}$$

$$B(X) \equiv [\{p'(X)X + p(X)\}(1 - \rho) + \rho] \tag{A4}$$

Eqs. (A1) and (A2) together imply:

$$H(X)\begin{pmatrix} dX \\ dL_n \end{pmatrix} = \begin{pmatrix} -\theta dL_g \\ 0 \end{pmatrix} \tag{A5}$$

where the matrix $H(X)$ is defined as follows:

$$H(X) \equiv \begin{pmatrix} A(X) & B(X) \\ B(X) & -C''(L_n) \end{pmatrix} \tag{A6}$$

The determinant of $H(X)$, Δ, is given by:

$$\Delta = -C''(L_n)A(X) - B(X)^2 \tag{A7}$$

We are assured that both X and L_n have interior maximums if $A(X)$ is negative and if the determinant of $H(X)$, Δ is positive.[9] In that case, the inverse of $H(X)$ exists. Then, solving for dX and dL_n, we find

$$\begin{pmatrix} dX \\ dL_n \end{pmatrix} = \frac{1}{\Delta} \begin{pmatrix} -C''(L_n) & -B(X) \\ -B(X) & A(X) \end{pmatrix} \begin{pmatrix} -\theta dL_g \\ 0 \end{pmatrix} \tag{A8}$$

Eq. (A8) implies:

$$\frac{dX}{dL_g}\Big|_{X=X^*} = \frac{\theta}{\Delta}C''(L_n) > 0 \tag{A9}$$

Note that:

$$B(X^*) = -\frac{\theta L_g}{L_n} < 0 \tag{A10}$$

Then, Eq. (A8) implies:

$$\frac{dL_n}{dL_g}\Big|_{X=X^*} = \frac{\theta}{\Delta}B(X^*) < 0 \tag{A11}$$

For the case of $\rho < \rho^*$, we totally differentiated Eqs. (9) and (13) to get:

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[9] Note that these two conditions are easily satisfied. For example, if $p(X) = 1 - MX$ is defined over the range $[0, M^{-1}]$, then the two conditions hold. See Boyd and Nicolo (2005).

$$F(X)dX + G(X)dL_n + [(p'(X)X + p(X))\theta - p'(X)]dL_g = 0 \text{ (based on Eq.(9))}$$

(A12)

and

$$G(X)dX - C''(L_n)dL_n = 0 \text{ (based on Eq.(13))}$$

(A13)

where

$$F(X) \equiv [(p''(X)X + 2p'(X))(L_n + \theta L_g) - p''(X)(L_n + L_g - E)]$$

(A14)

$$G(X) \equiv [p'(X)(X - 1) + p(X)]$$

(A15)

Eqs. (A13) and (A15) together imply:

$$\widetilde{H}(X)\begin{pmatrix} dX \\ dL_n \end{pmatrix} = \begin{pmatrix} [p'(X) - \theta(p'(X)X + p(X))]dL_g \\ 0 \end{pmatrix}$$

(A16)

where the matrix $\widetilde{H}(X)$ is defined as:

$$\widetilde{H}(X) \equiv \begin{pmatrix} F(X) & G(X) \\ G(X) & -C''(L_n) \end{pmatrix}$$

(A17)

The determinant of, $\widetilde{H}(X)$, $\widetilde{\Delta}$, is given by:

$$\widetilde{\Delta} = -C''(L_n)F(X) - G(X)^2$$

(A18)

Then, solving for dX and dL_n, we obtain:

$$\begin{pmatrix} dX \\ dL_n \end{pmatrix} = \frac{1}{\widetilde{\Delta}}\begin{pmatrix} -C''(L_n) & -G(X) \\ -G(X) & F(X) \end{pmatrix}\begin{pmatrix} [p'(X) - \theta(p'(X)X + p(X))]dL_g \\ 0 \end{pmatrix}$$

(A19)

Eq. (A19) implies:

$$\left.\frac{dX}{dL_g}\right|_{X=X^*} = -\frac{\theta}{\widetilde{\Delta}}[p'(X^*) - \theta(p'(X^*)X^* + p(X^*))]C''(L_n) = -\frac{\theta}{\widetilde{\Delta}}\left[\left(1 - \frac{\theta D}{L_n + L_g}\right)p'(X^*)\right] > 0$$

(A20)

Similarly,

$$\left.\frac{dL_n}{dL_g}\right|_{X=X^*} = -\frac{\theta}{\widetilde{\Delta}}G(X^*)[p'(X^*) - \theta(p'(X^*)X^* + p(X^*))] = -\frac{\theta}{\widetilde{\Delta}}G(X^*)\left[\left(1 - \frac{\theta D}{L_n + L_g}\right)p'(X^*)\right]$$

(A21)

Note that $G(X^*) = [p'(X^*)(X^* - 1) + p(X^*)] = p'(X^*)\left(\frac{L_n + L_g - E}{L_n + \theta L_g} - 1\right)$

Therefore, if the condition $\frac{L_n + L_g - E}{L_n + \theta L_g} > 1$ holds, i.e., $(1 - \theta)L_g > E$ holds, then $G(X^*) < 0$, and $\left.\frac{dL_n}{dL_g}\right|_{X=X^*} < 0$.

Similarly, if the condition $\frac{L_n + L_g - E}{L_n + \theta L_g} < 1$ holds, i.e., $(1 - \theta)L_g < E$ holds, then $G(X^*) > 0$, and $\left.\frac{dL_n}{dL_g}\right|_{X=X^*} > 0$. □

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