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BANK CONCENTRATION AND CRISES

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**ABSTRACT**

Motivated by public policy debates about bank consolidation and conflicting theoretical predictions about the relationship between the market structure of the banking industry and bank fragility, this paper studies the impact of bank concentration, bank regulations, and national institutions on the likelihood of suffering a systemic banking crisis. Using data on 70 countries from 1980 to 1997, we find that crises are less likely in economies with (i) more concentrated banking systems, (ii) fewer regulatory restrictions on bank competition and activities, and (iii) national institutions that encourage competition.

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## **I. Introduction**

The consolidation of banks around the globe is fueling an active public policy debate on the impact of consolidation on financial stability.<sup>1</sup> Indeed, economic theory provides conflicting predictions about the relationship between the market structure of the banking industry and banking system fragility. Motivated by public policy debates and ambiguous theoretical predictions, this paper investigates empirically the impact of bank concentration on banking system stability.

Some theoretical arguments and country comparisons suggest that a less concentrated banking sector with many small banks is more prone to financial crises than a concentrated banking sector with a few large banks (Allen and Gale, 2000, 2003). First, proponents of the “concentration-stability” view hold that large banks can diversify better so that banking systems characterized by a few large banks will be less fragile than banking systems with many small banks.<sup>2</sup> Second, concentrated banking systems may enhance profits and therefore lower bank fragility. High profits provide a “buffer” against adverse shocks and increase the franchise value of the bank, reducing incentives for bank owners to take excessive risk (Hellmann, Murdoch, and Stiglitz, 2000). Third, some hold that a few large banks are easier to monitor than many small banks, so that corporate control of banks will be more effective and the risks of contagion less pronounced in a concentrated banking system. According to Allen and Gale (2000), the U.S., with its large number of small banks, supports this “concentration-stability” view since it has had a history of much greater financial instability than the U.K or Canada, where the banking sector is dominated by fewer larger banks.

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<sup>1</sup> See Group of Ten (2001), Bank for International Settlements (2001), International Monetary Fund (2001), and Boyd and Graham (1998, 1991).

<sup>2</sup> Models by Diamond (1984), Ramakrishnan and Thakor (1984), Boyd and Prescott (1986), Williamson (1986), Allen (1990), and others predict economies of scale in intermediation.

An opposing view is that a more concentrated banking structure enhances bank fragility. First, advocates of the “concentration-fragility” view note that large banks frequently receive subsidies through implicit “too big to fail” policies.<sup>3</sup> This greater subsidy for large banks may in turn intensify risk-taking incentives, increasing the fragility of concentrated banking systems (Boyd and Runkle, 1992 and Mishkin, 1999).<sup>4</sup> Second, proponents of the concentration-fragility view would disagree with the proposition that a few large banks are easier to monitor than many small banks. If size is positively correlated with complexity, then large banks may be more opaque than small banks, which would tend to produce a positive relationship between concentration and fragility. Finally, Boyd, and De Nicolo (2003) stress that banks with greater market power tend to charge higher interest rates to firms, which induces firms to assume greater risk. If concentration is positively associated with banks having market power, this model predicts a positive relationship between concentration and bank fragility.

Despite conflicting theoretical predictions and policy debates, there is surprisingly little cross-country empirical evidence on bank structure and fragility. For the United States, Boyd and Runkle (1993) examine 122 bank holding companies. They find that there is an inverse relationship between size and the volatility of asset returns, but no evidence that large banks are less likely to fail. In fact they observe that large banks failed somewhat more often in the 1971-90 period. They explain this result by showing that larger banks are more highly leveraged and less profitable in terms of asset returns.

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<sup>3</sup> Even in the absence of deposit insurance, banks are prone to excessive risk-taking due to limited liability for their equity holders and to their high leverage (Stiglitz, 1972).

<sup>4</sup> There is a literature that examines deposit insurance and its effect on bank decisions. According to this literature (e.g. Merton (1977), Sharpe (1978), Flannery (1989), Kane (1989), and Chan, Greenbaum and Thakor (1992)) – mis-priced deposit insurance produces an incentive for banks to take risk. If the regulatory treatment were the same for insured banks of all sizes, these models would predict no relationship between bank size and riskiness. Since regulators fear potential macroeconomic consequences of large bank failures, most countries have implicit “too large to fail” policies which protect all liabilities of very large banks whether they are insured or not. Thus, largest banks frequently receive a

Although there is a growing cross-country empirical literature on banking crises, this literature does not address the issue of banking structure. Earlier work has mostly focused on identifying (i) the macroeconomic determinants of banking crises (Demirgüç-Kunt and Detragiache, 1998, henceforth DD), (ii) the relationship between banking and currency crises (Kaminsky and Reinhart, 1999), (iii) the impact of financial liberalization on bank stability (DD, 1999), and (iv) the impact of deposit insurance design on bank fragility (DD, 2003). Barth, Caprio, and Levine (2004) examine the relationship between bank regulations and crises, but they do not examine bank concentration and they use pure cross-country comparisons rather than panel analyses.

This paper studies the impact of bank concentration, bank regulations, and national institutions on the likelihood of suffering a systemic banking crisis using data on 70 countries over the period 1980-1997. This is the first paper to examine the impact of concentration on crises across a broad cross-section of countries while controlling for differences in regulatory policies, national institutions governing property rights and economic freedom, the ownership structure of banks, and macroeconomic and financial conditions.<sup>5</sup> To draw accurate inferences about the impact of banking structure on crises, we control for an array of factors that may influence both bank concentration and fragility. We control for international differences in the generosity of deposit insurance regimes, capital regulations, restrictions on bank entry, and regulatory restrictions on bank activities. Furthermore, to assess the impact of concentration on crises, we need to control for cross-country differences in bank ownership, i.e., the degree to which the state and foreigners own the country's banks. Finally, we control for the overall institutional environment governing economic activity as

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greater net subsidy from the government (O'Hara and Shaw, 1990). This subsidy may in turn increase the risk-taking incentives of the larger banks. For an analysis of the corporate governance of banks, see Macey and O'Hara (2003).

<sup>5</sup> Demirgüç-Kunt, Laeven and Levine (2004) investigate the impact of bank concentration and regulations on bank net interest margins, but they do not examine bank fragility.

well as the level of economic development, economic growth, inflation, terms of trade changes, credit growth, etc.

The paper has three major findings. First, we find that crises are less likely in more concentrated banking systems. This is consistent with the concentration-stability view's argument that banking systems characterized by a few, large banks are more stable than less concentrated banking markets. Second, the paper shows that more competition lowers the probability that a country will suffer a systemic banking crisis. The data indicate that fewer regulatory restrictions on banks – lower barriers to bank entry and fewer restrictions on bank activities – reduce bank fragility. Third, countries with national institutions that promote competition in general have a lower likelihood of suffering a systemic banking crisis. These results are not driven by reverse causality and are robust to an array of sensitivity checks. In terms of linking the results back to specific parts of the concentration-stability view, the finding that competition reduces fragility is inconsistent with the argument that concentrated banking systems boost profits and therefore reduce fragility. Rather, the evidence is more consistent with the views that concentrated banking systems tend to have banks that are better diversified or easier to monitor than banks in less concentrated banking systems.

The results must be qualified. We investigate systemic banking crises, which are very difficult to define and date. Consequently, we use different definitions of and dates for crises and obtain robust results. Nevertheless, future work that assesses the impact of the market structure of the banking industry and bank regulations on individual bank fragility will provide a valuable complement to our research.

The rest of the paper is organized as follows. Section II describes the data set and presents summary statistics. Section III explains the methodology used in empirical tests. Section IV contains the main results and Section V concludes.

## II. Data and Summary Statistics

This section describes the data. The Appendix provides more detailed variable definitions and data sources.

*Crisis* is a dummy variable that equals one if the country is going through a systemic crisis, and zero if it is not. Following DD (2003), we identify and date episodes of banking sector distress using primarily information from Lindgren, Garcia and Saal (1996) and Caprio and Klingebiel (1999). Then, these episodes of distress are classified as systemic if emergency measures were taken to assist the banking system (such as bank holidays, deposit freezes, blanket guarantees to depositors or other bank creditors), or if large-scale nationalizations took place. Episodes were also classified as systemic if non-performing assets reached at least 10 percent of total assets at the peak of the crisis, or if the cost of the rescue operations was at least 2 percent of GDP. Many crises run for multiple years. We exclude the years after the initial year of the crisis because during a crisis, the behavior of some of the explanatory variables is likely to be affected by the crisis itself, leading to reverse causality. Note, however, that including the crisis years does not change the conclusions. Also, some countries experience more than one crisis. For instance, Turkey suffered systemic banking crises in 1982, 1991, and 1994. For the period 1980-1997, the sample includes all countries covered in the International Financial Statistics, excluding countries in transition, those without data, etc., as discussed in DD (2003). This results in 79 countries and 51 crisis episodes. Table 1 lists this information. Later in the paper we also investigate robustness of our results to differences in the crisis definition.

*Concentration* equals the share of assets of the three largest banks. We compute a measure of bank concentration using the Bankscope database compiled by Fitch-IBCA, which reports bank balance sheet data in a large cross-section of countries beginning in 1988. However, because the

sample of banks covered increased significantly over the sample period, changes in the measure of concentration may just reflect changes in coverage. To reduce this potential problem, we average the measure over the period 1988-1997. We have data on concentration for 70 countries including 47 crisis episodes. As reported in Tables 1 and 2, most countries have concentrated banking systems with a sample mean of 72 percent. Still, there is wide variation in the sample, with concentration levels ranging from less than 20 percent for the U.S. to 100 percent for many African countries. Simple correlations do not show a significant relationship between the crisis dummy and bank concentration, although the sign is negative.

Using this measure of concentration may blur the interpretation of estimation results since for many observations the crisis date would precede the time period for which we have the concentration values. However, we also use the initial level of concentration at the start of the sample period and focus on crises that occurred after this date. Although this cuts the number of observations in half and reduces crisis episodes to 20, we confirm our results.

To investigate the relationship between banking crises and bank concentration, we control for many factors. Specifically, we begin with the econometric specification in DD (2003) and include the same regressors. Thus, we include the rate of growth of real GDP, the change in the external terms of trade, and the rate of inflation, to capture macroeconomic developments that are likely to affect the quality of bank assets. The short-term real interest rate is included to capture the banks' cost of funds. Also, higher real interest rate may affect bank profitability increasing default rates. Bank vulnerability to sudden capital outflows triggered by a run on the currency and bank exposure to foreign exchange risk are measured by the rate of exchange rate depreciation and by the ratio of M2 to foreign exchange reserves. Lagged credit growth is also a control since high rates of credit expansion may finance an asset price bubble that may cause a crisis when it bursts. We also include



DD's (2003) index of moral hazard caused by deposit insurance generosity since they find that it contributes significantly to financial fragility.<sup>6</sup> Finally, GDP per capita is used to control for the level of development of the country, which DD (2003) included it to proxy for the quality of regulations and the general institutional environment. Thus, we leave GDP per capita out of the benchmark when we explore the impact of specific banking regulations and institutional indicators.

Simple correlations in Table 2 suggest that banking crises are more likely in countries with higher levels of inflation and exchange rate depreciation, and less likely in growing countries with higher GDP per capita.

In addition to bank concentration, we augment the benchmark specification in DD by using measures of bank regulation and supervision, bank ownership, the competitiveness of the banking system and the economy in general, and a summary institutional index. Measures of bank regulation and supervision come from Barth, et al., (2001, 2004). The data set is collected through surveys of government officials in the late 1990s, but according to additional analyses by Barth, et al., (2001) and Carkovic and Levine (2002), these aspects of bank regulation do not change much.

We use four measures of bank regulation and supervision.

*Fraction of Entry Denied* is the number of entry applications denied as a fraction of the number of applications received from domestic and foreign entities. This is a measure of entry restrictions in banking and thus the contestability of the market. To the extent restricted entry increases bank profits, this variable would be associated with a lower rate of fragility. If however, restricted entry induces inefficiencies in the banking market, it could also lead to greater fragility.

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<sup>6</sup> To build an aggregate index of moral hazard, DD (2003) estimate the first principal component of various deposit insurance design features. Specifically, they use coinsurance, coverage of foreign currency and interbank deposits, type of funding, source of funding, management, membership, and the level of explicit coverage to create this aggregate index that increases with the generosity of the deposit insurance regime. The index varies over time since different countries adopted deposit insurance or revised its design features at different points in time.

*Activity Restrictions* aggregates measures that indicate whether bank activities in the securities, insurance, and real estate markets and ownership and control of nonfinancial firms are (1) unrestricted, (2) permitted, (3) restricted, or (4) prohibited. The aggregate indicator has therefore a possible maximum variation between four and 16, with higher numbers indicating more restrictions on bank activities and nonfinancial ownership and control. If these restrictions manage to keep banks from entering lines of business that are too risky for them to adequately evaluate or manage, banking systems with greater restrictions may be more stable. If however, restrictions prevent firms from diversifying outside their traditional lines of business, they may increase the fragility of the system.

*Required Reserves* is the ratio of bank assets that regulators require banks to hold as reserves. Banking systems with higher ratios of required reserves may be more stable since they would have a greater buffer to absorb liquidity shocks. However, greater required reserves are also a tax on the banking system, which may lower profits and raise fragility.

*Capital Regulatory Index* is a summary measure of capital stringency, and it is given by the sum of initial capital stringency and overall capital requirements. To the extent that book capital is an accurate measure of bank solvency we expect better capitalized banks to be less fragile.

Table 2 indicates that fraction denied, activity restrictions, and required reserves are positively and significantly correlated with each other. Capital regulatory index is also positively correlated with required reserves but negatively correlated with activity restrictions. The moral hazard index is negatively and significantly correlated with all regulatory variables except capital regulatory index where the correlation is positive. It is also interesting that deposit insurance schemes in concentrated banking systems tend to be designed such that moral hazard is significantly lower. Among the regulatory variables only activity restrictions is significantly correlated –albeit at ten percent - with the crisis dummy, and the sign is positive.

We also control for ownership. If public banks are considered to have government guarantees, banking systems with a larger share of public banks may be less prone to banking runs. However, inefficiencies in public banks may also make them more fragile, destabilizing the system. Indeed, Caprio and Martinez-Peria (2000) and Barth, et al., (2001) find evidence supporting the former argument.

The extent of foreign bank ownership is another important control. To the extent foreign banks improve domestic banks' efficiency (as found in Claessens, Demirguc-Kunt and Huizinga, 2001), they may also make the system more stable. However, reduction in profits due to higher competition from foreign banks may also hurt the domestic banks making the system more fragile.

*State Ownership* and *Foreign Ownership* are from Barth, et al., (2001), defined as the percentage of banking system's assets in banks that are 50 percent or more government or foreign owned. As in the case of regulatory variables, the assumption is that ownership of banks does not vary significantly over the years.<sup>7</sup> Simple correlations in Table 2 do not reveal significant relationships between bank ownership variables and crisis occurrence.

We also use three additional variables to capture the extent of banking freedoms and general economic freedoms and institutional environment.

*Banking Freedom* is an indicator of relative openness of the banking system. Specifically, it is a composite index of whether foreign banks and financial services firms are able to operate freely, how difficult it is to open domestic banks and other financial services firms, how heavily regulated the financial system is, the presence of state-owned banks, whether the government influences

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<sup>7</sup> We also use state bank data from La Porta, Lopez de Silanes, and Shleifer (2002) who report figures on the percentage of assets of the largest 10 banks owned by the government. For each country there are two data points, one for 1995, and one referring to public ownership "before the privatizations of the 1990s." In the regression, we use the latter figures for the 1980s and the former for the 1990s.

allocation of credit, and whether banks are free to provide customers with insurance products and invest in securities. Higher values indicate fewer restrictions on banking freedoms.

*Economic Freedom* is an indicator of how a country's policies rank in terms of providing economic freedoms. It is a composite of ten indicators ranking policies in the areas of trade, government finances, government interventions, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, and black market activity. Higher scores indicate policies more conducive to competition and economic freedom. Both variables are available from the Heritage Foundation and are average values for the 1995-97 period. To the extent freedoms allow banks to improve efficiency and to engage in different activities and diversify their risks, we expect increased level of freedoms to reduce fragility. However, it is also true that greater freedoms allow banks to undertake greater risks, particularly if the underlying institutional environment and existing regulations and supervision distort risk-taking incentives. Thus, overall greater freedoms may also lead to greater bank fragility.

*KKZ\_Composite* is an index of the overall level of institutional development constructed by Kaufman, Kraay and Zoido-Lobaton (1999). The underlying indicators are voice and accountability, government effectiveness, political stability, regulatory quality, rule of law, and control of corruption. This index is available for 1998. We expect better institutions to lead to reduced bank fragility, controlling for all other factors. Simple correlations indicate that the crisis dummy is negatively and significantly correlated with the two freedom indicators and the institutions variable. Countries with better institutions also tend to have more competitive banking systems with fewer regulatory restrictions.

### III. Methodology

In estimating the crisis model, we follow DD (1998, 2003) and use a logit probability model. Using this model of banking crisis, we can test the hypothesis that bank concentration and competition have an impact on fragility when controlling for other factors. Thus, we estimate the probability that a systemic crisis will occur at a particular time in a particular country, assuming that this probability is a function of the explanatory variables ( $X(i,t)$ ) discussed above. Let  $P(i, t)$  denote a dummy variable that takes the value of one when a banking crisis occurs in country  $i$  and time  $t$  and a value of zero otherwise.  $\beta$  is a vector of  $n$  unknown coefficients and  $F(\beta NX(i, t))$  is the cumulative probability distribution function evaluated at  $\beta NX(i, t)$ . Then, the log-likelihood function of the model is:

$$\ln L = \sum_{t=1..T} \sum_{i=1..n} \{P(i,t)\ln[F(\beta NX(i,t))] + (1-P(i,t)) \ln[1 - F(\beta NX(i,t))]\}.$$

In modeling the probability distribution we use the logistic functional form, which is commonly used in studying banking difficulties.<sup>8</sup> We estimate the model with robust standard errors since there may be heteroskedasticity across different observations. Observations within each country group may also be correlated. We also deal with this problem below, by relaxing the assumption that errors are independent within country observations.

When interpreting the regression results, it is important to remember that the estimated coefficients do not indicate an increase in the probability of a crisis given a one-unit increase in the corresponding explanatory variables. Instead, the coefficients reflect the effect of a change in an explanatory variable on  $\ln(P(i,t)/(1-P(i,t)))$ . Therefore, the increase in probability depends on the original probability and thus upon the initial values of all the independent variables and their coefficients. While the sign of the coefficient does indicate the direction of the change, the

magnitude depends on the slope of the cumulative distribution function at  $\beta'X(i,t)$ . In other words, a change in the explanatory variable will have different effects on the probability of a crisis depending on the country's initial crisis probability. Under the logistic specification, if a country has an extremely high (or low) initial probability of crisis, a marginal change in the independent variables has little effect on its prospects, while the same marginal change has a greater effect if the country's probability of crisis is in an intermediate range.

In the analysis presented below, we investigate the impact of bank concentration variable and different regulatory, competition, ownership and institutional variables on bank fragility one at a time. We also analyze if the impact of concentration is robust to controlling for regulatory variables and indicators of competition and institutional development and whether there are significant interactions with concentration and these variables. Finally, we explore the potential non-linearity of the crisis-concentration relationship, and discuss the robustness of our results to different definitions of concentration and reverse causality.

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<sup>8</sup> In addition to DD (1998,1999, 2003) also see Cole and Gunther (1993), Gonzalez-Hermosillo et al. (1997), and Demirguc-Kunt (1989).

## IV. Results

### A. Main findings

#### *1. Concentration and crises*

The concentration variable enters the regressions negatively, significantly, and with an economically large coefficient. This result suggests that concentrated banking systems are less vulnerable to banking crises (Table 3). Evaluating the marginal impact of concentration on the probability of crisis at the mean values for all variables, we see that a one standard deviation increase in concentration leads to a decrease in crisis probability of one percent. Since crisis probabilities at any point in time are quite low, with a mean value of four percent, this is a substantial reduction. This result is supportive of the concentration-stability view that concentration fosters a more stable banking system.

Among the control variables, GDP growth and per capita GDP enter negatively, while the real interest rates enter positively, as suggested by economic theory and earlier empirical studies. Credit growth is positive, but significant only at the ten percent level, which lends weak support to the argument that credit booms signal future fragility. Confirming the results of DD (2003), moral hazard enters positive and significantly, indicating that deposit insurance design can have an important impact on fragility, and the result is weaker controlling for bank concentration. The model also fits the data well, classifying 65 percent of all observations and over 70 percent of crisis observations accurately.<sup>9</sup>

In column (3) we also add a squared concentration variable to the specification to check for potential nonlinearities in the relationship between concentration and banking crises. When including the squared term, the concentration variable retains a negative and significant coefficient at the ten

percent level, while the squared concentration term is positive and insignificant. Testing for the joint significance of the two variables, we see that together the coefficients are significantly different from zero at the five percent level. This indicates that, although weak, at very high levels of concentration, there is an offsetting effect at work where concentrated banking systems are no longer as stable. Below, we try to understand the nature of this nonlinearity better. Finally, the table shows that the concentration result is not sensitive to excluding GDP per capita from the regression.

## *2. Concentration, regulations, and crises*

In Table 4, we include indicators of bank regulation to the specification. These specifications exclude GDP per capita since it is also a proxy for the institutional environment. We have also estimated specifications where we have left out the concentration variable and included only the regulation supervision variables one at a time. The results on these variables are virtually unchanged, thus we do not report them for brevity.

The results indicate that tighter entry restrictions and more severe regulatory restrictions on bank activities boost bank fragility (Table 4). These are consistent with the results obtained by Barth et al. (2004), who examine the impact of entry restrictions on crises in a purely cross-country investigation that does not control for bank concentration. A higher fraction of entry applications denied- a proxy for tighter entry regulations – leads to higher levels of fragility in the banking system. This is consistent with the argument that restricted entry reduces the efficiency of the banking system, also making it more vulnerable to external shocks. Similarly, we find that restrictions on bank activities increase crisis probabilities. This result indicates that overall these restrictions prevent banks from diversifying outside their traditional business, reducing their ability to

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<sup>9</sup> In classifying observations, predicted probabilities significantly higher than 4 percent (no of crisis observations divided by total number of observations which equals the sample mean of the crisis dummy) are classified as crisis observations and those below 4 percent are classified as no crisis.



reduce the riskiness of their portfolios. The required reserves and capital regulatory index do not enter with significant coefficients.

The results also indicate that the concentration result is robust to inclusion of regulatory variables. The overall effect of bank concentration on crisis likelihood is still negative and significant. In unreported regressions we have also explored specifications where we have interacted the concentration variable with these regulatory variables, but the interaction terms did not enter significantly.

### *3. Concentration, ownership, institutions, and crises*

In Table 5, we explore the impact of concentration, bank ownership, and the overall institutional environment variables on bank fragility. We examined each of the ownership and institutional indicators both with and without concentration included in the regression. Since the coefficients on the ownership and institutional variables are not significantly different in either specification, we only report the results of the regressions that include concentration. The first two columns explore the impact of bank ownership on fragility.

The data do not indicate a strong link between bank fragility and either state or foreign ownership. While some regressions indicate a positive impact of state ownership on bank fragility, this result is not very robust.<sup>10</sup> The impact of foreign ownership on fragility is negative, but insignificant.

In contrast, the variables that capture the general openness and competitiveness of the banking system and the economy enter with negative and very significant coefficients. Thus countries with greater freedoms in banking and generally more competitive economic policies are less likely to experience banking crises. This is the case despite the fact these policies also tend to reduce entry

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<sup>10</sup> In the specification that excludes bank concentration, state ownership is not significant. Replicating these regressions using LLS (1999) measure of state bank ownership confirm these findings.

barriers and are correlated with reduced levels of bank concentration. Better institutional environment is also associated with a lower probability of systemic crisis, as expected. The evidence is consistent with theories that emphasize the stabilizing effects of competition (Boyd and De Nicolo, 2003), but inconsistent with the many models that stress the destabilizing effects from competition.<sup>11</sup>

The results on bank concentration are robust to including bank ownership and general competition and institutional variables. In unreported regressions we also explored whether the impact of concentration on fragility differs in countries with different levels of freedoms and institutional development, by including interaction terms in the regressions. None of these interaction terms were significant, suggesting that bank concentration reduces fragility regardless of the competition environment or the institutional development of the country.

#### *4. Concentration, regulations, ownership, institutions, and crises*

In Table 6, we simultaneously include bank concentration, regulations, ownership, and institutions. In each specification we enter bank concentration, the index of overall institutional development, and a measure of regulation.

Bank concentration remains significantly, negatively associated with bank fragility even when controlling for the regulatory variables and overall institutional development. Indeed, the size of the coefficient on concentration is not substantially affected by expanding the conditioning information set.

In contrast, the regulatory restriction variables and the overall institutional development indicators exhibit substantial multicollinearity. Their independent significance is materially weakened in Table 6 when they are included jointly. These results suggest that regulatory

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<sup>11</sup> Boyd and De Nicolo (2003) stress that competition exerts a stabilizing impact on banks because more competitive banks charge lower interest rates to firms and these lower rates reduce the likelihood of default. This prediction is consistent with our results. However, Boyd and De Nicolo (2003) use bank concentration as an indicator of bank

approaches to banking are part of the overall national approach to openness, competition, and private property in the economy.

The evidence in Table 6 suggests that bank concentration is not a simple proxy for regulatory restrictions or national institutions. Bank concentration enters negatively in the crisis regression when controlling for regulations and institutions. These findings support the view that concentrated banking systems are more stable than less concentrated systems. The data are inconsistent with theories that predict more fragility in more concentrated banking systems.

The findings that (i) concentration lowers fragility and (ii) low competition raises fragility imply that future research needs to move beyond a simple “concentration-stability” versus “concentration-fragility” debate where concentration is viewed as a simple proxy for market power. There are at least three possible explanations for our finding that concentration is negatively associated with bank fragility. First, concentrated banking system may have bigger banks that are better diversified than less concentrated banking systems. Second, concentrated banking systems may reduce fragility by boosting bank profits. Third, concentrated banking systems with a few large banks may be easier to monitor than a banking system with many small banks. Recall, however, that this paper finds that greater competition in banking promotes bank stability, which is inconsistent with the argument that concentration enhances stability by boosting bank profits. If our measures of regulatory restrictions and market openness do a reasonably good job of measuring the competitiveness of the banking industry, then the finding that concentration remains negatively associated with the probability of suffering a systemic banking crises while controlling for the competitiveness of the market implies that concentration is measuring “something else” besides market power. Thus, within the concentration-stability view, at least two remaining explanations

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competition. Thus, they stress that concentration will exert a destabilizing impact on banks, which is inconsistent with our results.

may account for the positive link between concentration and stability: more diversification and easier monitoring. We hope that future studies at the individual bank-level can identify why bank concentration is negatively correlated with bank fragility even after controlling for the degree of competition in the banking industry.<sup>12</sup>

## B. Sensitivity analyses

In Table 7, we try to better understand how the relationship between concentration and fragility changes at high levels of bank concentration. In columns (1) to (6) we define a high concentration dummy for different cut-off levels of concentration using 45<sup>th</sup> to 70<sup>th</sup> percentiles, where the dummy takes the value one at this cut-off value of concentration or higher. Results indicate that the high concentration dummy is significant between the 45<sup>th</sup> and 65<sup>th</sup> percentiles, for concentration levels between 74 and 84 percent. However, once we hit the 70<sup>th</sup> percentile, at concentrations levels of 87 percent or higher, the effect is no longer significant. The loss of significance may be due to the fact that we only have 11 countries with concentration levels of over 87 percent that experienced a crisis, and when the sample becomes very imbalanced with respect to crisis/non-crisis observations estimation becomes imprecise. In the last column, we estimate a polynomial, including squared and cubed concentration terms. The squared term is positive and the cubed term is negative in this specification, both significant at ten percent, suggesting that there are indeed nonlinear effects at high levels of concentration. To see if in addition to the intercept change there is also a slope change at high concentration levels, we also explored specifications where we included an interaction term of

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<sup>12</sup> We tried to assess directly the views that (1) concentration is negatively related to bank fragility because a few large banks tend to be better diversified and (2) concentration is negatively related to bank fragility because a few large banks are easier to monitor than many small banks. However, the available measures of these two views at the country level are very crude. To proxy for the diversification channel, we used measures of bank size, economy size, an indicator of the ability of banks to diversify abroad, and an indicator of whether regulatory authorities enforce diversification guidelines. When controlling for these variables, concentration remained significant and these proxies for diversification did not enter significantly. To measure monitoring complexity, we used the number of banks in the economy and the indicator of regulatory restrictions on bank activities (since more complex financial institutions – that is, banks that are able to engage

the concentration variable and high concentration dummy. The coefficient estimate was not significant.

We conclude that while there is some evidence that the impact of concentration on stability is less strong at high levels of concentration, this result is somewhat sensitive to how we define high concentration. In sum, our results indicate that the overall effect of concentration on fragility is negative at all levels of bank concentration, even after we control for bank regulation and supervision, differences in bank ownership, the level of competitiveness in banking and the economy and general institutional development.

In Table 8, we investigate the sensitivity of our results to the way we define the crisis dummy and the concentration variable. As discussed above, when a crisis lasts for more than one year, we only include the first year of the crisis and omit the other years. In column 2, we include these crisis period observations that occur after the first year of the crisis and treat them as crisis observations. In column 3, we include these crisis period observations that occur after the first year of the crisis and treat them as non-crisis observations. As shown, the results are not sensitive to the treatment of the crisis period observations that occur after the first year of the crisis. In the next two columns we redefine the crisis dummy using the definitions provided in Caprio and Klingebiel (1999). Column 4 still focuses on systemic bank crises<sup>13</sup> and column 5 also includes borderline crises.<sup>14</sup> Since the focus of our study is on systemic crises, we think it is more accurate to only examine system-wide failures. Nonetheless, concentration is still negative and significant at the ten percent level.

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in underwriting, brokerage activities, insurance activities, etc. – maybe more difficult to monitor). Again, these proxies did not change our findings on concentration.

<sup>13</sup> Portugal and Guyana are re-defined as noncrisis countries and India, Italy, Jordan, Papua New Guinea, and US are excluded from the sample since they are classified as borderline as opposed to systemic banking crises.

<sup>14</sup> Portugal and Guyana are re-defined as noncrisis countries and the following crises are added to the sample Burundi (1994-97), Canada (1983-85), Congo (1992-97), Denmark (1987-92), and France (1994-95).

Next we turn to the definition of the concentration variable. In column 6 we first replicate the baseline regression replacing the concentration variable by the one obtained from Barth, et al., (2001). This measure of concentration, obtained through surveys of bank regulators, is calculated as the fraction of deposits held by the five largest commercial banks in each country as of end-1999. We expect this measure not to suffer from problems of differential coverage in each country since the source is the bank regulators themselves. Using this different measure of bank concentration, we get very similar results.

There may exist concerns regarding reverse causality. This would be the case if systemic crises led to lower levels of concentration in the banking system through greater entry or changes in general competition policies. When we inspect individual crisis cases in our sample, however, we do not see a significant pattern of reduced concentration after the crisis episodes and the concentration levels do not vary significantly from year to year.<sup>15</sup> Nevertheless, we estimate a specification where we define concentration as the initial level of concentration (1988 or the first available year) instead of the 1988-97 average. As can be seen in column 7 of Table 8, this does not change our results significantly, which is consistent with the observation that concentration does not vary much over time. This estimation is still subject to problems though, since some of the crisis episodes have taken place before the date for which we have data for concentration. Thus, we drop all those crisis episodes that precede the initial concentration date. This leaves us with only 20 crisis episodes and less than half of the total number of observations, yet the concentration variable still remains negative and significant (column 8, Table 8). These results lead us to believe that the negative impact of concentration on banking system fragility is not due to reverse causality.

So far in the analysis, we have allowed for heteroskedasticity of errors and corrected for it, but assumed that the errors are independent. However, given that we use a panel data set, it is likely

that the error terms within individual country observations are correlated with each other. Table 9, column 1 reports our results relaxing the assumption that within country observations are independent. Concentration still enters with a negative and significant coefficient. In column 2, we estimate a logit model with random country effects. Again, the results are not significantly different.

We also investigate the sensitivity our results to using alternative samples. In column 3 of Table 9, we exclude from the sample all countries with populations less than 1 million. Results are not sensitive to excluding small countries. In column 4, we exclude all African countries since they tend to have very high bank concentration ratios. We see that our results are not driven by African observations. In column 5, we exclude all developed countries from the analysis. Again, we see that concentration significantly reduces fragility also in the sample of developing countries. Finally, in column 6 we exclude a few outlier observations in terms of inflation and interest rates, which leaves the results unchanged.<sup>16</sup>

## **V. Conclusions**

This paper investigates the impact of bank concentration, bank regulations, bank ownership, and the overall competitive/institutional environment on banking system fragility. We use cross-country data on 70 countries and 47 crisis episodes. In concluding, we emphasize three findings.

First, bank concentration has a stabilizing effect. Concentrated banking systems are less likely to experience systemic banking crises, even after controlling for a wide array of macroeconomic, regulatory and institutional factors. There is also some evidence that the stabilizing effect of bank concentration is weaker at higher levels of concentration, although this does not change the fact that the overall impact of concentration on fragility is negative and that the

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<sup>15</sup> Also note that the actual crisis period immediately following the crisis is taken out of the estimations.

<sup>16</sup> Excluded observations are Gabon (1993) and Ivory Coast (1993) because their M2/reserves values are outliers and Peru (1991) because its inflation and real interest rate values are outliers.

relationship holds when controlling for bank regulations and the overall competitive/institutional climate.

Second, confirming the earlier results of Barth et al. (2003), we find that entry barriers and activity restrictions have a destabilizing effect on banking systems. Banking systems where a larger fraction of entry applications are denied, and those where regulations restrict banks from engaging in non-loan making activities have a greater likelihood of experiencing a systemic crisis. The data do not support the view that more competition induces greater fragility. Quite to the contrary, more competitive banking systems and those with fewer entry regulations and activity restrictions tend to be more stable.

Finally, we find that countries with better-developed institutions and with policies that promote competition throughout the economy are less likely to suffer from systemic banking crises. The composite indicator of institutional development always has a negative and significant sign in the fragility regressions. Moreover, we find that it is difficult to identify the independent effect of bank regulations and bank policies that promote competition from the overall institutional environment. Countries with better institutions (property rights, rule of law, political openness, low corruption, etc.) also tend to be countries with bank regulations and bank policies that support openness and competition. Thus, while bank regulations and policies that foster competition and contestability promote bank stability, these regulations and policies cannot be viewed in isolation from the overall institutional environment.



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**Table 1. Bank Concentration and Competition and Banking Crises**

GDP per capita is in constant dollars, averaged over the entire sample period. Crisis period denotes the years in which each country experienced a systemic banking crisis and the duration of said crisis. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Sources are in the data appendix.

	GDP per capita	Crisis Period	Concentration
Australia	17913		0.65
Austria	25785		0.75
Bahrain	9398		0.93
Belgium	24442		0.64
Belize	2996		
Benin	362	(1988-90)	1.00
Botswana	2781		0.94
Burkina Faso	230	(1988-94)	
Burundi	186		1.00
Cameroon	790	(1987-93, 1995-98)	0.95
Canada	18252		0.58
Chile	3048	(1981-87)	0.49
Colombia	1802	(1982-85)	0.49
Congo	940		1.00
Ivory Coast	843	(1988-91)	0.96
Cyprus	9267		0.88
Denmark	31049		0.78
Dominican Republic	1426		0.65
Ecuador	1516	(1995-97)	0.40
Egypt	905		0.67
El Salvador	1450	(1989)	0.84
Finland	23304	(1991-94)	0.85
France	24227		0.44
Gabon	4625		
Gambia	369		
Germany	27883		0.48
Ghana	356	(1982-89)	0.89
Greece	10202		0.79
Guatemala	1415		0.37
Guinea	523	(1993-94)	
Guyana	653	(1993-95)	1.00
Honduras	694		0.44
India	313	(1991-97)	0.47
Indonesia	761	(1992-97)	0.44

	GDP per capita	Crisis Period	Concentration
Ireland	13419		0.74
Israel	13355	(1983-84)	0.84
Italy	17041	(1990-95)	0.35
Jamaica	1539	(1996-97)	0.82
Japan	35608	(1992-97)	0.24
Jordan	1646	(1989-90)	0.92
Kenya	336	(1993)	0.74
Korea	6857	(1997)	0.31
Lesotho	356		1.00
Malawi	154		
Malaysia	3197	(1985-88, 1997)	0.54
Mali	260	(1987-89)	0.91
Mauritania	456	(1984-93)	
Mauritius	2724		0.94
Mexico	3240	(1982, 1994-97)	0.63
Nepal	179	(1988-97)	0.90
Netherlands	22976		0.76
New Zealand	15539		0.77
Niger	245	(1983-97)	
Nigeria	251	(1991-95)	0.83
Norway	28843	(1987-93)	0.85
Panama	2824	(1988-89)	0.42
Papua New Guinea	1024	(1989-97)	0.87
Peru	2458	(1983-90)	0.69
Philippines	1070	(1981-87)	0.49
Portugal	8904	(1986-89)	0.46
Senegal	562	(1988-91)	0.94
Seychelles	5719		
Sierra Leone	260	(1990-97)	1.00
Singapore	20079		0.71
South Africa	3680	(1985)	0.77
Sri Lanka	588	(1989-93)	0.86
Swaziland	1254	(1995)	0.95
Sweden	24845	(1990-93)	0.89
Switzerland	42658		0.77
Tanzania	170	(1988-97)	1.00

	GDP per capita	Crisis Period	Concentration
Thailand	1886	(1983-87, 1997)	0.54
Togo	366		1.00
Tunisia	1831		0.63
Turkey	2451	(1982, 1991, 1994)	0.45
United Kingdom	16883		0.57
United States	24459	(1980-92)	0.19
Uruguay	5037	(1981-85)	0.87
Venezuela	3558	(1993-97)	0.52
Zambia	464		0.84

**Table 2. Summary Statistics and Correlations**

Summary statistics are presented in Panel A and correlations in Panel B and C. Banking crisis is a crisis dummy, which takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Fraction of entry applications denied is the number of entry applications denied as a fraction of the number of applications received from domestic and foreign entities. Activity restrictions measures the degree to which a bank is able to engage in business of securities underwriting, insurance underwriting and selling, and in real estate investment, management, and development. Required reserves is the percentage of reserves regulators require to hold. Capital regulatory index measures capital stringency in the banking system. State ownership measures the percentage of banking system's assets in banks that are 50% or more government owned, while foreign ownership measures percentage of banking system's assets in banks that are 50% or more foreign owned. Banking freedom is an indicator of the relative openness of the banking system. Economic freedom is a composite measure of institutional factors determining economic freedom. KKZ\_composite is a composite measure of governance indicators. Sources are given in the data appendix.

**Panel A: Summary Statistics:**

	Mean	Median	St.Dev.	Maximum	Minimum	Observations
Banking crisis	0.04	0.00	0.20	1.00	0.00	1230
Growth	3.41	3.45	4.25	23.60	-17.15	1216
Terms of trade change	0.15	0.01	10.30	63.24	-51.45	1191
Real interest rate	1.58	2.68	19.34	151.21	-283.00	1160
Inflation	14.07	7.75	23.42	350.56	-29.17	1220
M2/reserves	19.87	6.56	68.86	1289.31	0.19	1222
Depreciation	0.10	0.04	0.22	2.62	-0.35	1238
Credit Growth <sub>t-2</sub>	6.01	5.09	15.84	115.42	-54.62	1203
Real GDP per capita	7813.94	2302.37	10299.92	45950.46	134.54	1222
Moral hazard	-1.09	-2.49	2.24	3.98	-2.49	1238
Concentration	0.72	0.77	0.21	1.00	0.19	1106
Fraction of entry applications denied	0.21	0.08	0.29	1.00	0.00	688
Activity restrictions	9.44	9.00	2.64	14.00	4.00	903
Required reserves	12.48	10.00	11.86	43.00	0.00	692
Capital regulatory index	5.41	5.50	1.70	8.00	2.00	871
State ownership	17.84	11.56	20.95	80.00	0.00	796
Foreign ownership	23.85	11.70	26.59	99.00	0.00	710
Banking freedom	3.36	3.00	0.88	5.00	1.00	1184
Economic freedom	3.17	3.05	0.61	4.50	1.9	1184
KKZ_composite	0.28	-0.03	0.79	1.72	-1.03	1220



## Panel B: Correlations: Banking Crisis, Concentration, Regulations, and Institutions

	Banking crisis	Concentration	Fraction of entry apps denied	Activity restrictions	Required reserves	Capital Regulatory index	Moral hazard	State ownership	Foreign ownership	Banking freedom	Economic freedom
Concentration	-0.032										
Fraction of entry apps denied	0.058	0.001									
Activity restrictions	0.058*	-0.027	0.461***								
Required reserves	0.016	0.183***	0.334***	0.233***							
Capital regulatory index	-0.016	0.053	-0.048	-0.084***	0.229***						
Moral hazard	0.013	-0.396***	-0.238***	-0.248***	-0.105***	0.107***					
State ownership	0.034	0.048	0.433***	0.284***	0.356***	0.039	-0.022				
Foreign ownership	-0.050	0.394***	0.059	0.025	0.262***	0.192***	-0.321***	-0.234***			
Banking freedom	-0.072***	-0.0249***	-0.382***	-0.477***	-0.101***	0.077***	0.174***	-0.385***	0.190***		
Economic freedom	-0.056**	-0.390***	-0.450***	-0.515***	-0.401***	0.069**	0.327***	-0.539***	-0.003	0.745***	
KKZ_composite	-0.070***	0.354***	-0.507***	-0.566***	-0.445***	0.067**	0.354***	-0.460***	0.029	0.560***	0.861***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

## Panel C: Correlations: Banking Crisis, Concentration, and Macro Indicators

	Banking crisis	Real GDP growth	Terms of trade change	Real interest rate	Inflation	M2/reserves	Depreciation	Credit Growth <sub>t-2</sub>	Real GDP per capita
Real GDP growth	-0.139***								
Terms of trade change	-0.021	0.046*							
Real interest rate	0.006	0.085***	-0.050**						
Inflation	0.063***	-0.103***	0.038	-0.980***					
M2/reserves	0.033	-0.098***	0.007	0.010	-0.015				
Depreciation	0.072***	-0.168***	-0.020	-0.546***	0.616***	-0.031			
Credit growth <sub>t-2</sub>	0.042	0.024	0.000	0.003	-0.007	-0.045*	-0.054**		
Real GDP per capita	-0.061**	-0.055**	0.017	0.026	-0.047*	-0.033	-0.201***	-0.008	
Concentration	-0.032	-0.076***	-0.007	0.004	0.000	0.100***	0.044*	-0.001	-0.246***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 3. Banking Crisis and Concentration**

The logit probability model estimated is  $\text{Banking Crisis}_{[\text{Country}=j, \text{Time}=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Real GDP per capita}_{j,t} + \beta_9 \text{Moral Hazard Index}_{j,t} + \beta_{10} \text{Average concentration}_{j,t} + \beta_{11} \text{concentration}^2_{j,t} + \varepsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. White's heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)
Real GDP growth	-0.145*** (0.031)	-0.169*** (0.035)	-0.165*** (0.035)	-0.166*** (0.036)
Terms of trade change	-0.009 (0.010)	-0.014 (0.012)	-0.013 (0.012)	-0.015 (0.013)
Real interest rate	0.009*** (0.004)	0.010*** (0.004)	0.011*** (0.004)	0.010*** (0.004)
Inflation	0.007 (0.008)	0.008 (0.009)	0.009 (0.009)	0.009 (0.008)
M2/reserves	0.001 (0.001)	0.002* (0.001)	0.002 (0.001)	0.002* (0.001)
Depreciation	0.667 (1.051)	0.441 (1.177)	0.488 (1.192)	0.807 (1.153)
Credit Growth <sub>t-2</sub>	0.013* (0.008)	0.013 (0.009)	0.014* (0.009)	0.015* (0.009)
Real GDP per capita	-0.004** (0.002)	-0.004** (0.002)	-0.005** (0.002)	
Moral Hazard Index	0.154*** (0.070)	0.102 (0.075)	0.117* (0.080)	0.037 (0.075)
Concentration		-1.654** (0.853)	-6.930* (4.807)	-1.467** (0.565)
(Concentration) <sup>2</sup>			4.013 (3.651)	
No. of Crises	51	47	47	47
No. of Observations	1103	989	989	989
% crises correct	61	66	68	66
% correct	73	73	73	71
Model $\chi^2$	47.94***	48.46***	54.38***	37.93***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 4. Banking Crisis, Regulation and Concentration**

The logit probability model estimated is  $\text{Banking Crisis}_{[\text{Country}=j, \text{Time}=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Moral Hazard Index}_{j,t} + \beta_9 \text{Concentration}_{j,t} + \beta_{10} \text{Regulatory measures}_{j,t} + \epsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. The Regulatory measures in specifications (1)-(4) - Fraction of entry applications denied, Activity restrictions, Required reserves and Capital regulatory index, - are included (one at a time) as regressors. Fraction of entry applications denied measures the number of entry applications denied as a fraction of the total received. Activity restrictions captures bank's ability to engage in business of securities underwriting, insurance underwriting and selling, and in real estate investment, management, and development. Required reserves is the percentage of reserves regulators require to hold. Capital regulatory index is a summary measure of capital stringency. White's heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)
Concentration	-2.320*	-1.928**	-2.695***	-2.375***
	(1.554)	(1.016)	(1.203)	(1.115)
Fraction of Entry Applications Denied	1.993***			
	(0.750)			
Activity Restrictions		0.182***		
		(0.073)		
Required Reserves			0.017	
			(0.017)	
Capital Regulatory Index				-0.078
				(0.129)
No. of Crises	21	34	27	33
No. of Observations	583	767	572	755
% crises correct	67	74	67	70
% correct	77	75	72	73
Model $\chi^2$	31.97***	37.38***	30.38***	37.38***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 5. Banking Crisis, Ownership, Institutions, and Concentration**

The logit probability model estimated is  $\text{Banking Crisis}_{[Country=j, Time=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Moral hazard index}_{j,t} + \beta_9 \text{Concentration}_{j,t} + \beta_{10} \text{Regulatory measures}_{j,t} + \varepsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. The Regulatory measures in n specifications (1)-(5) - State ownership, Foreign ownership, Banking freedom, Economic freedom, and KKZ\_composite - are included (one at a time) as regressors. State ownership is the percentage of banking system's assets in banks that are 50% or more government owned. Foreign ownership is the percentage of banking system's assets in banks that are 50% or more foreign owned. Banking freedom is an indicator of relative openness of banking and financial system, while economic freedom is a composite of 10 institutional factors determining economic freedom. KKZ\_composite is an aggregate measure of six governance indicators. White's heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)	(5)
Concentration	-2.571*** (1.132)	-2.199** (1.089)	-1.777** (0.839)	-1.752** (0.840)	-1.651** (0.810)
State ownership	0.015** (0.008)				
Foreign ownership		-0.003 (0.008)			
Banking Freedom			-0.513*** (0.164)		
Economic Freedom				-0.554*** (0.227)	
KKZ_composite					-0.484*** (0.203)
No. of Crises	32	31	47	47	47
No. of obs.	686	609	955	955	989
% crises correct	75	71	68	66	68
% correct	69	66	69	70	72
Model $\chi^2$	30.90***	33.66***	52.31***	47.01***	48.77***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 6. Banking Crisis, Governance, Ownership, Institutions, and Concentration**

The logit probability model estimated is  $\text{Banking Crisis}_{[Country=j, Time=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Moral hazard index}_{j,t} + \beta_9 \text{KKZ\_composite}_{j,t} + \beta_{10} \text{Concentration}_{j,t} + \beta_{11} \text{Regulatory measures}_{j,t} + \varepsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. KKZ\_composite is an aggregate measure of six governance indicators. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. The Regulatory measures in n specifications (1)-(4) – Fraction of entry applications, denied, Activity restrictions, and State ownership - are included (one at a time) as regressors. Fraction of entry applications denied measures the number of entry applications denied as a fraction of the total received. Activity restrictions captures bank's ability to engage in business of securities underwriting, insurance underwriting and selling, and in real estate investment, management, and development. State ownership is the percentage of banking system's assets in banks that are 50% or more government owned. Banking freedom is an indicator of relative openness of banking and financial system, while economic freedom is a composite of 10 institutional factors determining economic freedom. White's heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)
Concentration	-1.651** (0.810)	-2.324* (1.588)	-1.962** (0.992)	-2.515*** (1.141)
KKZ_composite	-0.484*** (0.203)	0.018 (0.517)	-0.138 (0.329)	-0.319 (0.313)
Fraction of Entry Applications Denied		2.016* (1.182)		
Activity Restrictions			0.162* (0.992)	
State ownership				0.011 (0.009)
No. of Crises	47	21	34	32
No. of obs.	989	583	767	686
% crises correct	68	67	74	75
% correct	72	77	74	70
Model $\chi^2$	48.77***	43.78***	46.01***	40.04***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 7. Banking Crisis and High Concentration: Robustness Tests**

The logit probability model estimated is  $\text{Banking Crisis}_{[Country=j, Time=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Real GDP per capita}_{j,t} + \beta_9 \text{Moral Hazard Index}_{j,t} + \beta_{10} \text{Average concentration}_{j,t} + \beta_{11} \text{High concentration}_{j,t} + \epsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. High concentration is a dummy taking a value of one in cases where the banking concentration is greater than or equal to the cutoff listed in the footnote of the table. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. Specifications (1)- (6) use high concentration at the 45<sup>th</sup>, 50<sup>th</sup>, 55<sup>th</sup>, 60<sup>th</sup>, 65<sup>th</sup>, and 70<sup>th</sup> percentile, respectively. White's heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Concentration	-3.453*** (1.386)	-4.118*** (1.359)	-4.255*** (1.306)	-4.513*** (1.350)	-4.513*** (1.351)	-2.296** (1.237)	-30.294** (15.178)
High Concentration	0.891* (0.559)	1.330** (0.635)	1.457** (0.651)	1.731*** (0.685)	1.731*** (0.685)	0.506 (0.657)	
Concentration <sup>2</sup>							43.831* (25.830)
Concentration <sup>3</sup>							-20.968* (13.735)
No. of Crises	47	47	47	47	47	47	47
No. of Observations	989	989	989	989	989	989	989
% crises correct	70	75	75	70	70	66	75
% correct	72	72	62	73	73	72	73
Model $\chi^2$	48.67***	51.49***	56.18***	56.05***	56.05***	52.33***	55.35***
Value of cutoff	0.73927	0.76707	0.78977	0.83955	0.84154	0.87530	

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 8. Banking Crisis and Concentration: Alternative Crisis and Concentration Measures**

The logit probability model estimated is  $\text{Banking Crisis}_{[Country=j, Time=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Real GDP per capita}_{j,t} + \beta_9 \text{Moral Hazard Index}_{j,t} + \beta_{10} \text{Average concentration}_{j,t} + \varepsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. Specification (2) includes the crisis period as crisis observations. Specification (3) includes the crisis period (after the initial crisis year) as non-crisis observations. Specifications (4) and (5) use alternative definitions of crisis based on Caprio and Klingebiel (1999). In specification (6) Average Concentration is replaced by the concentration data from Barth, Caprio and Levine (2001) – *Bank Regulation and Supervision*, for the entire sample period. In specification (7) Average Concentration is replaced by Initial Concentration, for the entire sample period. In specification (8) Initial Concentration is restricted to the actual starting date and the years following that date (for many of the countries, the restricted sample is either 1988-97 or 1990-97) White’s heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Concentration	-1.654** (0.853)	-0.960** (0.448)	-1.476** (0.791)	-1.432* (0.912)	-1.337* (0.823)	-1.536* (1.010)	-1.699** (0.846)	-3.534*** (1.477)
No. of Crises	47	202	47	40	50	32	47	20
No. of Observations	989	1144	1144	938	980	730	989	410
% crises correct	66	59	68	70	72	72	66	70
% correct	73	67	67	69	61	75	74	77
Model $\chi^2$	48.46***	90.50***	37.54***	49.56***	56.50***	47.99***	47.29***	40.62***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.

**Table 9. Banking Crisis and Concentration: Additional Robustness Tests**

The logit probability model estimated is  $\text{Banking Crisis}_{[Country=j, Time=t]} = \alpha + \beta_1 \text{Real GDP growth}_{j,t} + \beta_2 \text{Terms of trade change}_{j,t} + \beta_3 \text{Real interest rate}_{j,t} + \beta_4 \text{Inflation}_{j,t} + \beta_5 \text{M2/reserves}_{j,t} + \beta_6 \text{Depreciation}_{j,t} + \beta_7 \text{Credit growth}_{j,t-2} + \beta_8 \text{Real GDP per capita}_{j,t} + \beta_9 \text{Moral Hazard Index}_{j,t} + \beta_{10} \text{Average concentration}_{j,t} + \varepsilon_{j,t}$ . The dependent variable is a crisis dummy that takes on the value of one if there is a systemic and the value of zero otherwise. Growth is the rate of growth of real GDP. Real interest rate is the nominal interest rate minus the contemporaneous rate of inflation. Inflation is the rate of change of the GDP deflator. M2/reserves is the ratio of M2 to international reserves. Credit growth is the real growth of domestic credit, lagged two periods. Depreciation is the rate of change of the exchange rate. Moral hazard is an aggregate index of moral hazard associated with varying deposit insurance schemes. Concentration is a measure of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks in each country, averaged over the sample period. Bank data are from the BankScope database of Fitch IBCA. The sample period is 1980-1997. In specification (1) the sample is clustered by country. In specification (2) the estimation includes random country effects. In specification (3) the sample excludes all countries with populations less than 1 million. In specification (4) the sample excludes all African countries. In specification (5) the sample excludes all developed countries. In specification (6) we remove outliers found in three control variables – real interest rate, inflation, and m2/reserves. White’s heteroskedasticity consistent standard errors are given in parentheses. Detailed variable definitions and sources are given in the data appendix.

	(1)	(2)	(3)	(4)	(5)	(6)
Concentration	-1.654*** (0.755)	-1.654*** (0.799)	-1.709** (0.900)	-2.094** (1.113)	-1.519** (0.856)	-1.706** (0.859)
No. of Crises	47	47	45	35	39	47
No. of Observations	997	989	927	734	670	987
% crises correct	66		67	69	77	68
% correct	73		73	68	52	73
Model $\chi^2$	54.50***	40.96***	56.74***	45.18***	29.01**	48.89***

\*\*\*, \*\*, and \* indicate statistical significance at 1, 5, and 10 percent, respectively.



## Data Appendix

Variable Name	Definition	Source
Banking crisis	Dummy takes on value of one during episodes identified as a systematic banking crises	Demirguc-Kunt and Detragaiache (2001)
Growth	Rate of growth of real GDP	WDI (World Bank)
Terms of trade change	Change in the terms of trade	WDI (World Bank)
Real interest rate	Nominal interest rate minus the contemporaneous rate of inflation	IFS (IMF)
Inflation	Rate of change of GDP deflator	IFS (IMF)
M2/reserves	Ratio of M2 to international reserves	IFS (IMF)
Depreciation	Rate of depreciation	IFS (IMF)
Credit growth	Rate of growth of real domestic credit to the private sector	IFS line 32d divided by GDP deflator
GDP/CAP	Real GDP per capita	WDI (World Bank)
GDP	Real GDP in billions of US dollars	WDI (World Bank)
Moral hazard index	Principal component indicator measuring the generosity of deposit insurance, based on co-insurance, coverage of foreign currency and interbank deposits, type and source of funding, management, membership and level of explicit coverage.	DD (2003)
Concentration	Degree of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks. Averaged over the 1988-97 period.	Beck, Demirguc-Kunt, Levine (2000) - Financial Structures Database
Mean Bank Size	Total banking assets divided by number of banks.	BankScope database.
No Foreign Loans	Survey question 7.2 asks if banks are prohibited from making loans abroad (yes=1, no=0).	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
No. of Banks	No. of banks in hundreds.	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
Fraction of entry applications denied	Number of entry applications denied as a fraction of the number of applications received from domestic and foreign entities	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
Activity restrictions	Sum of four measures that indicate whether bank activities in the securities, insurance, and real estate markets and ownership and control of nonfinancial firms are (1) unrestricted, (2) permitted, (3) restricted, or (4) prohibited	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
Required reserves	Ratio of reserves required to be held by banks	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision

Variable Name	Definition	Source
Capital regulatory index	Summary measure of capital stringency: sum of overall and initial capital stringency. Higher values indicate greater stringency.	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
State ownership	Percentage of banking system's assets in banks that are 50% or more government owned	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
Foreign ownership	Percentage of banking system's assets in banks that are 50% or more foreign owned	Barth, Caprio, and Levine (2001) - Survey of Bank Regulation and Supervision
Banking Freedom	Indicator of relative openness of banking and financial system: specifically, whether the foreign banks and financial services firms are able to operate freely, how difficult it is to open domestic banks and other financial services firms, how heavily regulated the financial system is, the presence of state-owned banks, whether the government influences allocation of credit, and whether banks are free to provide customers with insurance and invest in securities (and vice-versa). The index ranges in value from 1 (very low – banks are primitive) to 5 (very high – few restrictions). Averaged over 1995-97 period.	Index of Economic Freedom (Heritage Foundation)
Economic Freedom	Composite of 10 institutional factors determining economic freedom: trade policy, fiscal burden of government, government intervention in the economy, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, and black market activity. Individual factors are weighted equally to determine overall score of economic freedom. A high score signifies an institutional or consistent set of policies that are most conducive to economic freedom, while a score close to 1 signifies a set of policies that are least conducive. Averaged over 1995-97 period.	Index of Economic Freedom (Heritage Foundation)
KKZ_composite	Composite of six governance indicators (1998 data): voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and corruption. Individual factors are weighted equally to determine overall score of economic freedom. Higher values correspond to better governance outcomes.	Kaufman, Kraay and Zoido-Lobaton(1999)

