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The Japanese Experience in International Comparison

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Abstract

This paper examines episodes of banking sector distress for a large sample of developed and developing countries, highlighting the experience of Japan. By a host of criteria, Japan appeared to be in a stronger position than most countries at the onset of banking problems—low inflation, appreciating currency, balanced government budget, and large external surpluses. However, Japan followed a clear international boom-and-bust pattern in terms of real output growth, credit growth and stock price movements. We estimate a multivariate probit model that links the likelihood of banking problems to a set of macroeconomic variables and institutional characteristics. The model predicts a high probability of banking sector distress in Japan in the early 1990s. In particular, the likelihood of an episode of banking distress rose in line with the sharp drop in asset prices, deepening recession and "moral hazard" problem (financial liberalization combined with explicit deposit insurance). The Japanese case is also noteworthy by the long duration of the banking crisis, the length of the coincident recession and general malaise over the economy, the slow regulatory response, and the long delay in the commitment of public funds to re-capitalize the banking sector.

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1. Introduction

Recent events in Japan and East Asia draw renewed attention to the many problems associated with financial sector distress— how quickly and unexpectedly crisis situations arise, disruption in credit channels, economic contraction, and the difficulty in designing effective policy responses. Japan's banking problem emerged gradually and received scant attention in the early 1990s. The problem grew to crisis proportions by the end of the decade, however, ranking it among the largest episodes of financial sector distress experienced by any industrial country over the past fifty years. Amidst a series of bankruptcies, nationalization and forced-mergers of financial institutions, the Japanese government and Diet were virtually forced in 1998 to commit huge amounts of public funds to shore up the deposit insurance fund and re-capitalize problem banks.

Banking crises have become commonplace during the past two decades, but the range of experience in terms of the nature of the crisis, causes and effects, vary widely across countries and time periods. Japan's banking problem is distinctive in several dimensions, as seen by comparison with similar episodes in developed and developing countries over the 1975-1997 period (Table 1).[1] The average duration of an episode of banking sector distress is 3.9 years. Japan's banking problem had continued for 7 years by end-1998 and is likely to continue through the end of the decade. The public commitment of funds to resolve banking sector distress in Japan (12 percent of GDP through 1998)[2] is also substantially larger than the international average (with estimates ranging from 6-10 percent of GDP), and may grow greater yet.

The full impact of the banking crisis on the Japanese economy in unclear at this point, but is clearly substantial. Costly recessions such as that experienced by Japan have usually coincided with periods of severe banking distress, most likely reacting to and reinforcing each other. When measured as the present discounted value of deviations from trend output, the average output loss during 61 episodes of banking sector distress worldwide was 7.3 percent of GDP.[3] Focusing on those countries experiencing recessions following the onset of banking problems (49 countries), estimated output loss was 9.7 percent of GDP and output was below trend for about 3 years. This measure indicates that the depth of Japan's economic contraction to date has been less severe that typical (with output loss of around 4.0 percent of GDP through 1997), but Japan's recession continued into 1998—the sixth year of economic weakness (below potential GDP).[4] Japan's weak economy has already

lasted more than twice as long as the average recession experienced by other countries experiencing serious banking problems.[5]

These distinctive features might carry over to other dimensions—the factors leading up to and coincident with Japan's ongoing episode of banking sector distress may or may not fit with the experiences of other countries. To address this question we investigate the causes and consequences of banking sector distress in a large sample of developed and developing countries, focusing in particular on the special circumstances that distinguish the current Japanese episode. In addition to macroeconomic developments—especially asset prices-- we consider specific institutional characteristics that may increase the likelihood of a banking problem emerging. We pay special attention to the moral hazard problem—particularly the interaction of a recent bout of financial liberalization with explicit deposit insurance—and how the institutional position of the central bank may affect the likelihood of a banking problem emerging.

Several recent research papers have attempted to identify the key factors preceding or coincident with episodes of banking sector distress in a systematic way (i.e. Demirgüç-Kunt and Detragiache, 1998a,b; Eichengreen and Rose, 1998; Hardy and Pazarbasioglu, 1998; Kaminsky and Reinhart, 1996). We contribute to this literature in five ways. First, our focus is on Japan. Our statistical analysis, including the probit model used to predict the likelihood of banking sector distress, investigates the causes and consequences of the Japanese case in detail and addresses the question of whether this episode fits an internationally recognizable pattern. Second, we consider a substantially larger sample of developed and developing countries (updated to include the 1997 banking crises in Asia) than other studies. We analyze the statistical characteristics of countries experiencing banking sector distress (65 episodes) and test several empirical propositions about the factors that affect the likelihood of severe banking problems arising.[6]

Third, we pay particular attention to how institutional characteristics—the extent of financial liberalization, the presence of explicit deposit insurance, moral hazard, and the position of the central bank—may affect the likelihood of a banking crisis. Institutionally oriented work indicates that the moral hazard problem is a key element in the Japanese banking crisis (Cargill, Hutchison and Ito, 1997, 1998). Fourth, we consider the affect of asset prices on the likelihood of a banking problem arising. In particular, we estimate several formulations of the model, on a limited range of countries, with stock price

changes.[7] Fifth, we address a number of critical issues that are germane to the general literature in this area—robustness of statistical results to model specification, variable definitions, and lag structure; and the ability of the these types of empirical models to predict and forecast the onset of banking crises out-of-sample.

In the next section, Section 2, we briefly review the theoretical and empirical literature on financial and banking sector distress. In section 3 we discuss the data and methodology for the study. In section 4 we analyze the key macroeconomic and institutional characteristics, focusing on those aspects which (i) distinguish countries experiencing banking sector distress from those avoiding major problems, and (ii) distinguish the periods preceding, during and following episodes of banking sector distress. Section 5 presents estimates of the probit model, and considers the predictions of the model for Japan. This section also reports predictions for a number of other industrial countries experiencing banking distress and results from extending the model in several dimensions. Section 6 concludes the paper and raises questions of why the Japanese banking crisis and economic stagnation have been so prolonged and deep.

2. Analytical issues and empirical literature

Much of the theory on banking crises focuses on the special characteristics of banks, such as maturity and currency transformation and asymmetric information, which make the industry particularly vulnerable to collapse following adverse shocks (e.g. Jacklin and Bhattacharya, 1988 and Diamond and Dybvig, 1986). Institutional features of economies, such as the existence of deposit insurance and market-determined interest rate structure, are also emphasized in the literature as impacting the profitability of banks and the incentives of bank managers to take on risk in lending operations. The special features of banks, combined with particular institutional characteristics of economies, frequently lead to the emergence of banking problems when adverse macroeconomic shocks such as a fall in asset prices (impacting bank capital and/or collateral underlying loans) or economic activity (more delinquent loans) occurs. Adverse economic shocks may be of domestic origin (e.g. recession, inflation, budget deficits, credit slowdown) or external (e.g. external balance, exchange rate depreciation).

Several common features of countries experiencing banking problems emerge from numerous case studies. A recent IMF (1998) report summarizes this literature and identifies several general categories of problems frequently associated with financial crises: unsustainable macroeconomic policies, weaknesses in financial structure, global financial conditions, exchange rate misalignments, and political instability. Macroeconomic instability, particularly expansionary monetary and fiscal policies spurring lending booms and asset price bubbles, has been a factor in many episodes of banking sector distress, including most experienced by the industrial countries in the postwar period. External conditions, such as large shifts in the terms of trade and world interest rates, have played a large role in financial crises in emerging-market economies. By affecting the profitability of domestic firms, sudden external changes can adversely impact banks' balance sheets.

Weakness in financial structure refers to a variety of circumstances ranging from the maturity structure and currency composition of international portfolio investment flows to the allocation and pricing of domestic credit through banking institutions. These weaknesses oftentimes arise in times of rapid financial liberalization and greater market competition, when banks are taking on new and unfamiliar risks on both the asset and liability side of balance sheets. Weak supervisory and regulatory policies under these circumstances have also increased moral hazard by giving an incentive for financial institutions with low capital ratios to increase their risk positions in newly competitive environments, and allowing them to avoid full responsibility for mistakes in monitoring and evaluating risk. Further, deficiencies in accounting, disclosure, and legal frameworks contribute to the problem because they allow financial institutions (or financial regulators) to disguise the extent of their difficulties. Governments have frequently failed to quickly identify problem institutions, or to take prompt corrective action when a problem arises, resulting in larger and more difficult crisis situations.

Observable Characteristics and Banking Crises

The above discussion suggests that several observable characteristics of economies may be associated with the onset of banking crises. We consider a number of candidate variables in our empirical analysis, focusing on those that are likely to be important for both developed and developing countries. That is, some variables that are mainly relevant for developing countries are not included.

In terms of institutional characteristics, *financial liberalization* is an important candidate variable. The potential conflict between banking sector stability and competitive financial markets is a theme running through much of the banking literature. We follow Kaminsky and Reinhart (1996) and Demirgüç-Kunt and Detragiache (1998b) in attempting to link the onset of banking crises with a proxy for financial liberalization. A second institutional variable we consider is whether a country has instituted a system of *explicit deposit insurance*. The idea is that explicit deposit insurance may lead to a greater incentive to take on risk (moral hazard) and make the banking system more vulnerable to adverse economic conditions. Demirgüç-Kunt and Detragiache (1998a) find some support for this hypothesis. An alternative view, however, is that a system of explicit deposit insurance may limit the liability of the government to support depositors and banks. By contrast, a country with an implicit system of deposit insurance—presumably the majority of countries without an explicit system—may actually be taking on greater, and potentially unlimited, responsibility for the protection of depositors by not making clear government policy on the issue. In principle, explicit deposit insurance could potentially decrease the likelihood of a banking problem emerging.[8]

We consider two additional institutional variables. We term one characteristic "*moral hazard.*" This is an indicator measuring the coincidence, for a given country at a particular point in time, of both financial liberalization and explicit deposit insurance. The idea is to capture the potentially more potent effect on moral hazard when both of these institutional factors are combined. That is, explicit deposit insurance provides an incentive for banks to invest in relatively more risky assets, and financial liberalization—to the extent that it reflects fewer restrictions on portfolio allocation opportunities-- provides them with the opportunity to do so.

The final institutional variable considered is the relative *independence of the central bank* (legal and institutional). Central banks almost always play a role as a lender of last resort, oftentimes providing credit to problem financial institutions. They also usually play an important role in the supervision and regulation of banking institutions. A "dependent" central bank closely aligned with the government may be more inclined to provide monetary finance to problem institutions, thereby creating an additional channel for the moral hazard problem. Relatively independent central banks may also play a more credible role in its regulatory, supervisory and monitoring functions over financial institutions.

A number of macroeconomic characteristics suggested by theory are good candidate variables. We follow most studies in this area and consider *real GDP growth*, *real credit growth*, and *inflation*. Going beyond the standard variables, we also consider *stock price* movements. The decline in stock prices has especially hit Japanese banks since they hold substantial equity positions in the firms to which they lend. Following Calvo (1996), we also consider the ratio of *M2* to *International Reserves*. He argues that this variable should be a good predictor of a country's vulnerability to balance-of-payments crises. We also consider the *budget balance of the government.* Governments in strong financial positions may more quickly re-capitalize problem banks, avoiding a crisis situation altogether. Eichengreen and Rose (1998), focusing on developing economies, find that increases in "Northern" interest rates and overvalued real exchange rates increase the probability of a banking problem. Given our broader sample of countries, including developed and developing countries, we focus instead on exchange rate movements and domestic real interest rate changes. (For developing countries, however, domestic real interest rate changes may be driven in large part by foreign interest rate changes).

3. Data and Methodology

This section explains the definition of banking sector distress employed in the study, the alternatives used to exclude observations from sample so as to avoid double counting of banking sector distress episodes (exclusion windows), and the data (definitions, transformations and sources).

Defining Banking Distress

Banking problems are usually difficult to identify empirically because of data limitations. The potential for a bank run is not directly observable and, once either a bank run or large-scale government intervention has occurred, the situation most likely will have been preceded by a protracted deterioration in the quality of assets held by banks. Identifying banking sector distress by the deterioration of bank asset quality is also difficult since direct market indicators of asset value are usually lacking. This is an important limitation since most banking problems in recent years are not associated with bank runs (liability side of the balance sheet) but with deterioration in asset quality and subsequent

government intervention. Moreover, it is often laxity in government analysis of banking fragility, and slow follow-up action once a problem is recognized, that allows the situation to deteriorate to the point of a major bank crisis involving large-scale government intervention.

Given these conceptual and data limitations, most studies have employed a combination of events to identify and date the occurrence of a bank crisis. Institutional events usually include forced closure, merger, or government intervention in the operations of financial institutions, runs on banks, or the extension of large-scale government assistance. Other indicators frequently include measures of non-performing assets, problem loans, and so on. We have identified and dated episodes of banking sector distress following the criteria of Caprio and Klingebiel (1997) and Demirgüç-Kunt and Detragiache (1998a). If an episode of banking distress is identified in either study, it is included in our sample. If there is ambiguity over the timing of the episode, we use the dating scheme of Demirgüç-Kunt and Detragiache (1998a) since it tends to be more specific about the precise start and end of each episode.[9] We have updated our sample on the occurrence of new episodes on banking sector distress from information given by the Bank for International Settlements (1998).

Although the dating of banking sector distress is somewhat arbitrary, we nonetheless follow these studies closely to avoid "data mining", i.e. identifying the date of the banking crisis after observing developments in macroeconomic and other variables thought to be determinants of the crises. Japan's banking crisis, for example, is dated by Caprio and Klingebiel (1997) as "the 1990s" and by the Demirgüç-Kunt and Detragiache (1998a) criteria as starting in 1992. 1992 was the first year of substantial government attention to the problem. However, the first substantial plans for restructuring a significant part of the financial sector wasn't until 1993 and many observers wouldn't characterize the Japanese banking problem as a full-blown "crisis" until 1995 or even 1997. On the other hand, using realistic estimates of non-performing loans as an indicator might date the beginning of Japan's banking distress already in 1991.

Data samples and windows

We initially consider data for 132 countries over the 1975 to 1997 period (or the longest sample available within this period), of which 67 countries had one or multiple

episodes of banking distress. The minimum data requirements to be considered in this study is that GDP and inflation are available, which in turn limits the sample to 97 countries of which 53 had severe banking problems at some point during the sample period. Since several countries had multiple occurrences over the sample period, 65 episodes of banking sector distress are identified.

The sample is even further limited by the availability of data, so that the sample size of the univariate statistics and multivariate probit analysis varies depending on the set of variables considered. We do not confine our analysis to countries experiencing banking crises. Rather, we consider a control group of 44 developed and developing countries that did not experience severe banking problems during the 1975-97 sample period. Caprio and Klingebiel's control group is the OECD countries in the 1960s and Eichengreen and Rose (1998) limit their sample to developing countries. Our approach is similar to Demirgüç-Kunt and Detragiache (1998a), although our sample of countries is substantially larger and includes more recent data.[10]

We start by dividing the sample into country-year observations with banking crisis and, in the formal statistical models, use only the first year of the banking crisis if it is more than one year in length. The duration of banking sector distress was greater than one year in 85 percent of the episodes. In the probit regressions we are interested in predicting the onset of banking sector distress. We therefore exclude all the remaining (after the initial year) observations of a particular banking crisis from the data set, keeping all the preceding observations, in most of the probit regressions. As an alternative windowing approach for the probit regressions, we follow the "event study" methodology of Eichengreen and Rose (1998), constructing three-year exclusion windows around each crisis observation to avoid double counting banking problems. This window excludes the three years preceding any given banking crisis and treats any date beyond three years as a tranquil period even if it part of an ongoing banking crisis (unless there is the onset of a new banking crisis).[11] This is an important difference given the observed persistence of banking crises.[12]

Institutional Variables

We consider four institutional variables in our study—explicit deposit insurance, financial liberalization, moral hazard, and the degree of central bank independence. Our source on the existence of explicit deposit insurance is the recent survey on the issue by

Kyei (1995). We construct a dummy variable that takes a value of unity at times when a particular country had a formal system of deposit guarantee arrangements in place, and zero otherwise. In the Kyei study, forty-seven explicit arrangements were identified, as against fifty-five arrangements implicitly guaranteeing government support for deposits. Our main source for the financial liberalization data is Demirgüç-Kunt and Detragiache (1998b), supplemented by national and international sources. The variable is constructed on the basis of the beginning of observed policy changes to liberalize interest rates, taking on a value of unity during the liberalized period of market-determined rates and zero otherwise.

The moral hazard variable is an interaction term of explicit deposit insurance and financial liberalization. It takes on a value of unity when both financial liberalization and explicit deposit insurance are observed in the same year, and zero otherwise. Our central bank independence variable is taken from Cukierman (1992). It takes on a value from zero (no independence) to unity (complete independence), and represents a weighted average of legal and institutional characteristics reflecting the central bank's relationship with the government.

Macroeconomic Variables

The macroeconomic variables, discussed in the previous section, are: real GDP growth, real credit growth, nominal (and real) interest rate increase, inflation, the change in an index of stock prices, the budget position of the general government, the M2/Reserve ratio (ratio of a broad money aggregate to international reserves), and the rate of exchange rate depreciation. The source of this data is the International Monetary Fund's International Financial Statistics (CD-ROM).

Two dummy variables are included. One dummy variable (OECD) is for the industrial countries (OECD members excluding Korea, Mexico and Turkey). This takes on a value of unity if the country is an industrial country, and zero otherwise. A second dummy variable ("High Inflation") takes on a value of unity for countries with sample average inflation rates over 30 percent, zero otherwise.

Methodology

We estimate the probability of banking sector distress using a multivariate probit model on an unbalanced panel data set for both developing and developed countries over

the 1975-97 period (or most recent year available). We observe that a country at a particular time (observation j) is either experiencing banking distress (dummy variable, y_j, takes on a value of unity), or it is not ($y_j=0$). The probability that a crisis will occur, Pr(y_j=1), is hypothesized to be a function of a vector of of characteristics associated with observation j, x_j , and the parameter vector ß. The likelihood function of the probit model is constructed across the n observations (the number of countries times the number of observations for each country) and (the log of the function) is then maximized with respect to the unknown parameters ↕ using non-linear maximum likelihood

$$\ln L = \sum_{j=1}^{n}\left[y_j \ln F(\beta' x_j) + (1-y_j)\ln(1-F(\beta' x_j))\right]$$

The function *F(.)* is the standardized normal distribution.

Section 4. Macroeconomic and Institutional Characteristics

In this section we investigate the general macroeconomic and institutional characteristics associated with episodes of banking sector distress, and to determine whether Japan's experience (or circumstances surrounding the banking crisis) is idiosyncratic. We are somewhat limited in discussing the economic developments during and following Japan's experience, however, because the Japanese episode of banking distress was continuing through the end of the sample period (1997).

We begin with a graphical examination of the periods surrounding the onset of banking crises (Figure 1), as well as summary and test statistics in tabular form (Tables 2 and 3). In the panels of Figure 1, we plot the behavior of eight macroeconomic and financial variables at the outset of the banking crisis (denoted as time zero), five years preceding the crisis, and five years following crisis. The dashed line is the mean value of the variable (at each point in time) for the 65 crisis episodes in our sample (or that number for which data is available for the variable in question). The two lightly shaded lines at the top and bottom of each panel represent one standard deviation around the mean value of the variable. The dark solid lines represent the values for Japan. The constant mean value for the control group—the mean value over the full sample period for the 44 countries

(depending on data availability) not experiencing an episode of banking sector distress—is given by the medium-shaded solid line.

Table 2 shows summary statistics highlighting differences in economic characteristics between the group of countries experiencing banking distress and the group that avoided severe problems. The objective is to identify different movements in these variables that *distinguish the crisis and non-crisis countries* during the periods of relative tranquillity, i.e. before banking problems become critical. The average values of these variables are calculated over the full sample period for those countries which have not experienced banking sector distress and over the five-year period leading up to the banking crisis for the crisis countries. The first column of statistics show the mean values for the countries not experiencing banking sector distress and the second column shows the mean values for the bank crisis countries. The third column shows the mean difference (t-statistic) tests, and the fourth column presents the corresponding value for Japan over the period prior to the banking crisis. The standard deviations are shown in parentheses below the mean values.

Table 3 shows the economic characteristics of the countries *experiencing episodes of banking sector distress at different periods.* The mean values (standard deviations in parentheses) shown are, across time and countries, for the period prior to the banking crisis, the year of the crisis, the remaining years of the crisis (with the time period varying with the length of the crisis), and the period after the crisis. The number in brackets below the mean value is the probability that the sample mean for that period is different from the immediately preceding period.

From the figure and tables we observe that mean real GDP growth for the non-crisis countries (control group) was 3.7 percent over the sample period. Mean real GDP growth for the crisis countries during the "tranquil" period preceding the onset of distress was 3.5 percent, which is not significantly different from the non-crisis mean value (Table 2). In economies experiencing banking sector distress, real output growth slowed gradually prior to the crisis point, dropped sharply at the onset of the crisis and gradually recovered (Figure 1). As Table 3 shows, real GDP growth during the first year of the crisis (0.77 percent) was significantly lower than the preceding five-year period, and growth during the crisis episode (2.4 percent per annum average) was significantly higher than the initial year. The lower right panel illustrates the pattern of the cyclical movements in real GDP ("GDP

deviation" is the H-P filtered series described in endnote 3). A boom period in economic activity preceding the crisis, followed by a sharp downturn, is clearly evident.

There are a number of other noteworthy differences in macroeconomic and financial developments. In comparing the tranquil period leading up to a banking crisis and the non-crisis control group, shown in Figure 1 and Table 2, we find that the rate of currency depreciation, average rate of inflation, and the M2/Reserve ratio are significantly higher. Real interest rates also appear to be marginally lower and stock price increases somewhat higher (but not significant at the 10 percent level). Average values of budget deficits, contrary to conventional wisdom, are not markedly higher in the crisis countries.

Time series behavior, shown in Figure 1 and Table 3, is also quite informative. Beyond the real GDP developments noted above, three variables indicate a distinct shift over crisis episodes: exchange rate depreciation, credit growth and stock prices. Movements in credit growth are striking and mirror real GDP growth: strong growth rates prior to the crisis, credit contraction during the first year of the crisis, and moderate rebounds during the latter phase of the crisis episode. Exchange rate depreciation also jumps significantly at the onset of the crisis and the rate of stock price increase drops markedly.

Where does Japan fit in?

Where does Japan fit into the general pattern distinguishing economic developments in the crisis countries from the non-crisis countries? By most indicators in Figure 1 and Table 2, Japan was in a very strong position relative to most countries *prior* to the onset of its banking problem. Japan experienced stronger GDP growth, less exchange rate depreciation (indeed, strong appreciation), lower inflation, lower budget deficits and somewhat higher real interest rates than even the non-crisis countries. Credit growth was also slower in Japan than either the crisis or non-crisis countries.

The "bubble" pattern, and similarities with a number of crisis countries, comes out more clearly in the time series patterns illustrated by Figure 1 and the statistics presented in Table 3. Japan clearly had a boom economy prior to the banking crisis as reflected by rapid real GDP and credit growth, rising inflation, and strong asset price appreciation (rapid stock price increase). A sharp slowdown in output and credit growth and collapse in stock prices followed the onset of banking sector distress.

One striking difference emerges, however. Japan failed to recover from its banking crisis and recession at the same pace as other countries facing banking sector distress. The economies of other countries experiencing banking problems generally rebounded fairly quickly-- output and credit growth picked up markedly and stock prices sharply rebounded after the first crisis year. Real output growth, credit growth, and the stock market in Japan, by contrast, remained very weak and continued to languish seven years after the onset of banking sector distress. This observation, together with the long duration of the banking sector problem and large fiscal costs noted in Table 1, suggest that Japan may be a special case.

Japan's slow recovery is probably not because its economy *prior* to the crisis was more overheated or experienced a larger asset-price bubble than other industrial countries. Figure 2 shows, on a common scale with a 1980 base year, stock price movements of a number of industrial economies that experienced banking crises in the late 1980s or 1990s. Japan's stock market boom of the 1980s—representing a six-fold rise in the Nikkei stock price index—is nonetheless smaller than the price rises seen in Finland, Norway and Sweden, and on a par with Italy. Similarly, Japan's output and credit boom and crash prior to the emergence of banking sector problems is not greater than several other industrial countries that experienced much faster recoveries.

5. Probit Estimation Results

This section presents a multivariate probit analysis to estimate how a particular variable changes the probability of the occurrence of banking sector distress holding constant the other explanatory factors. We investigate whether economic and institutional characteristics of countries are associated with the onset of banking crises, and use the model to see if Japan's banking problems fit a pattern seen in other countries.

Table 4 reports the probit equation estimation results for four alternative model specifications. Since probit coefficients are not easily interpretable, we report the effects of changes in the regressors on the probability of crisis (expressed in percentage terms), evaluated at the mean of the variables. The estimated coefficients (standard errors) for each model are reported, as are the number of observations, pseudo R-square, and the percentage of crisis episodes that are correctly predicted by the model (using a 10 percent probability

as an indicator of prediction success[13]). Two groups of variables are considered: institutional characteristics and macroeconomic developments. In addition, the equations include a constant and a dummy variable for the OECD industrial countries (OECD, excluding Korea, Mexico and Turkey).

The number of observations ranges from 426 to 1317, depending on data availability of the included regressors. The "pseudo" R^2 ranges from 0.06 to 0.23 and, in particular, suggests a moderate degree of explanatory power for the model with stock price developments included (column 4). Episodes of banking distress which are correctly predicted range from 15 percent to 58 percent, depending on the specification of the model.

The results indicate that the institutional characteristics (central bank independence, explicit deposit insurance, financial liberalization and moral hazard), two of the macroeconomic variables (real GDP growth and change in stock prices), and the OECD intercept dummy variable are statistically significant (95 percent level) in most model specifications. In addition, real credit growth is significant in one specification of the model.

In terms of institutional characteristics, the coefficient estimates indicate that a high degree of central bank independence decreases the probability of banking sector distress. Explicit deposit insurance and a liberalized financial system, by contrast, increase the likelihood of banking sector distress. The combination of explicit deposit insurance and financial liberalization, given by the moral hazard variable, is also very significant and raises the likelihood of a banking problem.[14] In terms of macroeconomic developments, a sharp fall in real GDP growth is a very good indicator that banking problems may emerge. A fall in stock prices is also associated with an increased likelihood of banking sector distress.[15]

By contrast with the conclusions of a number of individual case studies and descriptive international comparison studies, we find that *contemporaneous* values of exchange rate depreciation, real interest rate changes and inflation do not affect the likelihood of banking sector distress. That is, in our sample, these variables do not help predict the occurrence of banking sector distress after controlling for the movement in stock prices, real GDP growth and institutional factors. Restricting the sample to developing countries, however, might indicate stronger support for these factors.

Predictions for Japan

The model estimates reported in Table 4 cover all the episodes of banking sector distress in the sample and may or may not do well in predicting the likelihood of a problem arising in any given country at a particular point in time. That is, the model could have relatively high predictive accuracy in general but still not predict the occurrence of any particular banking crisis. Our question is whether the general statistical characteristics of banking sector distress identified by the model help to explain the timing and likelihood of the banking crisis that occurred in Japan.

To this end, Figure 3 reports the predicted probability of banking sector distress occurring in Japan during the 1980-97 period. The line labeled "predicted in-sample" uses the coefficient estimates from column 4 of Table 4 (specification including stock price changes) to predict the probability of banking sector distress in Japan for each year. The probability was below 5 percent until 1990, at which time the probability jumps to almost 10 percent. The probability climbs further and peaks at about 20 percent in 1992. The estimated probability then declines, returning to below the 5 percent level again by 1996.

These results indicate that the model does quite well in predicting the occurrence of the Japanese banking crisis. Since the institutional variables are quite stable over time, the results are driven by the collapse in stock prices in 1990-92 and shift from strong to weak output growth.

Extensions

It is noteworthy that the model's predictive accuracy is not driven by the fact that Japan is included in the data sample from which the model coefficients are estimated, and then used to predict the probability of banking sector distress (an "in-sample prediction"). The line labeled "predicted out-of-sample" in Figure 3 shows the predicted values for Japan when Japanese data are excluded from the estimation equation.[16] The coefficients from the model (excluding Japan) are then matched up with actual macroeconomic developments in Japan to predict the probability of banking sector distress. Although somewhat lower in magnitude, the general pattern of a sharply rising probability of banking sector distress is again clearly evident.

We also report the predicted values for Japan from the model specification excluding stock price developments (column 2 of Table 4). This model has more observations than

the specification including stock prices but, of course, excludes an important explanatory variable. Nonetheless, the model accurately predicts 56 percent of the banking sector distress episodes. These predicted values, labeled "without stock prices" in Figure 3, also indicate an increasing likelihood of banking problems in Japan in the early 1990s. The peak probability value is again reached in 1992-93, but at a lower level (around 12 percent) than previously.

Our model also does well in predicting the likelihood of banking problems arising in other industrial countries. Figure 4 compares our model predictions for Japan with several other industrial countries experiencing bouts of banking sector distress. The top panel shows Finland, Norway and Sweden—the industrial countries, other than Japan, hardest hit by banking crises in the late 1980s and early 1990s. The lower panel shows Australia, Italy and Japan. The country names (abbreviated) are listed on each figure at the year the banking crisis started. The greatest likelihood of a banking problem arising matches the onset of a banking sector crisis for Japan and Finland, and shows the rising probability of a problem in the case of Sweden, Italy and, to a lesser extent, Norway. The model does not predict well for Australia.

We also consider several other extensions of the basic framework. Column 1 of Table 5 reports the results for the data set with the three-year exclusionary windows of Eichengreen and Rose (1998). These results are not qualitatively different, but somewhat stronger than the baseline model presented in column 4 of Table 4. In particular, the pseudo R2 is higher (rising from 0.23 to 0.26) and the percentage of crisis episodes correctly predicted is greater (climbing from 35 percent to 53 percent). The same institutional and macroeconomic variables are significant, however.

Column 2 of Table 5 considers the model with two alternative definitions of the real GDP and stock price variables. In particular, in this formulation of the model these variables are now defined as the percent deviation of the current level from the moving average of the five previous years. The percent deviation of stock price from the previous five-year moving average is highly significant, but not real GDP deviations. This model fits the data somewhat worse in terms of the pseudo R2, but is somewhat better at predicting the onset of banking crises (based on the percentage of crisis episodes correctly predicted), compared with the model presented in column 4 of Table 4.

Finally, we also investigated differences between the developed and developing countries in the sample, as well as structural differences between the coefficients estimated for Japan and the other countries. We included slope dummy variables for all of the regressors, where the dummy variable took on a value of unity for developed OECD countries and zero otherwise. The likelihood ratio test did not reject the null hypothesis that the coefficient values as a group were the same for the OECD countries and the other countries in the sample.[17] (The difference in the log likelihood of the two equations is 9.97 and is distributed chi-squared with 9 degrees of freedom. The 90 percent critical value is 14.68). A similar test is undertaken for Japan and the null again is not rejected. (The difference in the log likelihood of the two equations is 7.64 and is distributed chi-squared with 6 degrees of freedom. We did not include slope dummies on the institutional variables in this test. The 90 percent critical value is 10.64).

Leading Indicators of Banking Sector Distress

The results reported in Table 4 and Figures 3 and 4 are for macroeconomic variables that are *contemporaneously* associated with banking crises and, hence, caution should be exercised in interpreting these as causal relationships. It is possible that the onset of banking sector distress, for example, may in turn trigger a fall in stock prices, currency depreciation and recession.[18] Alternatively, there may be complicated interaction and feedback effects running between bank crises and these variables.

A number of previous studies have investigated, with limited success, whether some variables are useful *leading* indicators of banking sector distress. Eichengreen and Rose (1998) find that "Northern" interest rates (weighted average of short-term interest rates of the major industrial countries), external debt/GDP and exchange rate overvaluation are significant predictions (one-year ahead) of banking crises in developing countries. Demirgüç-Kunt and Detragiache (1998a) find that credit growth is a significant predictor of banking crises (two-years ahead) in one formulation of their model (where the other variables are contemporaneous values) in a sample of developed and developing economies. Kaminsky and Reinhart (1996), using monthly data, find that financial liberalization is a leading indicator of banking crises.

The descriptive statistics, reported in Table 3 and Figure 1, also suggest a discernable pattern to macroeconomic developments may be evident prior to the onset of banking

sector distress. Following Eichengreen and Rose (1998), we estimate a simple leading indicator model—a probit equation where the macroeconomic explanatory variables lagged one year (the institutional variables are contemporaneous values). These estimates are presented in columns (3) and (4) of Table 5 and the predicted values for Japan are presented in Figure 5. Column 3 presents the full set of macroeconomic variables and column 4 considers selected variables based on observing the lead and lag patterns in Figure 1. The model has moderate explanatory power and correctly forecasts a high probability of a future banking crisis in 40 percent of the actual occurrences.

One macroeconomic variable appears to be a useful (statistically significant) one-year ahead leading indicator of future banking problems-- declining stock prices. High real interest rates are also marginally significant.[19] Real GDP and credit growth, however, are not powerful predictors of banking sector distress. As in the baseline regressions, the OECD dummy, constant term, central bank independence and financial liberalization variables are also significant. The predictions of the model for Japan, shown in Figure 5, follow a similar pattern to the other results—a sharp rise in the likelihood of a banking problem in 1991 and a peak reached in 1992 (at close to 15 percent probability). It is apparent that modeling more complicated dynamics structures in predicting banking crises may be quite useful. Our preliminary work, however, does not indicate that they would materially change our main findings.

5. Conclusion

Several interesting findings emerge from our study. We find that, at the onset of the banking crisis, Japan was in a much stronger macroeconomic position than most countries experiencing similar difficulties—inflation performance, output growth, budgetary situation, external balances, and so on, did not indicate an emerging banking crisis. Indeed, macroeconomic developments during the period preceding Japan's banking crisis were not substantively different from countries avoiding severe financial problems altogether. Common features emerge in the *dynamics* of the banking crisis, however, and in the context of a multivariate probability model. Common features of many banking crises, including Japan, include a sharp asset price decline and deep recession. Institutional characteristics that increase the probability of banking distress—and which fit the case of

Japan-- include financial liberalization and explicit deposit insurance. In particular, the coincidence of recent financial liberalization and explicit deposit insurance together appear to play an especially important role in creating conditions of moral hazard and increasing the probability of a banking problem arising. The estimated probit model predicts that Japan was particularly vulnerable to banking sector distress in the early 1990s—predicting a 20 percent probability of banking sector distress in Japan in 1992 given the configuration of asset prices, credit conditions and other economic factors prevailing at the time.

Extensions of the model show the basic prediction results to be quite robust to model specification, included variables, variable definitions, and when Japan is excluded from the estimated sample. Institutional variables appear to be quite important, including the political independence of the central bank that lowers the likelihood of moral hazard and the probability of a banking problem arising. We find that two macroeconomic variables (real interest rates and stock prices) appear to be reliable, statistically significant, *leading indicators* of the emergence of banking sector distress.

The Japanese case is also noteworthy by the long duration of the banking crisis and the length of the coincident recession. By comparison with episodes in other industrial countries, the general malaise over the Japanese economy associated with its episode of banking sector distress appears unusually large. This is illustrated by the failure of asset prices to recover, the weak GDP growth/ near-recession that prevailed in Japan over much of the 1990s (output was below trend from 1993-98), and other signs of economic stagnation. The slow regulatory response and the long delay in the commitment of public funds to re-capitalize the banking sector, other features of the Japanese experience, may partly explain the large adverse effects on the economy. This is on our agenda for future research.

Table 1

Banking Sector Distress

Duration of Banking Crisis (66 episodes), years	3.9 years
Of which: Japan (through 1998)	7.0 years
Fiscal cost of banking crisis	
Lindgren et al. estimate (25 cases)	6.4 percent
Caprio and Klingebiel estimate (30 cases)	10.6 percent
Of which: Japan	12.0 percent
Severity of Recession Coincident with Banking Crisis,	
Average (percent of GDP)	7.3 percent
Of which: Episodes coincident with recessions (49)	9.7 percent
Japan	4.0 percent
Length of recession, average years (49 episodes)	3.3 years
Of which: Japan	6.0 years

Table 2

Macroeconomic Differences Between Countries Experiencing Banking Sector Distress and Control Group Mean Values and Standard Deviations

	Countries Not Experiencing Bank Distress[1]	Countries Experiencing Bank Distress[2]	Difference in Mean Values (Pr>|t|)	Japan
Real GDP Growth	3.684369 (8.642)	3.5011 (4.398)	0.6318	4.6169 (0.884)
Exchange Rate Depreciation	8.7872 (41.369)	20.2439 (54.334)	0.0000	-4.7924 (14.092)
Inflation[3]	10.1829 (11.583)	13.3282 (17.650)	0.0137	1.6422 (1.155)
Real Interest Rate[3]	0.5275 (8.647)	-0.3399 (14.954)	0.4375	3.6991 (0.967)
M2/Reserve Ratio	14.0397 (63.018)	21.6714 (52.766)	0.0363	42.4138 (9.152)
Credit Growth	11.6857 (72.176)	9.85498 (21.700)	0.6720	6.9694 (4.007)
Stock Price Change[3]	12.9518 (26.073)	16.4608 (29.990)	0.3624	9.3259 (26.573)
Budget Surplus	-3.7614 (5.061)	-3.8223 (8.625)	0.8832	-1.7728 (2.058)

[1] Control Group: Mean Value (Standard Deviation) over 1975-97 period (depending on data availability) of the countries not experiencing banking sector distress.
[2] Mean Value (Standard Deviation) for 5-year period preceding episodes of banking sector distress (mean for all countries in sample experiencing banking sector distress for which data was available)
[3] Excludes high inflation countries.

Table 3

Macroeconomic Developments Prior to, During, and After Episodes of Banking Sector Distress[4]

	Crisis Countries				Japan		
	5-Years Prior to Episode	First Year of Episode	During Episode[5]	After Episode	Before	First year	During
Real GDP Growth	3.5011 (4.398)	0.7634 (5.551) [0.000]	2.3525 (4.786) [0.047]	3.2461 (4.292) [0.126]	4.6169	1.0274	1.4511
Exchange Rate Depreciation	20.2439 (54.334)	35.9210 (78.854) [0.089]	17.7052 (39.539) [0.049]	27.9334 (69.960) [0.145]	-4.7924	-0.3601	0.8168
Inflation[6]	13.3282 (17.652)	14.2804 (17.606) [0.740]	10.7497 (12.875) [0.218]	12.334 (15.168) [0.456]	1.6422	1.7347	0.0581
Real Interest Rate[6]	-0.3399 (14.954)	-0.3266 (19.237) [0.997]	3.0038 (9.900) [0.295]	0.46901 (11.506) [0.132]	3.6991	2.8480	1.6767
M2/Reserve Ratio	21.6714 (52.766)	18.8139 (38.980) [0.590]	21.7090 (66.336) [0.655]	29.4828 (127.029) [0.555]	42.4138	56.7205	35.2631
Credit Growth	9.8550 (21.700)	-0.8679 (20.431) [0.000]	4.8038 (28.208) [0.107]	1.8084 (16.730) [0.303]	6.9694	1.1738	0.8300
Stock Price Change[6]	16.4608 (29.990)	1.8956 (23.304) [0.035]	14.1755 (54.712) [0.180]	13.7113 (43.096) [0.968]	9.3259	-25.9503	1.2307
Budget Surplus	-3.8223 (8.625)	-3.2522 (3.907) [0.432]	-3.7602 (5.282) [0.462]	-3.0675 (3.866) [0.263]	-1.7728	0.3127	-1.5394

[4] Mean Values (Standard Deviations) over period for countries experiencing banking sector distress. Brackets indicate the probability that the mean is different from the mean of the category to its left

[5] Length varies by duration of episode.

[6] Excludes high inflation countries.

Table 4
Determinants of Banking Sector Distress:
Probit Estimation Results

	(1)	(2)	(3)	(4)
OECD Dummy	-0.1664	-0.8806**	-0.9164**	-0.4577
	(0.1498)	(0.2478)	(0.2525)	(0.3786)
Constant	-1.5655**	-1.0353**	-0.8338**	-1.3632**
	(0.0852)	(0.3907)	(0.4054)	(0.6933)
Institutional Characteristics:				
Central Bank Independence		-2.0936**	-2.2823**	-2.4658**
		(0.9211)	(0.9414)	(1.2436)
Explicit Deposit Insurance		0.4450**		-0.0040
		(0.2053)		(0.2784)
Liberalization		0.6937**	0.4923*	1.0212**
		(0.2351)	(0.2615)	(0.4326)
Moral Hazard			0.5822**	
			(0.2361)	
Macroeconomic Developments:				
Real GDP Growth	-0.0496**	-0.0658**	-0.0644**	-0.0928*
	(0.0128)	(0.0222)	(0.0023)	(0.0502)
Exchange Rate Depreciation	0.0005	0.0026	0.0028	0.0017
	(0.0010)	(0.0023)	(0.0023)	(0.0080)
Real Credit Growth	-0.0067*	-0.0020	-0.0022	0.0047
	(0.0035)	(0.0046)	(0.0047)	(0.0075)
Real Interest Rate	0.00002	-0.00054	-0.0005	0.0159
	(0.00003)	(0.00062)	(0.0006)	(0.0197)
Inflation		-0.0006	-0.0006	0.0139
		(0.0006)	(0.0006)	(0.0157)
High Inflation Dummy		-0.2746	-0.2867	0.7635
		(0.2831)	(0.2817)	(0.6449)
Change in the Stock Market				-0.0148**
				(0.0067)
Obs	1317	657	657	426
Pseudo R2	0.0576	0.1507	0.1568	0.2268
Percent of episodes predicted at 10%	15.1%	54.5%	57.6%	35.3%

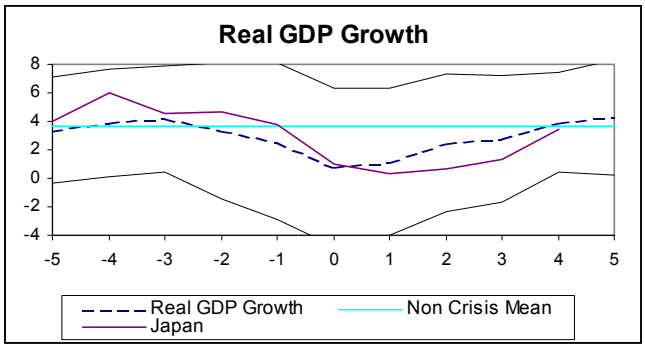
Notes: * and ** indicate significance at the 10% and 5% levels, respectively. All variables are contemporaneous. Standard Errors are in parentheses.

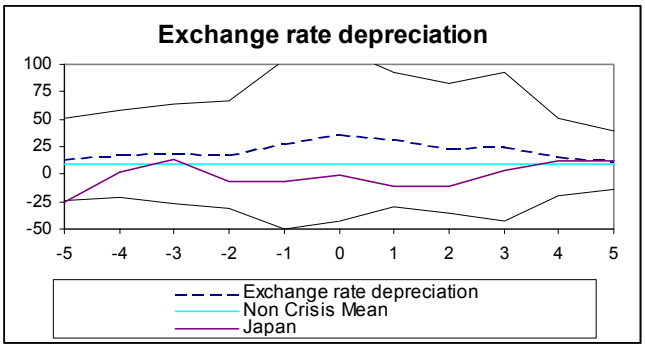
Table 5
Extensions: Probit Estimation Results

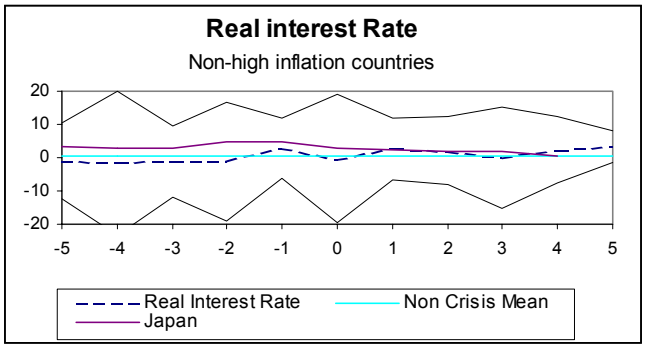
	(1)	(2)	(3)	(4)
	3-Year Windows	Alternative Variables	Lagged	Lagged
OECD Dummy	-0.6609*	-0.5473	-0.8481**	-0.8727**
	(0.3970)	(0.4254)	(0.3750)	(0.3136)
Constant	-1.119	-1.3509*	-1.2194*	-1.0836*
	(0.7312)	(0.8023)	(0.6685)	(0.5898)
Institutional Characteristics:				
Central Bank Independence	-2.5115**	-2.7422**	-2.4081**	-2.4633**
	(1.2568)	(1.2979)	(1.2021)	(1.1818)
Explicit Deposit Insurance	-0.2315	0.1395	-0.0230	0.0384
	(0.2951)	(0.2857)	(0.2765)	(0.2657)
Liberalization	1.1977**	1.1453**	1.1251**	1.1443**
	(0.4692)	(0.4700)	(0.4670)	(0.4406)
Macroeconomic Developments:				
Real GDP Growth	-0.0956*		-0.0548	-0.0570
	(0.05149)		(0.0533)	(0.0494)
% Deviation of GDP from 5 Year Average		-2.9203		
		(1.4881)		
Exchange Rate Depreciation	0.0022	-0.0062	0.0128	
	(0.0081)	(0.0098)	(0.0107)	
Real Credit Growth	-0.0054	0.0010	0.0092	
	(0.0073)	(0.0081)	(0.0122)	
Real Interest Rate	0.0190	0.0233	0.0396	0.0226
	(0.0208)	(0.0197)	(0.0263)	(0.0202)
Inflation	0.0147	0.0294	0.0169	
	(0.0174)	(0.1747)	(0.0177)	
High Inflation Dummy	1.0274	1.2278	0.0130	
	(0.7230)	(0.8630)	(0.7727)	
Change in the Stock Market	-0.0168**		-0.0097*	-0.0080
	(0.0073)		(0.0055)	(0.0051)
% Deviation of Stock Index from 5 Year Average		-0.7477**		
		(0.3052)		
Obs	390	413	432	432
Pseudo R2	0.2550	0.1882	0.1760	0.1574
Percent of episodes predicted at 10%	52.9%	43.7%	47.1%	47.1%

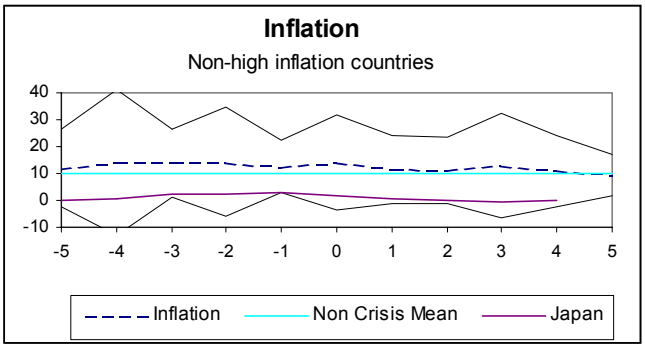
Note: Regressors in columns (1) and (2) are contemporaneous values. Macroeconomic regressors in columns (3) and (4) are lagged one year. See text for variable definitions. Standard errors are in parentheses.

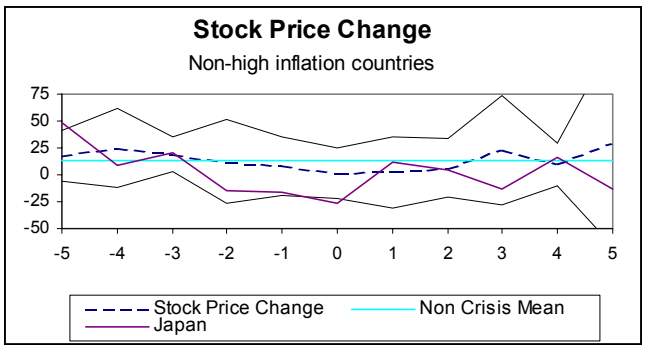
Figure 1

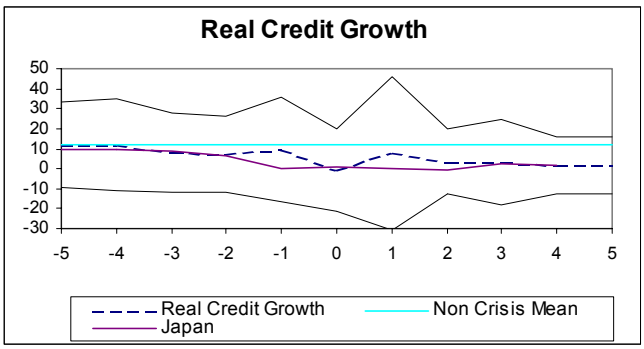

Real GDP Growth
Real GDP Growth
Non Crisis Mean
Japan

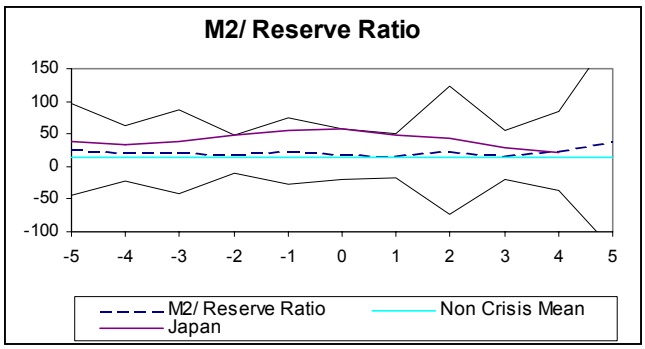

Exchange rate depreciation
Exchange rate depreciation
Non Crisis Mean
Japan


Real interest Rate
Non-high inflation countries
Real Interest Rate
Non Crisis Mean
Japan


Inflation
Non-high inflation countries
Inflation
Non Crisis Mean
Japan


Stock Price Change
Non-high inflation countries
Stock Price Change
Non Crisis Mean
Japan


Real Credit Growth
Real Credit Growth
Non Crisis Mean
Japan


M2/ Reserve Ratio
M2/ Reserve Ratio
Non Crisis Mean
Japan

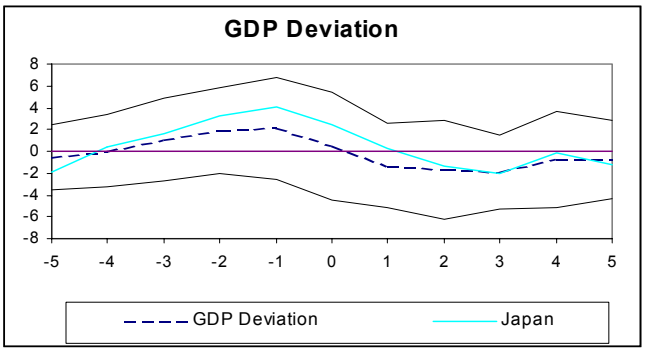

GDP Deviation
GDP Deviation
Japan

Figure 2

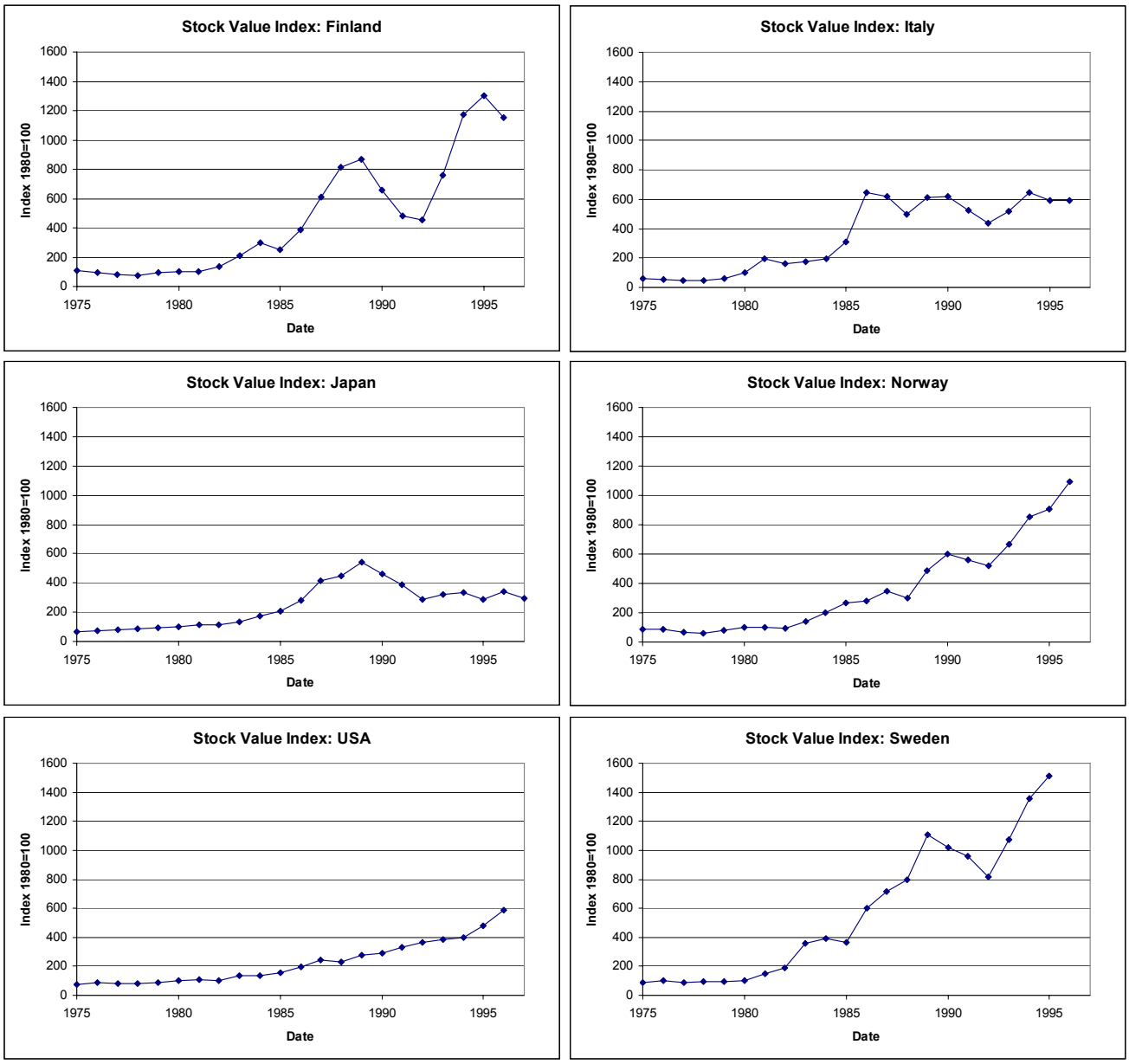

Stock Value Index: Finland
Stock Value Index: Italy
Stock Value Index: Japan
Stock Value Index: Norway
Stock Value Index: USA
Stock Value Index: Sweden
Index 1980=100
Date
0
200
400
600
800
1000
1200
1400
1600
1975
1980
1985
1990
1995

Figure 3

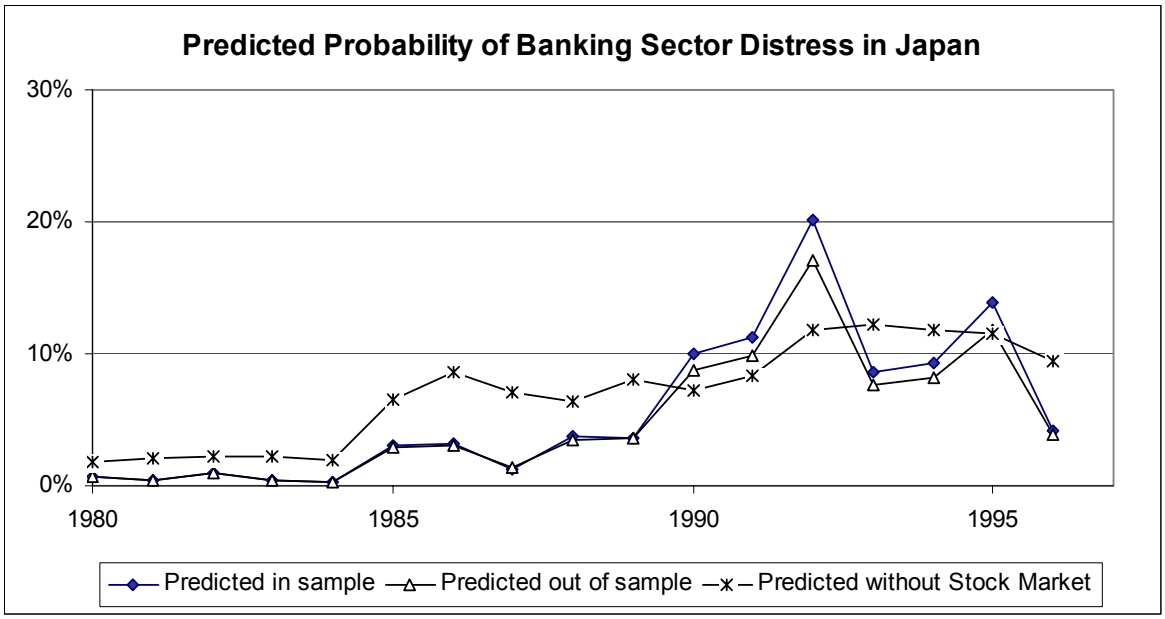
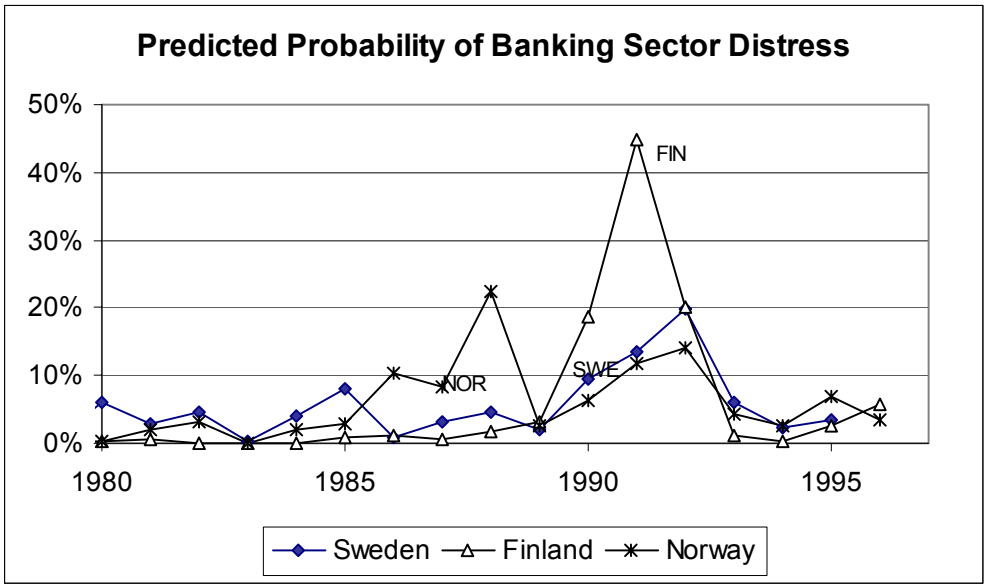

Predicted Probability of Banking Sector Distress in Japan
30%
20%
10%
0%
1980
1985
1990
1995
Predicted in sample
Predicted out of sample
Predicted without Stock Market

Figure 4


Predicted Probability of Banking Sector Distress
50%
40%
30%
20%
10%
0%
1980
1985
1990
1995
FIN
SWE
NOR
Sweden
Finland
Norway

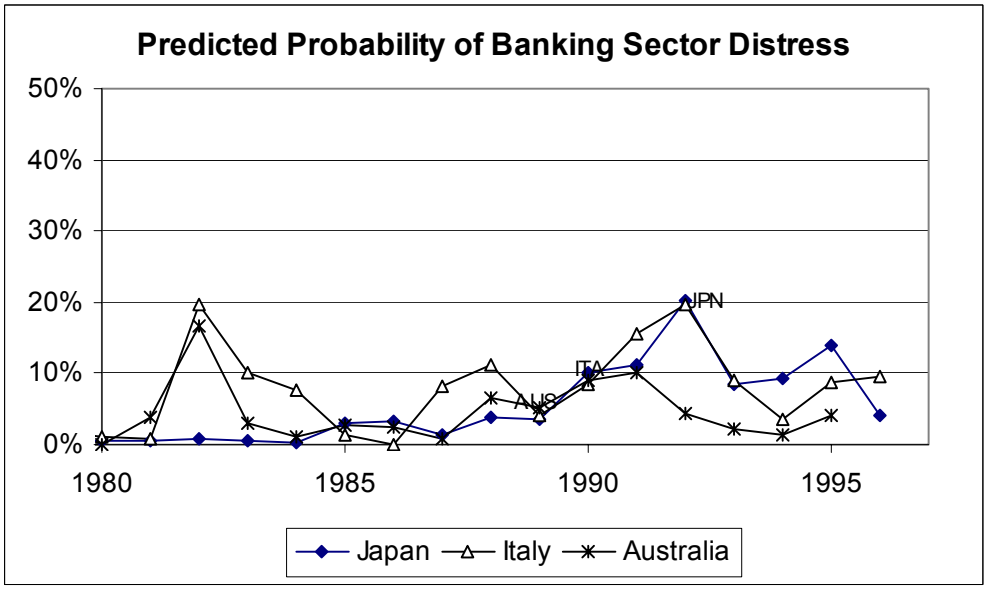
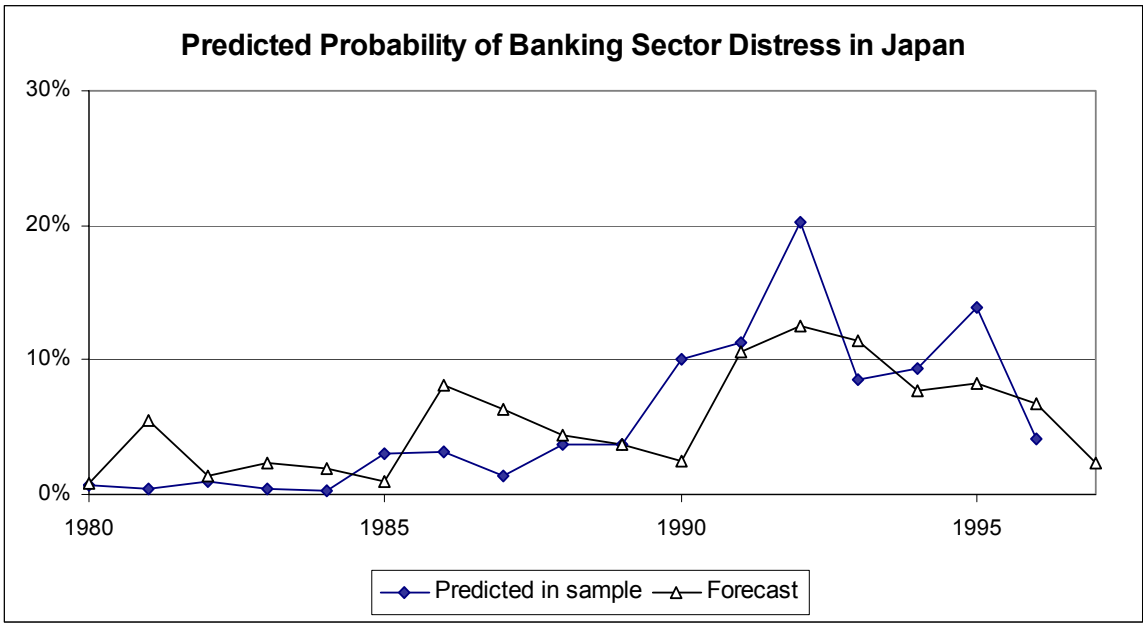

Predicted Probability of Banking Sector Distress
50%
40%
30%
20%
10%
0%
1980
1985
1990
1995
JPN
ITA
AUS
Japan
Italy
Australia

Figure 5


Predicted Probability of Banking Sector Distress in Japan
30%
20%
10%
0%
1980
1985
1990
1995
Predicted in sample
Forecast

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[1] The identification of banking crisis episodes and duration is from Caprio and Klingebiel (1996) and Demirgüç-Kunt and Detragiache (1997).

[2] This amount includes the 685 billion-yen public monies for the *jusen* resolution and the 60 trillion-yen commitment in 1998 for re-capitalizing banks and deposit insurance.

[3] We measure the output cost associated with each episode of banking sector distress as the present discounted value (at a 3 percent discount rate) of the cumulative output loss starting from the year after which banking sector distress is identified. The Hodrick-Prescott filter is used to estimate the "normal" or trend output level, and the output gap is measured as the percentage difference of actual from trend output. When the output gap is negative following a banking problem (49 episodes), the (discounted) sum of the output gap loss is calculated up to the point to where the output returns to within 0.5 percent of trend. When the output gap is positive following the onset of a banking problem (12 episodes), no recession had occurred, and the single year's (positive) output gap is considered an output gain.

[4] Our cyclical output measures, upon which the output loss measures are based, indicate that economic activity in Japan was below "normal" from 1993 to 1997. Preliminary data indicate a deepening recession in 1998.

[5] The HP filter also tends to underestimate the output loss for countries, such as Japan, with particularly long recessions. The longer period of recession, the more the HP filter will tend to smooth the series so a weak period becomes part of trend output.

[6] We begin with a sample of 132 countries, but data availability limits our sample to 97 developed and developing countries (identify 65 episodes of banking sector distress). The sample period is 1975-97 period (or to the point data is available). Demirgüç-Kunt and Detragiache (1998a) data includes 65 countries with 31 banking crisis episodes over the 1980-94 period. Eichengreen and Rose (1998) consider data on developing countries from 1975-92 and initially consider 105 countries. They identify 39 banking crises. Kaminsky and Reinhart (1996) consider 20 banking crisis countries in their data set.

[7] None of the aforementioned studies investigate the effects of stock prices on the probability of banking sector distress. We would also like to consider real estate values in our empirical work, but only limited data is available and it is frequently not comparable across countries due to differences in definitions and scope.

[8] We thank Takeo Hoshi for this insight.

[9] Demirgüç-Kunt and Detragiache (1998) identify banking sector distress as a situation where one of the following conditions hold: ratio of non-performing assets to total assets is greater than 2 percent of GDP; cost of the rescue operation was at least 2 percent of GDP; banking sector problems resulted in a large scale nationalization of banks; and extensive bank runs took place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis.

[10] Demirgüç-Kunt and Detragiache's (1998) sample period is 1980-94.

[11] Hardy and Pazarbasioglu (1998), by contrast, only consider the 5-year period preceding and the year of the onset of banking sector distress. For all countries not experiencing problems, they consider the 6-year 1990-95 period.

[12] In practice, however, only one banking crisis is excluded using this windowing procedure (Turkey, 1994) and the estimation results (shown in the extensions section), despite fewer observations, are not qualitative different from the main set of results.

[13] Demirgüç-Kunt and Detragiache (1998a), by contrast, consider a successful prediction to be one where the model predicts at least a 5 percent probability of crisis and a crisis occurs during the year in question.

[14] Financial liberalization is also found to be a significant determinant of banking crises in Kaminsky and Reinhart (1996) and Demirgüç-Kunt and Detragiache (1998b). Explicit deposit is also found to a significant determinant of banking crises in Demirgüç-Kunt and Detragiache (1998a). We find, however, that the coincident of these two events, either entered separately in the regression or through our "moral hazard" interaction term, is especially important. No other study of which we are aware attempts to measure moral hazard in this way or considers the role of an independent central bank in lowering the likelihood of a banking problem.

[15] Several studies have found that declining output leads to a higher probability of banking sector distress (e.g. Eichengreen and Rose, 1998). We are not aware of any other study introducing stock prices in the context of probability models of this form

[16] The coefficient estimates are not shown for brevity but are available from the authors upon request.

[17] Other combinations of slope dummies on particular variables for the OECD countries were also tested. In no case were these coefficients jointly significant. Only the introduction of the intercept dummy variable for the OECD countries is significant, indicating that they have a lower average probability of a banking crisis occurring.

[18] In Japan's case, however, we know that the fall in the stock market (which peaked in December 31, 1989) preceded the banking crisis by a full two years, indicating a causal link running from a collapsing stock market to the onset of banking sector distress.

[19] It is noteworthy that the inclusion of stock prices in the estimation equation eliminates most of the developing countries from the sample. Other, more inclusive, formulations of the model that exclude stock prices would include more developing countries in the sample and could change the results. For example, the predictive power of high real interest rates—perhaps emanating from "Northern" countries as in Eichengreen and Rose (1998)—would likely be statistically significant. Our objective, however, is not to find the equation with the highest predictive power but to check the robustness of the baseline model to changes in lead/lag relationships, especially as it relates to Japan.