Financial Intermediation, Agency and Collateral and the Dynamics of Banking Crises: Theory and Evidence for the Japanese Banking Crisis

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August 2002
First Draft for Comments Only

Abstract

We outline a model of an endogenously evolving banking crisis in a growing economy subject to either idiosyncratic or aggregate productivity shocks. The model incorporates agency problems at two levels: between firms and their banks and between banks and the banks' depositors and deposit insurers. In equilibrium, banks have an incentive to renegotiate loans to insolvent firms, leading to an increasing contingent liability of the government with deposit insurance and regulatory forbearance. The growth rate of output is endogenous, and we explain how the agency problems affect the qualitative dynamics of the economy in this framework. We find that the dynamics predicted by our model fit the recent behavior of the Japanese economy well. As Japan was hit by a succession of adverse aggregate shocks in the 1990s, bank portfolios continued to deteriorate, and the market value of collateral (land) collapsed. The decline in collateral values led to a fall in bank lending, a decline in physical investment, and finally, a fall in GDP.

1. Introduction

One of the most important issues in international finance today is the weakness in the Japanese financial system. Japanese banks have been saddled with high non-performing loans. These problems in the banking system have led to a contraction in bank lending, worsening Japan's recent economic downturn. Despite the injection of massive public funds in late 1998, problems loans have continued to mount, renewing international pessimism about the Japanese banking sector, as evidenced by the widening "Japan Premium" on internationally traded Japanese bonds.

In this paper, we outline a model of an endogenously evolving banking crisis in a growing economy subject to either idiosyncratic or systemic productivity shocks. In our model, the banking crisis arises progressively as banks renegotiate loans to insolvent enterprises. We explain how deposit insurance schemes, under which banks are not continuously assessed premiums based on the true riskiness of their portfolios due to private information, change the dynamics of loan renegotiation and rollovers. The model incorporates agency problems at two levels: between firms and their creditor banks and between banks and their creditors - depositors and the deposit insurer. The agency model extends the model of Dekle and Kletzer [2002] of bank intermediation applied to twin crises in the emerging markets of East Asia which is based on credit market models of Bernanke and Gertler [1988, 1990].[1] In these models, the agency problem between banks and firms is mitigated by partial self-financing requirements. In our model, loan renegotiation erodes the degree of co-financing enforced by banks leading to ever riskier investment decisions.

In the agency problem faced by a guarantor of deposits, the erosion of bank capital increases contingent liabilities and the riskiness of bank actions. The deterioration of the banking sector arises progressively and endogenously in the stochastic growth model even though output can continue to grow at a constant, or even rising rate, as the production sector becomes more vulnerable to shocks over

time. An output decline follows widespread bank insolvencies as the resources available for investment in new projects diminishes as evergreened non-performing assets dominate bank portfolios. Our model emphasizes the role of the market value of enterprises by introducing adjustment costs in investment and firm capital as collateral for loans. The value of collateral is endogenous and decreases as the riskiness of a firm's investments rises with diminishing at-risk capital for the firm's shareholders. Self-financing naturally equals shareholder equity, and our addition of adjustment costs makes this interesting. The value of each firm's capital depends upon the history of renegotiation of its loan repayments as well as the history of its productivity. Adverse shocks lead to decreases in the share of equity in capital, which in turn induces the firm to undertake riskier projects. This erodes the value of the firm's capital in our model economy, reducing further the capacity of banks to recover the value of their loans.

Deposit guarantees and regulatory forbearance affect the dynamics of the economy qualitatively in this framework. If banks are required to reserve against all non-performing loans continuously, bank shareholders are unable to pay out dividends against future insurance indemnities under limited liability rules. With loan loss reserves, the progressive increase in riskiness and bank insolvencies will not occur. However, with deposit guarantees and no continuous monitoring of non-performing assets, the owners of banks always have an incentive to raise the liability of the insurer paying dividends against non-performing loans in a portfolio that becomes stochastically riskier.

The model is extended by introducing an second sector producing a non-tradable good (housing services) in which loans are covered by tradable collateral (housing capital). Capital used in the production of tradable goods by a firm can be sold at its opportunity value in the housing sector in this case. The model implies that decreasing output due to a common aggregate productivity shock will lead to a reduction in the value of collateral, hence an increase in loan renegotiations. This propagates through lower debt-equity ratios and riskier investments to stochastically deteriorating bank balance sheets. We discuss how temporary shocks can have long-term effects on investment and productivity

through financial intermediation in a dynamic model of imperfect credit markets.

We find that the dynamics predicted by our model fit the Japanese pattern well. As Japan was hit by a succession of adverse aggregate shocks in the 1990s, bank portfolios continued to deteriorate, and the market value of collateral (land) collapsed. The decline in collateral values led to a fall in bank lending, a decline in physical investment, and finally, a fall in GDP growth.

We find that our story of a banking crisis, embeded in a growth model with financial intermediation, provides a complement to the traditional view of Japan's banking crisis in the 1990s. The traditional view puts the blame of Japan's banking mess on the pattern of deregulation that started in the mid-1970s.[2] Briefly, as alternative financial instruments were introduced, higher quality customers (that is, large, internationally-oriented firms) moved to raise funds directly in the domestic and foreign bond markets. When large banks started to lose their large clients in the late 1980s, they began lending to small- and medium-sized firms. As the asset priced boom in Japan in the late 1980s collapsed, the Japanese economy slumped into prolonged stagnation. The small- and medium-sized firms had difficulty paying back their loans, and bank non-performing loans soared.

Our general equilibrium model, while not downplaying the role of bond market deregulation, puts the blame for the banking crisis more squarely on moral hazard in banking lending. Cargill, Hutchison, and Ito [1997], and Cargill [1999], as in our paper, emphasize the roles explicit and implicit deposit guarantees and regulatory forbearance played in the crisis, although they do not propose a formal model of credit market dynamics.[3] We also emphasize the role that the government has played in exacerbating this moral hazard, by providing implicit and explicit guarantees to bank deposits, and by being lax in prudential regulation and enforcement.

The next section sets up the theoretical model and outlines its implications for the dynamics of bank intermediation, banking crisis and output growth. The third section connects the assumptions and implications of our dynamic framework to the institutional environment and experience of the Japanese

economy in recent decades. The fourth section concludes with some provisional policy implications.

2. A Theoretical Model of Financial Crisis

We portray the development of a banking crisis in an endogenous growth model of financial intermediation in an infinitely-lived economy with capital accumulation in discrete time. Firms are established by entrepreneurs each of whom has access to a set of projects that can be undertaken. Domestic household savings net of foreign asset accumulation finances domestic investment by firms. All financial flows are intermediated by banks. In our model, banks are firms that operate a monitoring technology, and some of the potential entrepreneurs have access to this technology. This simple set up allows us to abstract from inessential characteristics of firm and industry structure. The number of potential firms is fixed.

The economic environment is described first and followed by an analysis of the dynamics of bank lending. The dynamics of a financial crisis and its consequences for economic growth are then discussed.

2.1 Economic Environment

We begin by assuming that there is a single good that can be consumed, invested or traded internationally and will add a second non-tradable consumption good later. Output is produced using capital and entrepreneurial labor. Investment is costly to reverse, and for simplicity's sake, we ignore depreciation of the capital stock. Production takes one period, and the output produced in any period is stochastic.

All residents have identical preferences over infinite-horizon consumption plans and are endowed with a single unit of labor each period. Each person is a potential entrepreneur who operates a technology using the capital accumulated by the firm and her single unit of labor. The investment opportunities available to different people are not necessarily identical, so that entrepreneurs may be

heterogeneous with respect to skills or knowledge. The set of techniques of production available to each entrepreneur does not change exogenously over time, but the distribution of output in any period displays serial correlation. In any period, the entrepreneur makes a project choice from a set of potential projects that depends upon the past choices made by the firm. That is, the returns to current investment decisions depend upon the past investment decisions for the firm. A subset of potential entrepreneurs know how to operate banks and do so.

Households are risk averse and seek to smooth consumption over time. They receive entrepreneurial income and interest earnings from financial savings. The utility function for a household is given by

$$U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} u(c_s), \tag{1}$$

where $u(c)$ is strictly concave and the discount factor satisfies $0 < \beta < 1$. Households maximize utility with respect to a consumption plan subject to the intertemporal budget identity,

$$a_{s+1} - a_s = \left(r_s^d w_s + r^* f_s\right) + \pi_s - c_s - \varphi\left(w_s\right), \tag{2}$$

and the solvency condition,

$$\lim_{s\to\infty} a_s \prod_{v=t}^{s-1} \left(\frac{1}{1+r_v^*}\right) \geq 0, \tag{3}$$

given initial financial wealth, $a_t = w_t + f_t$. All expenditures and assets are denominated in units of domestic currency. Deposits held in domestic banks which earn a deposit rate of interest, r^d, are denoted by w, and f denotes holdings of interest-bearing internationally tradable bonds which earn interest, r^*. Money is held (in the form of interest-bearing deposits) to economize on transactions costs, $\varphi\left(w_t\right)$, where $\varphi'\left(w_t\right) < 0$. If domestic residents hold foreign assets or domestic government debt in equilibrium, then the opportunity return to domestic bank deposits, $r^d - \varphi'\left(w_t\right)$, will be equal to the opportunity rate of interest, r^*. Banks can also hold foreign assets or government debt. π represents entrepreneurial income from production. The model is written under the simplifying assumption that each entrepreneur owns the equity in her firm. Informational assumptions made below will justify

household portfolio diversification through banking rather than through the holding of tradable firm equities. We can still model the value of firm equities without explicitly introducing a stock market using this set up. Demand deposits can pay a non-negative rate of return so that money is held only as deposits in equilibrium for the model economy.

Firms are associated with entrepreneurs. Production requires one unit of entrepreneurial labor each period, and output is proportional to the capital stock employed by the firm. There are constant returns to capital and increasing returns to entrepreneurial effort. The net output produced by any given input bundle is stochastic. A particular collection of available projects is identified with each firm. These projects differ with respect to the distribution of output produced across states of nature for any given capital input. The set of projects associated with a firm does not change over time, but the distribution of output produced under a given project changes endogenously with the past choices of the firm.

The production function for a firm j is given by

$$y_t^j = \alpha_t^j k_t^j, \tag{4}$$

where k_t^j is the capital stock of firm j at the beginning of period t, y_t^j is period t output (net of the capital stock) and α_t^j is the stochastic marginal and average productivity of capital. For each possible project, α_t^j is non-negative, and the distribution of α depends on a state variable, $\phi_t\left(\phi_{t-1}, \xi_t\right)$, where ξ_t is an index for the project chosen in period t. The investment decision of the firm is an ordered pair of the increase in the capital stock,

$$i_t = k_t - k_{t-1},$$

and the choice of project, ξ_t, from among those available to the particular firm. This is a simple way to capture serial correlation in output for the firm due to choices that cannot be directly monitored (the choice of ξ_t) by creditors.

We also implicitly assume adjustment costs to investment so that the value of the firm can be expressed as the product of a price, q, and the capital stock, k, excluding current net output, y. Because

credit market imperfections arise in this economy, q will depend upon k in general, even if adjustment costs are quadratic. In equilibrium, the value of the firm,

$$V_t^j = q_t^j k_t^j + \alpha_t^j k_t^j,$$

is stochastic. q_t^j is stochastic because the firm's investment decisions from period t onward depend upon the realization of α_t^j at time t. $q_t^j k_t^j$ reflects the past investment decisions, both capital accumulation and project selection, by the firm.

Capital accumulation by firms can be financed by borrowing from banks or through self-investment. Dividends, debt repayments and self-financed investments are paid from net output, y_t. Each entrepreneur seeks to diversify her income risk by allocating her wealth between bank deposits and equity in her own firm. These are the only two choices taken in equilibrium due to imperfect information. Bankers are assumed to have an absolute advantage monitoring the choices of projects, output realizations and values of firms over households. Households reduce their exposure to risk by lending to banks which in turn lend to many firms to diversify against individual firm project risk for depositors. Banks, like other firms, can use current profit income to increase bank capital or to pay dividends to its owner. The model of entrepreneurship is used to represent corporate borrowing, so that we add the restriction that the household cannot be forced to draw against its other assets to provide additional capital to the firm. That is, the role of the owner as manager is separated from the role of the household in aggregate savings and consumption in a Robinson Crusoe fashion.

Following existing well-known models of banking as delegated monitoring (Diamond [1984], Freixas and Rochet [1997]), the asymmetric informational advantage of banks rules out direct equity investment by households in the projects of other firms and implies that banks use conventional debt contracts. The output realizations by a firm in each period are observed at no cost by the manager of that firm only, so that they can also evaluate the current value of the firm at no cost. Banks are able to observe the current value of the firm, V_t^j, at a positive cost. For simplicity, we assume that households

are unable to observe the realized output or value of any firm other than their own at finite cost and do not have information regarding the projects that other firms can undertake. Further, banks are unable to observe the project choices taken by a firm, but do know the capacities of different entrepreneurs. That is, a bank knows the set of projects available to a firm and can observe the past and current loan contracts taken by the firm. Along with observability of the firm's past investment decisions, bankers can infer which project would be undertaken by an optimizing firm in equilibrium. However, it can only influence the firm's choice of projects indirectly through the quantity and interest rate charged on loans. The asymmetry of information rules out direct contracting on project selection, as in Stiglitz and Weiss [1981]. The availability of information regarding the state variables, k_t^j and ϕ_t^j, to banks allows them to value the capital stock of firms, so that q_t^j is known to lenders. The costs of monitoring a firm are indivisible, implying that each firm borrows from only one bank in equilibrium to realize economies of scale in financial intermediation.[4]

Costly observability can be used to rationalize bank lending using standard debt contracts, but the primary informational asymmetry here concerns the choice of project by the firm. This choice gives rise to adverse selection as in a variety of credit market models following Stiglitz and Weiss [1981]. The bank lends an amount ℓ_t to a typical firm in period $t-1$ to finance a capital stock equal to k_t which will produce output in period t. The firm selects its project for period t in period $t-1$ to maximize the expectation of the value of its equity. The firm's capital stock evolves according to

$$k_{t+1} - k_t = \alpha k_t - \pi_t - R_t \ell_t + \ell_{t+1} - c\left(i_t\right), \tag{5}$$

where R_t is the gross interest charged to the period t loan and $c\left(i_t\right)$ are adjustment costs, where superscripts j have been dropped. The firm's value is given by

$$V_t - R\ell_t = q_t k_t + \alpha_t k_t - R\ell_t, \tag{6}$$

but under limited liability, the value of the owner's equity is

$$\widetilde{V}_t = \max\left\{q_t k_t + \alpha_t k_t - R\ell_t, 0\right\}. \tag{7}$$

The return to the lender is given by

$$V_t^b = \min\left\{R_t\ell_t, q_t k_t + \alpha_t k_t - \gamma\right\} - \left(1 + r_t^d\right)\ell_t, \tag{8}$$

where γ represents the cost of observing current output.

This model introduces collateral into the agency model of banking used in Dekle and Kletzer [2002] through the inclusion of firm capital and adjustment costs to capital accumulation. The value of the collateral depends upon the investment choices of the firm and is a forward-looking quantity (through q_t). The decisions of a bank after a firm chooses to default on its debt will influence the value of the loan collateral, $q_t k_t$, in this economy. Furthermore, firms will make their forward-looking decisions cognizant of the limited liability of their equity holders and of bank renegotiation of future debts during periods of firm distress. The path dependence of the value of the firm is very important for the consequences of time consistent equilibrium behavior of banks and firms is this framework. The role of collateral here differs markedly from that in Kiyotaki and Moore [1997]. Repayments are not limited to the value of collateral (net output can also be used to satisfy debt obligations in bankruptcy), and loans are risky for banks. The value of collateral also depends on firm actions which cannot be contracted upon with lenders. In Kiyotaki and Moore [1997], an entrepreneur could go bankrupt, lose her capital and simply borrow again to purchase more capital using a loan that is fully collateralized by that capital. To do so, the firm would need access to resources to pay the interest (forward) on that loan (the downpayment in that model). This is consistent with that model, because net output cannot be attached by the banks; however, it plays no strategic role because borrowers cannot gain (or lose) by reneging on loan repayments, going bankrupt and starting out fresh.[5] Asymmetric information complicates this in our approach.

Below, we concentrate on the renegotiation of loans. However, if a bank forecloses a loan and claims the collateral, it will need to resell the firm's capital. For the single sector model developed here, the value of the capital stock to another entrepreneur can be either greater or lower than it is for the current firm. The value of the capital stock per unit, q_t^j, is a forward looking variable that depends upon the state variable, ϕ_t^j, which is firm specific. Another entrepreneur, i, will have available to her other projects, but our assumptions are consistent with the implication that past project choices by firm j affect the distribution of output under any of entrepreneur's i projects. The value of collateral may be higher or lower in resale to the highest bidder after bankruptcy and dissolution of the firm's assets.

Under limited liability for the firm, the returns to investment are convex, rather than concave, so that the firm will select ever riskier projects from among those with a common mean return as the gross interest obligations rise (Stiglitz and Weiss [1981]). The projects chosen by firms will not be those that maximize the expectation of the present value of current and future output because downside risk is borne by the firm's creditor. While informational imperfections restrict an entrepreneur's capacity to diversify her income risk, limited liability under conventional debt contracts provide a degree of risk sharing between households that is constrained by the disincentives for risk avoidance by firms. Co-financing of investment can reduce the incentives for the firm to choose a riskier project and raise the expected return to the lender. In this model, co-financing requires that shareholder assets include part of the value of the capital stock, even though the bank can set collateral equal to the total capital stock, k_t. Co-financing equals the difference between the equity value of the firm and the total debt, $q_{t-1}k_t - \ell_t = x_t$. The bank chooses a combination of loan size, ℓ_t, rate of interest, $r_t = R_t - 1$, and co-financing requirement,

$$z_t = \frac{q_{t-1}k_t - \ell_t}{q_{t-1}k_t},$$

to maximize its expected return. As z decreases, the riskiness of the projects selected by the firm currently and in the future rises. Bernanke and Gertler [1989 and 1990] demonstrate the importance of

co-financing as a solution to the agency problem in banking and for generating credit cycles.

The firm faces a decision of whether to declare bankruptcy based on its observation of current output from past investment decisions. It chooses to declare bankruptcy, or if it can, seek to renegotiate its debts, if

$$q_t k_t + \alpha_t k_t - R\ell_t < 0 \tag{9}$$

$$\Rightarrow q_t k_t - (1 - z_t) Rq_{t-1} k_t + \alpha_t k_t = (q_t - Rq_{t-1}) k_t + (z_t Rq_{t-1} k_t + \alpha_t k_t) < 0.$$

The firm also decides the riskiness of the project it chooses in period t given the distribution of its returns,

$$\max \{z_t Rq_{t-1} k_t + \alpha_t k_t, 0\}, \tag{10}$$

under each of the projects available to it. This choice depends upon the terms of the loan contract, including co-financing.

Irreversibility in investment in this model does not incorporate time-to-build assumptions. This could easily be added to allow for the possibility of self-fulfilling bank runs as demonstrated by Diamond and Dybvig [1983]. This extension is not explored in this paper.

The economy can be opened to international financial capital inflows and outflows. In this case, net capital inflows will equal the current account deficit plus any increase in central bank reserves (through the balance of payments identity). Foreign asset accumulation and decumulation are not central to our discussion of banking crises under a flexible exchange rate regime in this paper. Fiscal policy is important because the deposit insurance liability of the government will grow over time in the cases considered below. Although public expenditures are unimportant for growth in this model, public debt and public sector contingent liabilities accumulated through deposit insurance and other guarantees of the financial sector are important. The implied future tax liabilities of both can be financed by lump-sum taxes imposed on households, or through monetization. Households will take these into account through their intertemporal budget constraints, but deposit insurance will be distortionary in

equilibrium. Therefore, contingent government liabilities associated with financial sector distress do not result in pure redistributions of taxes and transfers over time, and so public debt is not neutral in this economy.

2.2 Bank Lending and Firm Growth

In this section, we consider the dynamics of domestic bank lending and economic growth in our model economy under contrasting institutional environments. Borrowing and investment is discussed for a typical firm, although firms are assumed to be heterogeneous. We rule out the possibility noted above that bank foreclosures can result in value-enhancing (or reducing) reorganizations of firms under a new entrepreneur. Any such value-increasing bankruptcies can only be transitory in this model with a finite supply of entrepreneurs and stochastic production. If another entrepreneur can generate a higher value from the capital stock of a firm, the current equity holder will want to sell her interest and move on, so that such cases should be eliminated in the absence of firm financial distress.

At the end of period $t-1$, let a typical firm have a capital stock equal to k_t and a debt equal to $(1-z_t)\,q_{t-1}k_t$. The collateral for this loan can be the entire stock of capital, k_t. The firm will wish to repay its loan in period t if the realization of α in period t satisfies the inequality,

$$q_t k_t + \alpha_t k_t - R\ell_t \geq 0, \tag{11}$$

where

$$\ell_t = (1-z_t)\,q_{t-1}k_t.$$

The flow budget identity for the firm is given by equation (5) so that if the firm foregoes a dividend, the capital stock evolves as

$$k_{t+1} - k_t = \alpha k_t - (1-z_t)\,Rq_{t-1}k_t + (1-z_{t+1})\,q_t k_{t+1} - c\,(i_t)\,. \tag{12}$$

For constant z and q, this becomes

$$k_{t+1} - k_t = (\alpha k_t - c(i_t)) - (1-z)\, q\, (R k_t - k_{t+1}), \tag{13}$$

which can be rewritten as

$$k_{t+1} - k_t = \frac{\alpha k_t - c(i_t) - r\ell_t}{1-(1-z)\, q}. \tag{14}$$

Equation (14) shows the growth rate of a firm that remains solvent in period t. If this were a deterministic constant returns to scale growth model, adjustment costs could be set equal to zero for steady-state (balanced) growth and positive for deviations from this growth rate. In that case, q would equal unity along the balanced growth path and the condition would simplify to

$$k_{t+1} - k_t = \frac{1}{z}(\alpha k_t - r\ell_t) \tag{15}$$

and

$$\ell_{t+1} - \ell_t = \frac{1-z}{z}(\alpha k_t - r\ell_t), \tag{16}$$

which emphasize that the firm grows roughly in proportion to additional investment made its owners, $\alpha k_t - r\ell_t - c(i_t)$, where the constant of proportionality rises as the co-financing share decreases. The inverse of $(1-(1-z)\, q)$ is a financial accelerator in this model (as in Bernanke and Gertler [1989, 1990] and Bernanke, Gertler and Gilchrist [1999]). In the agency model, z will be positive and less than one in equilibrium.[6]

A solvent firm can grow endogenously with realizations of the productivity of capital drawn from its chosen distribution each period. The capital accumulation equation (14) implies that a firm will expand if net income, $\alpha k_t - r\ell_t$, is positive. In this case, it would be profitable for any bank to assume the outstanding debt of the firm, ℓ_t. Therefore, competition among banks ensures that the interest rate charged on the loan, ℓ_{t+1}, is independent of any particular bank's loan portfolio.[7]

Consider a case in which realized output is low,

$$\alpha k_t - r\ell_t < 0, \tag{17}$$

but

$$q_t k_t + \alpha_t k_t - R\ell_t \geq 0, \tag{18}$$

so that the firm is solvent. The equation of motion implies that the firm must shrink, and adjustment costs imply that q will fall reducing the accelerator. In this case, the owner of the firm is better off repaying the debt than abandoning the collateral to the bank.

If

$$q_t k_t + \alpha_t k_t - R\ell_t < 0, \tag{19}$$

then the value of the shareholder equity in the firm is negative and will prefer bankruptcy to repaying its debt. The current creditors may be able to do better than take possession of the capital stock of the firm, k_t. This is because the bank will need to sell the firm. The value of the firm will depend upon the level of self-financing of its purchase by any other entrepreneur and that entrepreneur's access to projects. The project selected by any firm depends upon the ratio of equity to total firm value in the agency model. As self-financing decreases, the entrepreneur will select a riskier project (for example, from among those with the same mean productivity). For any given level of self-financing, no other entrepreneur can raise the value of the firm's capital stock. We have assumed that the supply of entrepreneurs is inelastic and that every one has established a firm of her own already. Therefore, the best that the bank can do if it forecloses is to sell the firm's capital stock, fully leveraged, to another owner.

Essentially, the bank can take the entire shareholder equity of the firm if it chooses to do so, but this may not be optimal. q is forward-looking and depends upon the current project choice of the firm in this economy. Therefore, the value of the capital stock depends upon the level of self-financing and decreases as this declines. There are two reasons why a bank can optimally renegotiate its loans to insolvent firms if allowed to do so. The first is that it now has monopoly power over the terms of new loans. Subsequent renegotiations may be more probable as it raises the interest rate charged, but the bank's debt also becomes more an equity claim than a conventional debt claim. Second, the bank

may maximize its value by reducing the debt obligation of the firm so that shareholder equity remains positive. The value of the debt claim to the bank depends upon the project choice of the firm, which cannot be directly contracted upon.

The first of these follows from the observation that the firm would need to borrow the old loan principal plus interest from a new lender, so that the new lender must charge a premium on the loan to cover the cost of paying off the old debt net of the remaining value of the firm. The interest premium also induces riskier project selection. The current bank may gain by offering a new loan when other lenders will not. This is the case if

$$\max_{R,\ell} E_t \left[\min \left\{ R\ell, q\ell + \alpha\ell - \gamma \right\} - \left(1 + r_{t+1}^d \right) \ell \right] > 0 \tag{20}$$

conditional on the optimal choice of project by the borrower conditional on R and ℓ. The interest rate charged may be constrained by the interest rate that a new lender would impose, if such a loan could be made profitably. If there is no such loan, then the firm's current lender faces no potential competition in a debt renegotiation from the rollover market. The (stochastic) returns over the opportunity costs of funds for the renegotiated debt reduce the bank's liability from the outstanding period t debt, $R_t \ell_t$. Therefore, the firm's bank can choose to rollover the unpaid debt and offer new capital in exchange for a deeper claim, $R_{t+1} \left(\ell_t + k_{t+1} \right)$, against the subsequent equilibrium value of the firm, $\left(q_{t+1} + \alpha \right) k_{t+1}$, in high productivity states for the firm. The supernormal profits on these rollovers encourage the renegotiation of short-term bank debt and discourage the formal bankruptcy of insolvent firms when inequalities (19) and (20) hold. For inequality (20) to hold, we need to impose the condition that the optimal project choice of the entrepreneur when $z = 0$ yields at least positive expected total surplus; that is, $E_t \alpha > r_t^d$. Banks can write these loan renegotiations as a rollover of the unpaid outstanding debt (plus, possibly, new principal to cover additional investments); this is essentially evergreening of the firm debt. Repeated loan rollovers can allow the bank to acquire a permanent monopoly franchise on lending the firm, but the bank will seek repayments in equilibrium that maximize the bank shareholder's

expected utility from the total portfolio.[8]

Once a loan has been renegotiated, the share of equity in the value of the firm has decreased (likely, to zero) and the firm chooses riskier projects. This has two effects in this model. One is that the probability of further debt difficulties rises. The other is that the value of the collateral falls. The bank can continue responding by renegotiating the firm's debts, effectively becoming an equity holder. Eventually, the probability that the value of the firm is less than the opportunity cost of its capital,

$$\Pr\left\{\alpha k_t \leq \left(1 + r_t^d\right) k_t\right\},$$

rises. Post-renegotiation, the bank's portfolio is becoming riskier. The renegotiation of loans by the bank is forward-looking and rational, although each renegotiation represents a loss for the bank. Further, the value of the bank's portfolio is path-dependent.

Condition (20) assumes that the bank meets its deposit obligations with probability one. With limited liability, the bank will take a riskier renegotiation strategy. In this second tier agency problem, the bank will take ever riskier actions as its equity decreases. The incentives to renegotiate, that arise in the expression (20) will lead the bank toward an ever riskier portfolio as the bank owner's equity declines. Under deposit insurance, the liability of the government rises stochastically over time in this economy as the bank's clients become stochastically insolvent. The value of the bank's assets, inclusive of collateral, can be deteriorating over time if the bank's liability is limited.

It is common to require that banks reserve against loan losses. Continuous loan loss reserving means that the bank's equity falls simultaneously when firms fail to repay their debts and the bank renegotiates. Under this type of regulation, the bank bears the full cost of risky loans and of risk increases with debt renegotiation. In the absence of regulatory enforcement that requires bank shareholders to pay the entire increase in portfolio risk, the insurer pays at least part of the cost. Each renegotiation becomes more likely, and bank equity decreases stochastically under subsidized deposit insurance without continuous monitoring of the bank's portfolio. Under limited liability, the bank's shareholders have an incentive

to pay out dividends agains the value of the contingent liability of the insurer. Monitoring the bank's portfolio, restricting evergreening and requiring loan loss reserves removes these incentives and limit the increase in the riskiness of aggregate investment.

For firms that have able to repay their debts in full in the previous period (for example, growing firms), a bank faces competition from other banks and charges the market risk premium on loans to these firms. This premium covers the expected present value loss if revenues fall short of the opportunity cost of the funds lent, where this present value takes into account the equilibrium renegotiation of the loan should it fall into default. Competition implies that a bank cannot charge a premium on loans to solvent clients so as to cover past losses on other, renegotiated, loans in its portfolio. With limited liability, banks will not hold perfectly diversified loan portfolios even if they can. As a loan is renegotiated (without loan loss reserving), a bank with constant deposits will begin shifting its loan portfolio towards this firm. The probability of a subsequent rollover rises with each renegotiation as the positive probability that $\alpha k_t + q_t k_t \leq R_t \ell_t$ rises as $\ell_t - q_t k_t$ rises stochastically with low productivity shocks. The probability that the bank will be unable to meet its deposit obligation,

$$\Pr\left\{\sum_j \min\left\{\alpha^j k_t^j + q_t^j k_t^j - \gamma, R_t^j \ell_t^j\right\} < \left(1 + r_t^d\right) \sum_j \ell_t^j\right\} > 0, \tag{21}$$

must rise stochastically. That is, its expectation is non-decreasing. The sum in inequality (21) is taken with respect to the all the client firms of the individual bank.

As the probability that a bank becomes insolvent rises, the equity of the bank shareholders is falling. The bank has an incentive to take ever riskier lending actions as its equity falls and its deposit insurance indemnity rises. As bankruptcy becomes more likely, the distorting effect of the deposit insurance subsidy will rise. There is an acceleration of the process of individual bank fragility and overall financial instability due to debt accumulation with inadequately regulated deposit insurance.

In the endogenous growth model, banks can grow as long as household savings is positive which will be true if the average net productivity of capital exceeds the discount rate of households and any

risk premium associated with the residual risk faced by households in equilibrium. Eventually, however, some firms do become insolvent as implied by equation (14). As these loans are renegotiated, less capital is available to lend to solvent growing firms. In the closed economy, domestic savings constrains the growth of the aggregate capital stock, so that loan rollovers necessarily reduce the growth rates of other firms. As bank portfolios become riskier, the co-financing requirements for solvent firms must rise as other firms are unable to repay their current debts. This provides a partially offsetting effect in the closed economy; solvent firms will expand more slowly but make less risky project selections. In an open economy, foreign asset decumulation allows the banking system to sustain lending to firms that are solvent, so that the capital stock of such firms expands. Aggregate output can continue to grow and the value of the corporate sector can expand even though the value of the banking system declines over time in the open economy.

Without forced write-downs of or reserve accumulations against non-performing assets, bank portfolios will become increasingly risky over time. As the size of successful firms grows, these firms remain vulnerable to adverse productivity shocks. With increasingly concentrated bank portfolios, banks face increasing risk from solvent firms in the endogenous growth model. However, these are consequences of the failure of regulation with limited bank liability. With loan loss reserves continuously and correctly adjusted, banks have incentives to foreclose loans. The losses do not accumulate as rising contingent public liabilities. Instability of the banking system arises in the presence of idiosyncratic project risk under an agency problem.

This model could be extended to allow for differential costs of monitoring firm behavior between savers and banks. In the model of Holmstrom and Tirole [1997], firms begin to borrow directly as their capital increases. Access to direct borrowing could be added to this framework to provide another reason for competitive pressure to keep down interest rates for successful borrowers as bank portfolios shift towards non-performing firm debt.

2.3 Aggregate Shocks and Bank Regulation

In this model, idiosyncratic productivity shocks lead to financial fragility in the sense that the portfolios of individual banks become progressively riskier over time with inadequate monitoring by creditors. In the stylized model, the deposit insurer needs to monitor the banks' response to non-performing loans. As a bank's portfolio contains more non-performing assets and the loans to successful firms become more concentrated, the average value of the bank's collateral is also decreasing. A fall in the at-risk capital of a firm's shareholders leads to riskier project selection and hence to a lower value of the firm as a ratio of its capital stock.

Now, we consider the impact of aggregate productivity shocks. These are systemic shocks to the productivity of all firms. A decline in the value of collateral leads to a sudden decrease in the equity of shareholders given by

$$\widetilde{V}_t = \max\left\{q_t k_t + \alpha_t k_t - R\ell_t, 0\right\}$$

because the outstanding stock of debt is related to the ex ante value of the collateral,

$$\ell_t = (1 - z_t)\, q_{t-1} k_t.$$

An exogenous shock to $q_t k_t$ will lead the firm to contract and lower its level of self-financing. This leads to a riskier choice of project for the firm and, hence, higher bank risk.

The collateral value can fall if there is an aggregate shock to productivity even if it is a one-time event. A contraction in the size of a solvent firm or renegotiation of loan that becomes non-performing due the adverse productivity shock raises productivity risk for the next period which lowers $q_t k_t$. A once off shock leads to a reduction in the value of bank portfolios and has long-term effects through project selection with limited liability under imperfect information. By renegotiating loans after an adverse aggregate shock, the insurance liability of the banks rises and the probability that these liabilities will rise the next period also increases. The losses due the aggregate shock are not all taken in permanent

income and consumption at the time of the shock. The realization of these losses in not only postponed, but leads to riskier investment decisions in the aggregate. If banks self-insure, then the shock does not lead to these additional distortions that play out dynamically through future investment decisions by firms.

For this economy, the vulnerability of the banking system to firm insolvencies is rising over time with idiosyncratic shocks. This implies that the vulnerability of the economy to systemic productivity disturbances is also rising in the presence of deposit insurance and poor monitoring of loan loss reserving or foreclosures by the deposit insurer. With purely idiosyncratic shocks, output is growing on average with the economy-wide expectation of the productivity of capital. As the non-performing loans of solvent banks rise over time, a larger share of savings deposits represent the contingent liability of the government and, hence, an ultimate tax liability of the depositors. Solvent firms grow endogenously in the constant returns model according to equations (14) drawing more resources into the banking system, and the overall capital stock grows. The banking system becomes more vulnerable to aggregate shocks as the share on non-performing loans rises.

2.4 Extending the Model of Collateral

Thus far, collateral is priced according to its use by the particular firm. Another role for capital can be introduced as a way of pricing collateral in the market. Suppose that capital can be used for housing which supplies a flow of internationally non-tradable services to households. To make this concrete, we assume that households consume two goods, c, as before, and, d, housing services. Preferences are logarithmic.. We do not assume that households are unconstrained in the credit market, but rather face a collateral constraint as in the primary sector of Kiyotaki and Moore [1997].[9] Essentially, the unconstrained sector of Kiyotaki and Moore [1997] is replaced by the corporate sector already described above.

In the endogenous growth model, aggregate household consumption of tradable goods is growing at

an equilibrium rate g_t (to first order approximation, at the rate $E\alpha - \rho$, where ρ is the pure subjective rate of time preference). Expenditures on housing services will be growing at the same rate, which is also the rate of aggregate output growth. Clearly, households have heterogeneous wealth in this set up, and these growth rates will incorporate risk terms. For exposition, the flow of housing services is proportional to the amount of housing capital, and the stock of housing used at time t is denoted by h_t.

With credit constraints, the household's budget constraint for housing is given by

$$p_t h_{t+1} - p_t h_t = s_t + b_{t+1} - Rb_t,$$

where s_t is the share of savings used to accumulate housing and p_t is the per unit price of housing. The household is also constrained by the collateral requirement,

$$Rb_t \leq p_{t+1} h_t.$$

In this credit market, s is a prepaid interest on the loan and depends upon household permanent income. For a fixed supply of collateral, such as land for housing, the price would rise in a deterministic steady state at the rate, $r - g$. For a growing supply of housing capital, the price can stay constant as the quantity of housing consumed rises over time.

The value of collateral is now sensitive to changes in household permanent income. Incorporating this with the corporate side of the model, an adverse aggregate productivity shock will lower household permanent income, lowering the demand for housing capital. If housing is an alternative use for capital to the production of tradable goods, then the opportunity cost of collateral, k_t^j, for a bank is bounded from below by $p_t k_t^j$. An adverse shock lowers the value of bank assets because it lowers the value of the capital stock of contracting and insolvent firms and its lowers the value of the collateral in its alternative use. This general equilibrium effect implies that an alternative use for loan collateral does not necessarily provide banks with an incentive to foreclose non-performing loans. It also allows the knock-on effect of aggregate productivity shocks portrayed by Kiyotaki and Moore [1997]. Reversing

their shock to an adverse one, selling firm collateral leads to a reduction in the value of those assets, reducing further the asset side of the banks' balance sheets. Attempts to sell more collateral will reduce its price, p_t, further. The reduction in the value of collateral, with the corporate sector of this model, leads to higher corporate debt to equity levels and riskier investment choices for firms and lending choices for banks.

In a provocative application of Kiyotaki and Moore [1997], Miller and Zhang [2000] show that adverse shocks can lead to collapsing collateral prices. They analyze the effects of an exogenous collapse of a collateral (land) price bubble, but their paper implies that adverse aggregate productivity shocks can lead to a collapse of the credit-constrained sector. The collapse of the constrained sector with a sufficiently large productivity shock in the Kiyotaki and Moore model occurs with the bankruptcy of all firms in the collaterized sector. But banks would benefit from renegotiating, as in our argument, loans in the presence of collapsing collateral values. These effects of a collapsing bubble on land prices or an adverse systemic productivity shock are consequent to the specific set up of Kiyotaki and Moore, but they are surprisingly insensitive to the user cost of collateral in the credit-unconstrained sector. Our introduction of the collateralized (housing) sector suggests that persistent declines (rather than exogenous bubble bursts) in collateral values can follow productivity shocks and that the evergreening of loans contributes to the persistence.

2.5 Banking Crises and Contractions

Absent aggregate shocks, limited liability banking leads to individual bank failures that occur with increasing probability over time to idiosyncratic productivity shocks. Temporary aggregate shocks are contractionary, and under the credit market imperfections portrayed here have long-term effects on the pattern of investment. Bank insolvencies result in the realization of contingent liabilities for the government. An asset held by a bank against its deposit obligations is the deposit guarantee of the government. Our discussion assumes that the government faces an agency problem vis-a-vis the bank

that parallels that between the bank and its corporate clients. Each bank insolvency results in a sudden rise in the future tax liabilities of households. To the extent that these are not fully anticipated, bank insolvencies are contractionary in this model. This raises the problems facing other banks. One of the effects of a contraction in demand is a reduction in the market value of corporate loan collateral. Any shock to collateral value leads to the rise in the debt to equity ratio for corporations and exacerbates the agency problem between banks and firms.

Aggregate shocks can induce widespread banking problems if growth under idiosyncratic shocks with repeated corporate loan renegotiation (evergreening) has been long lived. The economy grows at its aggregate growth rate while banks accumulate more non-performing loans and domestic residents accumulate more claims against the banking system (this coincides with a decreasing rate of foreign asset accumulation for the AK model with logarithmic preferences). Underlying the constant growth rate of output is an increasing concentration of output by firms that have realized high productivities and falling bank equity. The vulnerability of the economy to individual firm productivity shocks is rising over time. As pointed out above, the economy becomes more vulnerable to adverse aggregate shocks. A shock could induce a sudden rise in public sector liabilities which is followed by a decrease in consumption demand and the value of capital. This decrease in equity can lead to more corporate insolvencies, more bank insolvencies and even further increases in government debt.

The contraction in domestic growth created by an unanticipated fall in net household wealth can be seen from the capital accumulation equation,

$$k_{t+1} - k_t = \ell_{t+1} - \ell_t + \left[\alpha k_t - r_t \ell_t - c\left(i_t\right) - \pi_t\right], \tag{22}$$

where ℓ_t and ℓ_{t+1} denote the total credit extended by the private sector to the banking system. Note that deposit withdrawals do not lead to Diamond and Dybvig [1983] types of crises in this economy, although they can make things worse due to capital stock adjustment costs through the impact of a reduction in loanable funds on the value of firm equity. An increase in outstanding government debt

held by domestic residents (or banks) caused by the deficit-financing of public expenditures will have the same contractionary effect on capital accumulation in this model. This is just classical crowding out. Foreign lending could fill in if they were subject to deposit insurance. With deposit insurance restricted to domestic residents, foreign capital inflows do not resolve the problem.[10]

2.6 Empirical Implications

In the model economy, domestic bank failures are inevitable under the financial sector regulatory policies assumed. The absence of effective prudential regulation in the presence of deposit insurance, whether explicit or implicit, are important. The consequences of these crises will depend upon how the public sector addresses individual bank insolvencies. However, the redistribution implicit in deposit insurance obligations paid by the public sector is distortionary in this economy due the dual agency problems in bank lending to corporate investors. With regulatory forbearance, the model implies that more and more banks will progressively become insolvent and the riskiness of the aggregate loan portfolio of the banking system and investments of the corporate sector increases. Sustaining insolvent banks must lead to a widespread financial crisis in the simple model. Foreclosure of bank insolvencies immediately as they occur (with entry by new banks, which is not in this model) would limit the contractionary impact of bank failures, but there are still distortions for long-term growth. Firm debt to equity ratios will rise over time and riskier projects will still be taken as they do even under the additional assumptions of bank and corporate foreclosures. The deposit insurance liabilities of insolvent banks paid by raising lump-sum taxes induce inefficiently risky investment decisions and relending decisions.

The model has several empirical implications for the impact of adverse aggregate shocks. An aggregate shock can precipitate a rise in non-performing bank assets that is self-perpetuating; it does not get corrected but gets worse. That is, a temporary shock can lead to higher future output volatility through the deterioration of bank balance sheets and increase in debt to equity ratios for the corporate

sector. Even a small aggregate shock can lead to ultimate widespread banking distress if bank growth has proceeded long enough with increasing portfolio riskiness under regulatory forbearance.. As the number of banks in distress rises, aggregate output growth does not decline in this model until the burden of deposit insurance losses is realized. The reduction in collateral values should coincide with a reduction in output and income growth following any idiosyncratic aggregate shock. It is consequent to shocks to the permanent incomes of households with the realization of financial sector distress. An increase in the overall riskiness of the banking sector can also coincide with an increase in the growth rate in this model, as the self-financing requirements for solvent firms are relaxed. This occurs as overall bank equity declines because the contingent insurance subsidy to banks rises. The shareholders of each bank face less risk to their wealth as the probability of their own insolvency rises under limited liability in this dynamic environment. As a result, they will require ever decreasing co-financing shares for solvent borrowers, leading to riskier investment projects but higher rates of firm growth.

There are also implications for the stochastic dynamics of the market value of corporate and bank equity. Because loans can be renegotiated, the value of a firm is not zero when

$$q_t k_t + \alpha_t k_t - R_t \ell_t \leq 0,$$

because the firm has an option value as an ongoing enterprise. With positive probability, it may be able to pay off its debts, allowing the entrepreneur to accumulate capital in the firm once more. The market equity value of the firm includes the option value and remains positive as long as a bank lends or evergreens its loans. This is not to say that the total value of the firm is positive. Part of this is carried as a liability to deposit insurance. Eventually, the accumulated losses can offset any option value for bank or corporate shareholders.

The equity value of the firm will equal the expected present value of the dividends net of interest payments on its current outstanding debt and investment adjustment costs subject to the imposition of the transversality condition. If a firm has positive net income, the capital stock will be increasing

and, along with it, the firm's equity value. The capital stocks for firms that have become insolvent or contracted due to negative net income are bounded from below. As banks continue to lend to solvent firms and renegotiate loans to insolvent ones, the average capital stock continues to grow. The average aggregate value of corporate equities continues to grow with the capital stock and output. However, bank equity values are declining over time in the aggregate in proportion to the share of non-performing assets in bank portfolios.

The equity value of banks changes over time with loan renegotiations and relending. For banks, there is an upper bound on the share of the gross returns to successful projects they can realize as a proportion of corporate returns due to competition from other banks. Each bank accumulates losses with positive probability each period, so that bank equity values decline in expectation subsequent to each bank's first renegotiation a loan to some client firm. The average equity value of a bank falls after one of its loans is renegotiated. As the probability of renegotiations and increasing deposit insurance liabilities rise, the expected equity of all banks declines. Bank equity decreases as

$$\Pr\left\{\sum_j \max\left\{q_t^j k_t^j + \alpha^j k_t^j, R_t^j \ell_t^j\right\} < \left(1 + r_t^d\right)\sum_j \ell_t^j\right\}$$

rises stochastically over time.

As a consequence, the ratio of bank stock market values to corporate stock market values should decline in advance of the other indicators of an impeding banking crisis. The decline in output should follow the decline in the relative value of bank equity to corporate equity. A decline in the value of collateral should also be coincident with the reversal of investment, output and corporate equity value growth.

3. The Assumptions of the Theoretical Model and the Financial System of Japan

The theoretical model generates endogenous accumulations of bank liabilities by a domestic banking

sector that is progressively less stable, and in the event of an aggregate shock, leads to an eventual crisis. Four of the model's assumptions are crucial in this process. First, is the predominance of corporate borrowing from domestic banks, arising from the informational advantage of banks over other lenders. Second, is the predominance of firm borrowing which are collateralized. Third, is the prospect of government deposit insurance, or government bailouts of the domestic banking sector. Fourth is supervisory forbearance and the absence of effective prudential regulation of the banking sector. In this section, we examine the financial system of Japan in relation to these four assumptions.

3.1 Corporate Reliance on Domestic Bank Borrowing

Post-war Japan represents a proto-typical bank-based financial system. Until the mid-1980s, the ratio of bank borrowing to total financing hovered over 80 percent as shown in Figure 1. Issuance of new equity represented almost the entire remainder. Subsequently, in the mid-1980s, as bond issuance restrictions were relaxed, the fraction of domestic and foreign bond financing increased. By 1995, the ratio of bank borrowing declined to almost 75 percent. However, this ratio is still much higher that what prevailed in the United States, and even in developing countries such as Korea, where the ratio (in 1997) stood at 50 percent (see Dekle and Kletzer [2002]).

Typically, only large, well-capitalized firms could raise funds in the bond markets. Small- and medium-sized domestic firms still relied on bank financing (Hoshi and Kayshap [2001]). The fraction of small- and medium-sized business loans to total loans increased from 73 percent in the 1977-86 period to 78 percent in the 1987-1990 period (Ogawa and Kitasaka [2000]).

3.2 Predominance of Collateralized Borrowing

In our model, costly observability of the choice of projects by the firm means that banks demand collateral for their lending. In the model, the collateral is equal to the value of the firm's capital stock, where capital is interpreted broadly, and includes land.

Much of Japanese corporate bank borrowing was secured by collateral, especially in land. Bank lending using reproducible capital (plant and equipment) as collateral was more limited, since the specificity of this capital meant that it was difficult to estimate its resale value. Between 1977 and 1995, about 40 percent of Japanese borrowing was secured by land. The percentages rose noticeably from the middle of the 1980s to the early 1990s, reversing a declining trend from 1977 to 1985. Collateralized borrowing was especially important for new customers, usually small- and medium-sized enterprises, which typically secured over 90 percent of their borrowing with real estate (Ueda [2000]). This is consistent with our model, since informational asymmetries should be most acute for new borrowers Land values were expected to rise in value, or at least not to decline by any serious amount.

3.3 Government Explicit and Implicit Guarantees of Deposits

In our model economy, the presence of deposit insurance, whether explicit or implicit, is important. Japanese bank deposits have been implicitly guaranteed by the government, traditionally through the "convoy system" or the "purchase and assumption" rescue, in which a healthy bank is encouraged by the government to provide assistance to a troubled one. Recently, however, the government has provided implicit guarantees through direct injections of funds to troubled banks.

The origins of the "convoy system" can be traced to the 1930s, to the forcible merger of weak commercial banks with strong ones. In the 1960s and 1970s, the rescues took the form of healthy banks offering not only financial support, but also personal assistance to a failing bank. For example, in 1965, Takachiho Sogo bank was suffering from increasing bad loans. The government decided that Takachiho Sogo bank needed help, and forced Nishi-Nihon Sogo bank to provide financial support, personnel assistance, and business support to Takachiho.

In the 1980s, the burden on healthy banks of the convoy rescue increased, as healthy banks were asked by the government to merge with failing banks. For example, in 1986, a large bank Heiwa Sogo failed, under a mountain of bad loans. The government pressured Sumitomo bank, the third largest

private bank, to acquire Heiwa and write off all the bad loans. The write-off of these bad loans cost Sumitomo 111 billion yen in 1986 (compared to Sumitomo's 82 billion yen in profits in 1985) (Hoshi and Kayshap, 2001).

As problem loans mounted in the 1990s, the frequency of convoy rescues skyrocketed. The convoy system came to be seen as stronger banks bearing the cost of bailing out weaker institutions (Hoshi and Kayshap [2001]). Perhaps the most dramatic of these convoy rescues was the rescue of Nippon Credit Bank in 1997. Nippon Credit Bank was crushed by an onslaught of problem loans, which essentially wiped out its capital and made it insolvent. The government strongly pressured Nippon Credit's creditor banks and insurance companies to swap the debt for shares. The financial institutions resisted, since they believed that these debt-equity swaps would weaken their own financial positions. However, under strong pressure from the government, the stronger financial institutions relented, and rescued Nippon Credit.

The ballooning of the problem loans in troubled banks, along with low profitability in the banking sector in general, meant that by the mid-1990s, the traditional "convoy system" was no longer workable. In a departure from the traditional approach, the government turned to injecting capital directly into the banks. The first instance of the injection of public capital was in 1995, to the 7 housing loan companies (jusens) that were technically insolvent, owing to the collapse of the real estate bubble. Throughout the 1990s, the jusens borrowed heavily from commercial banks and agricultural cooperatives; and the collapse of the jusens meant that the lender banks and agricultural cooperatives-already weakened by their own problem loansBwould be in trouble. The writeoff combined aspects of the "convoy system," and the new approach of injecting public capital. The lender banks and agricultural cooperatives contributed about 40 percent to the writeoffs; and public funds covered the remaining 60 percent (Ito [2000]).

As the banking sector problems worsened, the frequency of public capital injections increased. In

1998, the government injected capital by nationalizing and recapitalizing the most troubled of the major banks, Nippon Credit Bank and Long-term Credit Bank. (Eventually, the government sold Nippon Credit to a software company, and Long-Term Credit Bank to a foreign hedge fund). Subsequently, the injection of public capital took the form of an (almost) indiscriminate recapitalization of all the major banks. The government wanted all of the major banks to apply for the recapitalization, because it deemed that all the banks were sufficiently weak, and that discriminating among banks will cause deposits to flee from the weaker banks. To this end, in late 1998, the government set aside 43 trillion yen for the nationalization and recapitalization of the banks (9 percent of GDP), and all except one major bank, and some of the weaker smaller (regional) banks were recapitalized.

With regards to explicit guarantees, formal deposit insurance existed in Japan since 1971, but the system was understaffed, and underfunded. Following the turmoil in the banking sector in the mid-1990s, the government sharply increased the capitalization of the deposit insurance system, explicitly guaranteeing deposits up to 10 million yen (about 100 thousand dollars). Since larger deposits were not guaranteed, the government in early 1998, fearing that these larger deposits will flee the weaker banks, issued an explicit "blanket guarantee" of all bank deposits, regardless of size, until April 2003. Recently, the government has considered extending the "blanket guarantees" indefinitely.

The government's system of explicit and implicit guarantees meant that no deposits, large or small, were ever at risk in postwar Japan. Prior to 1991, the official policy was "no failures of financial institutions." Since 1991, banks have failed; for example, over the 1991-95 period, 11 small banks were formally declared insolvent. However, the guarantees meant that no depositor ever lost his money.

3.4 Government Prudential Regulations and Enforcement

In our model, the vulnerability of the economy to systemic productivity disturbances is rising in the presence of poor monitoring of loan-loss reserves by the regulatory authorities. Thus, lax government regulations and enforcement are essential for bank failures. Until the late 1990s, the main responsibility

for setting up and enforcing the prudential regulations of the banking sector rested with the Banking Bureau of the Japanese Ministry of Finance. Examiners from the Bureau would visit all of the major and regional banks once a year and classify the loans according the examiners perception of collectability. Banks with an increasing amount of irrecoverable loans were put on notice, and if matters did not improve, mergers would be arranged with a stronger bank. All was done very quietly, and behind the scenes.

This system of prudential supervision left much discretion to the bank examiners and their bosses in the Banking Bureau. Moreover, many high officials in the Banking Bureau retired into executive positions of commercial banks, where they maintained close contact with and influence over the Ministry of Finance (the amakudari system). Thus, there was much scope for supervisory forbearance. The banks, in turn, encouraged lax supervision by occasionally lavishly entertaining bank examiners (Grimes [2001]).

Given the problems with the existing bank supervisory regime, the politicians decided, in 1996, to move financial supervision and examination out of the Ministry of Finance to a newly created independent supervisory agency, the Financial Supervisory Agency. The politicians also tried to remove the discretion of supervisors by introducing the Prompt Corrective Action system in 1998. Under Prompt Corrective Action, regulators are required to intervene quickly at poorly capitalized banks; for example, regulators are required to close a bank if the bank's capital-asset ratio falls below zero.

Initially, these institutional changes led to improvements in prudential supervision and enforcement. The Financial Supervisory Agency moved on to examine the books of all banks, and this led to the immediate closure of five smaller banks. However, as the immediate financial crisis subsided, the regulations were redefined to make them less restrictive. The introduction of the Prompt Corrective Action was delayed a year. Accounting standards were changed, so that banks could make their financial statements appear better than they were. In some cases, banks that should have been closed, have been

allowed to operate as going concerns, given that bank closures would have led to an increase in local unemployment.

4. Empirical Implications of the Model

Under the assumptions of the previous period, without the forced write-offs of, or the reserve accumulations against non-performing assets, bank portfolios will become increasingly risky over time. Our model implies that, with idiosyncratic productivity shocks, individual bank failures will occur with increasing probability over time. As the non-performing loans of solvent banks rise over time, a larger share of saving deposits represent the contingent liability of the government, and ultimately a tax liability. In time, the economy may be hit by an aggregate shock that can induces a widespread banking crisis, if growth under idiosyncratic shocks and loan renegotiations (evergreening) has been long lived.

After the aggregate shock, each bank insolvency results in a rise in future tax liabilities of households. Household consumption collapses, and the market value of loan collateral falls. The decline in the market value of collateral exacerbates the information problems between banks and firms, and physical investment falls, which results in a reduction in output growth. Since banking distress occurs before corporate failures, the ratio of bank stock market values to corporate stock market values declines in advance of the banking crisis.

Dating the onset of the banking crisis in Japan is tricky. There are two candidate dates. In 1992, the Japanese Ministry of Finance first admitted the presence of rising non-performing loans. In fact, the early 1990s represent a turning point in the Japanese economy, with indicators such as GDP growth and investment sharply turning south. The sharp dip in these indicators is consistent with a banking crisis. However, our model predicts that banking distress can occur before the banking crisis; and there is no well-defined aggregate shock in the early 1990s, except for the Persian Gulf War. The second candidate date is 1997 to early 1998, when several financial institutions, including banks (Nippon Credit Bank

and Hokkaido Takushoku), and major securities companies (Sanyo Securities and Yamaichi Securities) collapsed. As mentioned, in late 1998, the government set aside 9 percent of GDP, to recapitalize the weakening banks. This period also overlaps with a major aggregate (global) shock, the East Asian Financial Crisis of 1997-98. Here we remain agnostic about the exact date of the banking crisis; we believe that the banking crisis started in the early 1990s, and has continued into the late 1990s, under repeated adverse aggregate shocks.

4.1 Lending, GDP Growth, and the Investment-Output Ratio

An important implication of the model is that bank loans are rising before the crisis. After the crisis, bank loans are predicted to fall. Figure 2 depicts the ratio of bank loans to GDP. The ratio rises sharply from 1980 to 1990, and then starts to fall, although only gradually. There does not seem to be a sharp fall in bank loans after 1998; the massive government recapitalization of the banking sector in 1998 may have averted a sharp decline in bank lending.

The model predicts rising investment-output ratios before the crisis, then a collapse. GDP growth also declines after the crisis. Figure 3 shows that both GDP growth and investment rates fell sharply in the early 1990s. The decline in GDP growth rates accelerated after 1998.

4.2 Rising Riskiness of Investment and Declining Returns on Capital

In our model, adverse selection under limited liability in financial intermediation implies bank portfolios that become progressively riskier. In the aggregate, lending and investment are increasingly allocated to firms that have experienced low productivities in the past, rather than to firms that had high productivity experiences.

In Japan, between 1970-80 and 1990-98, total factor productivity (TFP) growth rates dropped from 1.1 per annum to 0.2 per annum. (All data are from Fukao, Inui, Kawai, and Miyagawa [2002]). With regards to other measures of productivity, return on equity fell from 12 percent in 1980 to 4 percent in

1998; and the return on invested capital fell from 6 percent in 1980 to 4 percent in 1998.

4.3 Deterioration of Bank Portfolios

The model predicts that in the presence of government guarantees, the ratio of lending to GDP will rise and that the quality of bank portfolios will decline. The trend in the share of non-performing loans (NPLs) gives a measure of the quality of bank portfolios. Non-performing loans are defined as the sum of loans with arrears for more than 90 days and restructured loans. Figure 4 depicts the trend in the ratio of non-performing loans to total loans. Non-performing loans rise sharply from 2 percent of GDP in 1992-94 to about 5 percent of GDP in 1996, and then to 7 percent of GDP in 2000.

An implication of our theoretical model is that the stock market value of domestic banks should be declining. The decline should be evidenced by a significant decline in the ratio of the value of domestic bank equities to the stock market value of the entire domestic sector. Figure 5 shows the ratio of bank stock values to total stock market values. This ratio sharply increases from 1985 to 1990, and, consistent with the model, sharply declines from 1990 to 1995, and remains at the lowered level.

4.4 Rise and Collapse of Collateral (Land) Values

The model predicts sharply rising collateral (land) values before the crisis, and then a collapse concurrent with the decline in GDP growth and investment rates. Figure 6 depicts the pattern of land prices. Land prices rose sharply until 1990, and then declined until 1995. Land prices have declining moderately from 1995 until today.

5. Conclusion

The Japanese case supports rather well, the hypothesis and implied dynamics of our model of financial intermediation. The pattern of corporate reliance on collateralized bank borrowing, implicit and explicit guarantees of demand deposits, and prudential regulation fit the Japanese case well, a

country that has suffered through a banking crisis for most of the 1990s.

The dynamic relationship in our model between the deterioration in bank portfolios, the decline in collateral (land) values, and GDP growth and investment rates correspond roughly to the Japanese situation in the 1990s. The pattern of bank lending in the 1990s does not clearly fit the model. We attribute this rather high level of bank lending to the massive injection of public funds in the late 1990s.

Japanese firms have continued to rely heavily on bank financing. Deposit-insurance reform is much delayed. A previous two-year postponement supposedly to give the government time to clean up the banks, left the banks weaker than before. Now the government is intending to break its promise to lift its guarantee on deposits of over $85,000 by April 2003. Prudential supervision, although much improved on paper, continues be insufficient. Politicians meddle in the affairs of bank supervisors. The application of Prompt Corrective Action was supposed to close most of the smaller regional banks and credit cooperatives, but closures have been few and far between.

Our model predicts that banking sector problems in Japan will persist. If Japan is again hit with an adverse aggregate shock-say, another war in the Middle East, a double-dip recession in the United States–our model predicts that Japan will have another banking crisis. Government bailouts of the banking sector will add to the already substantial government debt, raising future tax liabilities, and depressing consumption, investment, and economic growth further.

To avert another banking crisis, Japanese policy makers should redouble their efforts in tranquil times, such as now, to eliminate the implicit and explicit insurance of depositors, and to improve banking supervision. The role of renegotiation and evergreening of loans under public deposit insurance schemes implies that extension of the protection of large-scale deposits could perpetuate bank insolvencies and low investment in productive industries. In the Japanese context, our analysis suggests that supervisory authorities should apply, without discretion, the Prompt Corrective Action criteria to all banks, and close those banks that do not meet those criteria.

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Endnotes

[1]Chinn and Kletzer [2000] use a somewhat different model of agency in lending to examine the dynamics of investment and productivity preceding the East Asian crisis.

[2]This interpretation is explained at length in Cargill, Hutchison, and Ito [1997], Hutchison [1998], Hoshi and Patrick [2000], Hoshi and Kashyap [1999], Hoshi and Kashyap [2002].

[3]Cargill, Hutchison, and Ito [1997] draw a more comprehensive picture of what caused the banking crisis in Japan. In particular, they emphasize the role played by monetary policy in precipitating the banking crisis. Monetary policy was easy between 1986 and 1988 and asset prices lost touch with fundamentals. The sudden shift to tight money in 1989 was responsible for the start of the asset deflation process. Since most bank loans were made using land as collateral, the collapse in land prices led to a surge in non-performing loans.

[4]Increasing returns to scale in monitoring by banks is a common assumption in the literature on financial intermediation as delegated monitoring (for example, see Freixas and Rochet [1997] and Holmstrom and Tirole [1997]). It greatly simplifies our analysis of loan renegotiation because it rules out gaming between lenders.

[5]This claim may not seem obvious, but it is true in equilibrium for the game between lenders and borrowers described in the footnotes and is used in the analysis. It also rules out renegotiation in the Kiyotaki and Moore model.

[6]For an interior solution with respect to co-financing and loan supply, the bank's return (equation (7)) needs to be increasing in z given the firm's optimal choice of project from maximization of (6). The very simple versions of Stiglitz and Weiss [1981] and Mankiw [1986] can be used to demonstrate an interior solution.

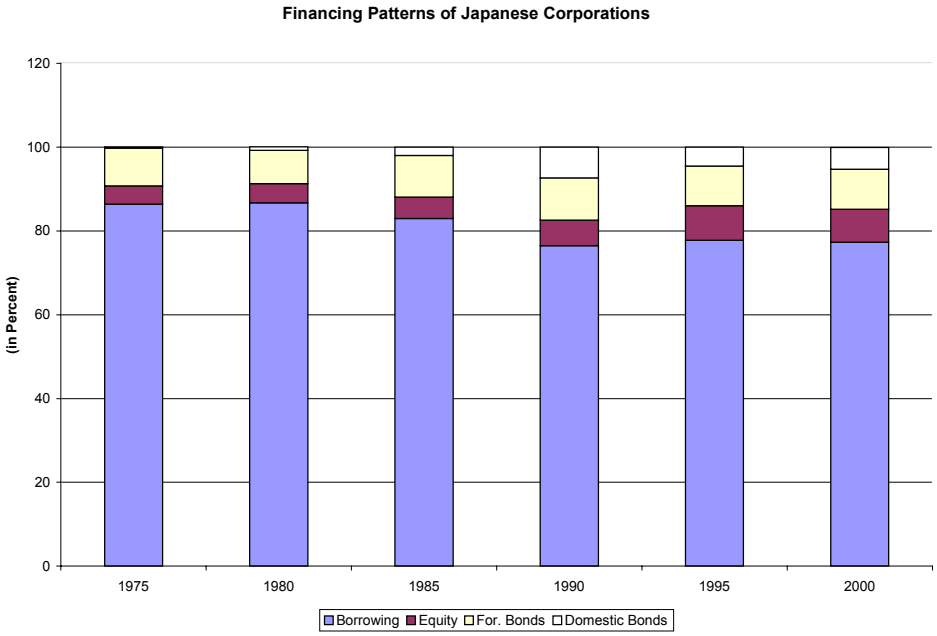
[7]This is stated in this way because bankers are risk averse in this model. With risk-neutral banks, the expected profit from this loan would be zero in equilibrium.

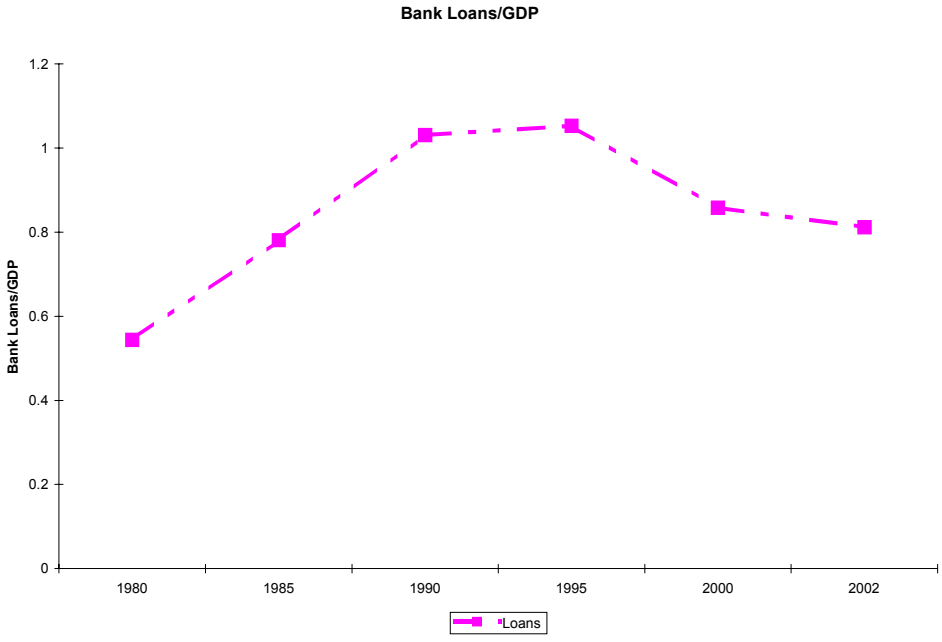
[8]In the adverse selection model, increasing the rate of interest induces riskier project choice by the entrepreneur and eventually lowers the lender's expected return (Stiglitz and Weiss [1981]). This implies that the bank may not claim all of the entrepreneur's potential future profits in every event in the equilibrium following renegotiation no matter how large the firm's debt on the bank's books grows. This depends on the set of projects available to the firm.

[9]Our suggested approach of introducing two sectors, both with imperfect credit markets, contrasts with the model of Kiyotaki and Moore [1997] (which has a credit-unconstrained sector) and with the model of Christiano, Gust and Roldos [2001] (which has a single sector with lending constrained to the value of collateral).

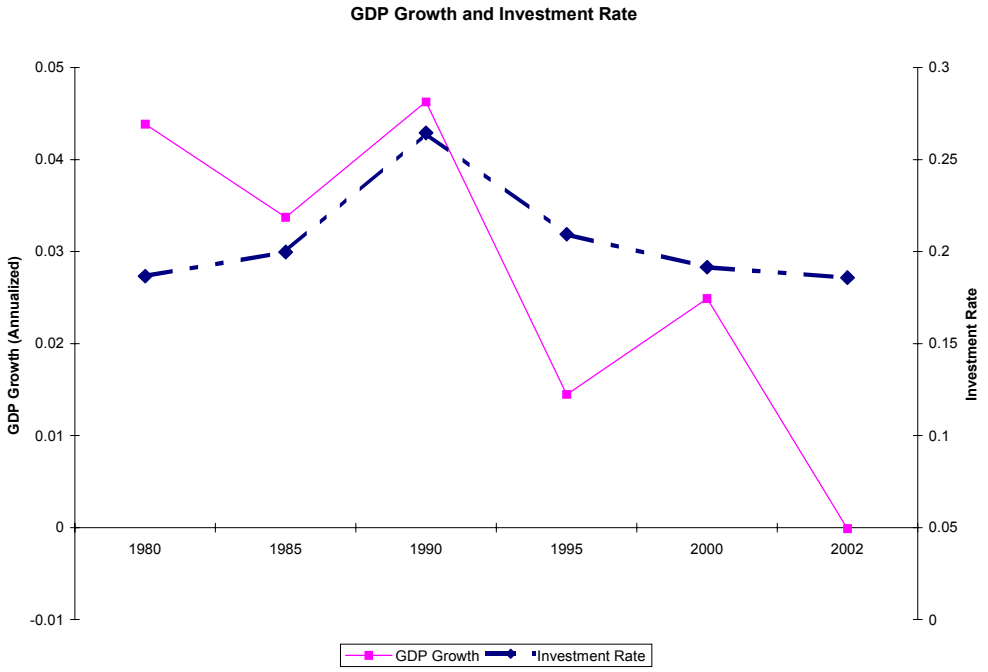
[10]Barth, Caprio and Levine [2000] survey the prevalence of deposit insurance for domestic and foreign depositors across a wide cross section of countries.

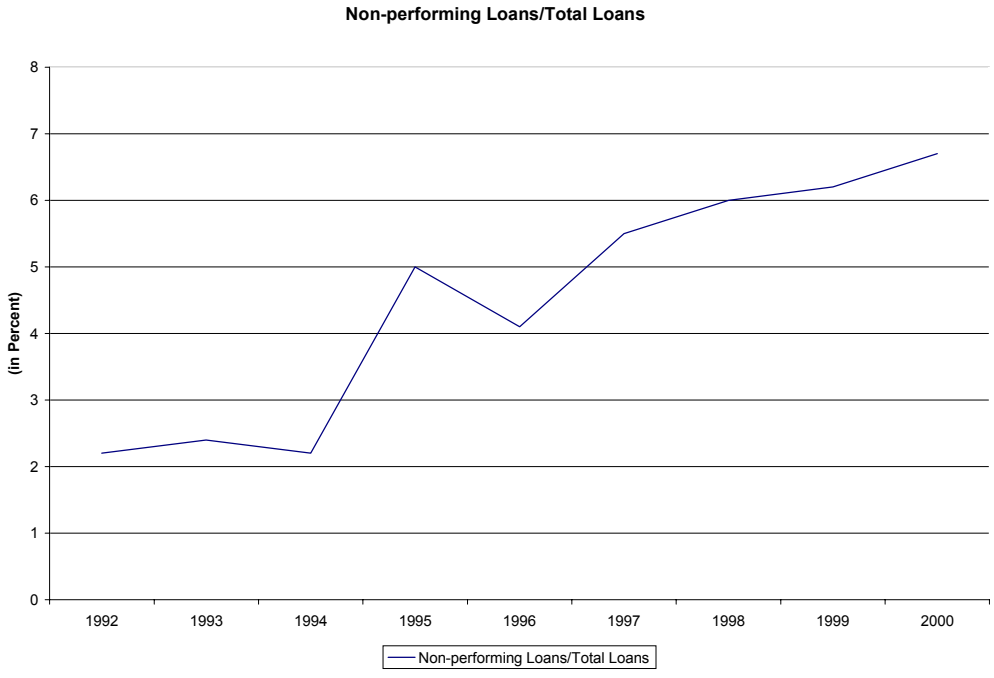
Figures 1 and 2





Figures 3 and 4





Figures 5 and 6