Concentration in the Banking Sector and Financial Stability

New Evidence

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Abstract

Theory suggests that the effect of banking market concentration on financial stability is mediated by several competing variables. Using a sample of 68 countries from 1997 to 2015, this paper proposes a unified empirical framework to test for the simultaneous presence and impact of the mediators through which concentration is expected to impact financial stability. The results indicate that the magnitude and net effect of the mediators depend upon the level of concentration. At lower levels of concentration, increasing concentration improves banking system stability via profitability. At higher levels of concentration, increasing concentration makes the banking system more fragile because of the cost of credit, diversification and the ease of monitoring. For intermediate levels, concentration has no significant effect on financial stability, as the competing moderators cancel each other out. The results suggest that an intermediate level of concentration may be optimal for welfare.
Concentration in the Banking Sector and Financial Stability: New Evidence

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1. Introduction

The relationship between banking market concentration and financial stability, despite a growing body of research, remains ambiguous. Two competing paradigms have come to dominate the theoretical debate:¹ on the one hand, the ‘concentration stability’ view posits that higher market concentration enhances the stability of the banking system; on the other hand, the ‘concentration fragility’ hypothesis maintains that higher concentration destabilizes the banking system and makes it more vulnerable.²

Theory posits that the effect of banking market concentration on financial stability is mediated by several variables, which may operate in opposite directions, making their magnitude and net effect ambiguous. First is profitability. Proponents of the so-called ‘concentration-stability’ view suggest that concentration may lead to greater market power and profits. Higher bank margins, in turn, boost the charter value of banks, thus decreasing incentives for risk-taking and ultimately making the banking system less prone to crisis (Boot and Greenbaum, 1993; Besanko and Takor, 1993; Hellman et al., 2000; Allen and Gale, 2000; Matutes and Vives, 2000).

A second mediating variable through which concentration affects financial stability is the cost of credit. Advocates of the so-called ‘concentration-fragility’ view acknowledge that concentrated markets lead to higher bank market power and higher profits. However, higher market power allows banks to charge higher interest rates to borrowers, which in turn increases

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¹ For a review and discussion of the different theoretical models see, for example, Allen and Gale (2004), Beck (2008) and Claessens (2009).
² These contrasting effects can be reconciled in models that show a U-shape relationship between concentration and financial stability (see Martinez-Miera and Repullo, 2010; see also De Nicolò and Lucchetta, 2011).
the incentive of borrowers to assume greater risks and, ultimately, makes the banking system less stable (Boyd and De Nicoló, 2005).

Third, banking market concentration has a bearing on financial stability through the *diversification* mediating variable. However, the sign of the relationship is ambiguous. On the one hand, concentrated banking systems may entail larger banks with more diversified portfolios due to economies of scale in intermediation, thus increasing stability, in line with the ‘concentration-stability’ view (Diamond, 1984; Ramakrishnan and Thakor, 1984; Boyd and Prescott; 1986; Williamson; 1986; Allen, 1990). On the other hand, larger and more diversified banks may be implicitly protected by ‘too-big-to-fail’ policies that intensify risk-taking incentives and hence increase banking system fragility, overcoming diversification advantages, in line with the ‘concentration-fragility’ hypothesis (O’Hara and Shaw, 1990; Boyd and Runkle, 1992; Mishkin, 1999; Acharya et al., 2012). Further, having larger banks in a concentrated banking system could also increase contagion risk, leading to more instability (Saez and Shi, 2004).

Finally, the effect of concentration on financial stability is mediated by the *ease of monitoring*. Like the *diversification* mediator, there is no prior on the sign of the relationship. If a more concentrated banking system implies a smaller number of large banks, this might reduce the supervisory burden and thus enhance overall banking system stability, as suggested by the ‘concentration-stability’ hypothesis (Allen and Gale, 2000). The countervailing argument is that along with a small number of large banks, concentrated markets can also present a large number of small banks that taken together may be systemically important, making more difficult the job of the supervisor and increasing the instability of the system. Moreover, if bank size is positively correlated with complexity then a relatively small number of large banks are harder to monitor.
than small banks hence increasing the fragility of the banking system, in line with the ‘concentration-fragility’ view (Beck et al., 2007).

The empirical literature, which is mostly concerned with measuring the direct impact of concentration on stability, does not clarify the ambiguity of the theoretical predictions. On the one hand, there is ample evidence that concentrated banking markets may increase financial stability (Keeley, 1990; Demirgüç-Kunt and Detragiache, 2002; Beck et al., 2006; Chang et al., 2008; Evrensel, 2008). The stability effects of higher concentration stem not only from charter values but also from diversification benefits in large banks (Benston et al., 1995; Parouch, 1995; Craig and Santos, 1997; Beck et al., 2006). On the other hand, as theory predicts, concentrated banking markets may also contribute to financial instability (De Nicoló et al., 2003; Boyd et al., 2006; Schaeck et al., 2009; Uhde and Heimeshoff, 2009; Mirzaei et al., 2013; IJtsma et al., 2017). In concentrated markets, as banks get larger and more diversified they may increase the risks of their portfolios, or strategically choose to operate at a closer distance to default (Chong, 1991; Hughes and Mester, 1998; De Nicoló, 2000; Boyd et al., 2006). Larger banks also become subject to internal inefficiencies and increased operational risk (Beck et al., 2006; Cetorelli et al., 2007; Laeven and Levine, 2007).

One possible explanation for the contrasting findings of the empirical literature is that the mediating variables through which concentration can affect financial stability are at work simultaneously, with different magnitudes and net effect on financial stability that crucially

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3 One related strand of the empirical literature investigates the relationship between competition and financial stability, using primarily measures of market power as opposed to indicators of market structure. However, in line with most recent literature (see, for example, Claessen and Laeven, 2004, and Schaeck et al., 2009), this paper acknowledges that market concentration and competition are two different concepts that are not always related, and accordingly focuses on the former only.
depends upon the initial degree of market concentration. If this intuition is correct, then, measuring the mediated net effect of concentration on financial stability is an empirical issue. This paper tests this hypothesis thus contributing to shed new light on the complex nexus between banking market concentration and financial stability, and adding to the policy and academic debate.

We propose a unified empirical framework to study whether and the extent to which concentration impacts banking system stability through the competing mediating variables identified in the theoretical literature, namely: (i) profitability, (ii) the cost of credit, (iii) diversification, and (iv) the ease of monitoring. In a seminal paper, Beck et al. (2007) investigate the impact of concentration on stability through diversification and the ease of monitoring, finding evidence for only diversification to play a role. More recently, Bretschger et al. (2012) test for the mediating effect of both profitability and the cost of credit and find evidence for both mediators operating simultaneously. The authors, however, do not measure the net effect of the mediating variables, which is left ambiguous. We build on these results and formally test that the conditionally offsetting mediators’ hypothesis does not hold, i.e. the hypothesis that the mediating variables through which concentration impacts financial stability hold simultaneously with equal strength conditional upon the level of concentration is rejected, and that the degree of concentration does change the effect of the mediators on banking crisis probability. Therefore, we estimate whether the impact of the mediators on financial instability varies at different levels of concentration, and measure their net effect.

Understanding the mechanisms through which banking market concentration affects financial stability is important for the calibration of effective structural policies in the banking system, especially entry/exit rules, consolidation policies and restrictions of activities. Far from being a new question, the global financial crisis (GFC) has reignited interest among policy makers
and academics in the relationship between concentration in the banking sector and financial stability, because market concentration may have played a role in the run-up to the crisis, and, more importantly, has tended to increase ever since, raising stability concerns (Committee on the Global Financial System, 2018).

Our empirical analysis rests on a data set comprising available cross-country, annual observations for 68 countries over the period 1997-2015. Financial stability is proxied by the probability of entering both a systemic and a non-systemic banking crisis. Data are drawn from an updated version of the Reinhart and Rogoff (2009) dataset, which gives 42 crisis episodes during the sample period. Crisis data are given by a binary dummy that equals 1 if country \( i \) at time \( t \) has entered a crisis, and zero otherwise. Concentration is measured by the share of banking assets held by the three largest banks. However, we also study the impact of alternative concentration measures, such as the share of banking system assets concentrated in the five largest banks. We proxy for the mediators through which concentration affects financial stability by using bank return on assets (ROA) for profitability; real lending rate for the cost of credit; bank foreign assets plus bank foreign liabilities to banking system assets for diversification; and the (log) number of banks for the ease of monitoring. Following Beck et al. (2006), we estimate a binomial logit model, and control for the following variables: real GDP growth, inflation, nominal exchange rate depreciation, current account balance, real domestic credit growth, and (log) real GDP per capita. In order to disentangle the role of each mediator through which concentration is expected to impact financial stability, we estimate a model where proxies for the mediators are allowed to interact with the level of concentration. This allows us to estimate the marginal effects of the mediators conditional upon selected percentiles of the concentration distribution, and calculate their net effect on crisis probability.
Results lend support to our hypothesis. We find that the competing mediators through which market concentration is expected to impact financial stability are at play simultaneously. However, their magnitude and net effect varies with the level of concentration. We find evidence that at lower levels of concentration *profitability* dominates: increasing concentration increases financial stability. Conversely, at higher levels of concentration, the *cost of credit, diversification* and the *ease of monitoring* dominate, and increasing concentration leads to financial instability. For intermediate levels of concentration, which we estimate in the range of 55-66 percent in our sample, the competing mediators cancel each other out, and concentration has no significant impact on banking system stability, suggesting that an intermediate level of market concentration may be optimal for welfare. Several robustness checks, including alternative proxies for the mediators, an alternative measure of concentration, a different subsample, and different econometric models confirm our findings.

This paper is structured as follows. Section 2 provides a description of the data and the econometric methodology. Section 3 discusses our main results, including a battery of sensitivity tests. Section 4 concludes, offering some policy implications.

2. **Data and methodology**

2.1. **Data**

Our data set is composed of annual observations from 68 countries over the period 1997-2015. Both the sample composition and time period are driven by data availability. We take information concerning financial stability from an updated version of the Reinhart and Rogoff
Reinhart and Rogoff (2009) mark a banking crisis by two types of events: (i) bank runs that lead to the closure, merging or takeover by the public sector of one or more financial institutions, and (ii) in the absence of bank runs, the closure, merging, takeover or large-scale government assistance of an important financial institution (or groups of financial institutions) that marks the start of similar outcomes for other financial institutions. This classification provides us with 42 annual crisis observations, comprising 25 systemic crisis episodes (severe financial distress, in the authors’ definition) and 17 non-systemic crises (milder financial distress) in 38 countries, which gives an in-sample frequency of crises of 3.6 percent, which is in line with similar studies (e.g. Barrell et al., 2010) and within acceptable bounds for the style of analysis.

Dating banking crises is not without drawbacks. Crises can be classified too late, because the financial problems usually begin well before a bank (or a group of banks) is finally closed or merged, or too early, because the worst of a crisis may come later. Moreover, unlike other types of financial crises such as external debt crises, which have well defined closure dates, it is difficult if not impossible to pinpoint the year in which a banking crisis ended. For these reasons, and because we are mostly concerned with investigating the effect of market concentration on the arrival of a banking crisis (i.e. the switch between non-crisis and crisis states), our binary crisis variable takes value of one if country $i$ at time $t$ enters into a crisis and zero otherwise. In other words, as in other studies (see, for example, Barrell et al., 2010), we treat crisis years other than the first (i.e. when the crisis arrives) as tranquil times. Such an approach, as well as the use of lagged control variables (see below) also allows us to control for potential endogeneity between

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4 Available at [http://www.hbs.edu/faculty/initiatives/behavioral-finance-and-financial-stability/Pages/global.aspx](http://www.hbs.edu/faculty/initiatives/behavioral-finance-and-financial-stability/Pages/global.aspx).
concentration and banking crisis, as bank failures typically modify the structure of the banking sector (Perotti and Suarez, 2002).

Our baseline measure of market structure is the aggregate share of banking assets held by the three largest banks. Market structure should ideally be measured by relevant product and geographic markets; however, such disaggregated data are often not available, and most measures cannot be computed separately for these submarkets. Therefore, as is common in the cross-country literature, we resort to an aggregate measure of concentration. To test the validity of our main findings, we also use an alternative indicator of concentration such as the share of total banking assets held by the largest five banks.

To proxy for the mediating variables through which market concentration affects financial stability, we use several indicators, in line with similar studies (see Bretschger at al., 2012; and Beck et al., 2007). The ‘concentration-stability’ hypothesis assumes that market concentration affects systemic stability or, put differently, the probability of a banking crisis, through higher profits. Therefore, we proxy profitability by a standard measure of bank profitability in the literature: the return on assets (ROA). The ‘concentration-fragility’ view suggests that the effect of higher concentration works through loan rates. Accordingly, we use the real lending rate charged by banks to the private sector as a proxy for the cost of credit. Concentrated banking systems are typically more diversified than diffuse banking systems. Therefore, to proxy for the diversification variable we construct a measure of cross-border financial activity such as the sum of banks’ gross external assets and liabilities relative to total banking system assets. Finally, higher market concentration usually entails a small number of large and diversified banks hence we proxy the
ease of monitoring mediator by the (log) number of banks in the country.\footnote{We acknowledge that the number of banks is often used as a proxy for banking market structure. However, given the relatively low correlation between this variable and our baseline concentration measure (-0.26), we retain it as our preferred proxy for the ease of monitoring mediator.} We provide robustness checks using alternative indicators for the four mediators.

Control variables reflect what the theory of the determinants of systemic banking crises suggests, and include the most common predictors of banking crisis found in the empirical literature (see Kauko, 2014, for a review). A first group of covariates captures macroeconomic developments which can have a direct impact on the performance of the banking system, especially on the quality of assets and the level of nonperforming loans. This group of variables includes real GDP growth and inflation. A second set of control variables reflect structural characteristics of the banking system such as the exchange rate depreciation and the current account balance, which measure the degree of vulnerability of the banking system to currency mismatch and to sudden capital outflows, respectively. Credit growth is also included to reflect the risk that high rates of credit expansion may fuel an asset bubble which can ultimately lead to a banking crisis. Finally, we control for the level of economic development by including the (log) real GDP per capita. To control for potential endogeneity of the regressors, we lag all variables by one year. Moreover, to help interpret how concentration transmits to financial stability through the mediating variables we standardize all variables.

Table 1 provides summary statistics for all variables included in our empirical analysis while Table 2 presents the correlation matrix. Appendix A presents data sources and definitions while Appendix B provides the list of countries with related crisis periods.
2.2. Methodology

We estimate a binary logit model that is robust to heteroscedasticity (see, for example, Beck et al., 2006). In the logit model, the probability of a banking crisis is assumed to be a function of a vector of potential explanatory variables. Let $P_{t,i}$ denote a dummy variable that takes value of one if at time $t$ country $i$ is experiencing a banking crisis and zero otherwise. Let $\beta$ be the vector of parameters to be estimated, and $F(\beta'x_{t,i})$ the cumulative probability distribution function, assumed to be logistic. Then, the log-likelihood function of the model that must be maximized is:

$$L = \prod_{t=1}^{T} \prod_{i=1}^{n} \left[ P_{t,i} \ln[F(\beta'x_{t,i})] + (1 - P_{t,i}) \ln[1 - F(\beta'x_{t,i})] \right]$$

It must be noticed that while the signs of the coefficients can be easily interpreted as representing an increasing or a decreasing effect on crisis probability, their values are not as immediate to interpret. As Eq. (1) shows, the coefficients on $x_{t,i}$ reflect the impact of a change in the correspondent explanatory variable upon $\ln(P_{t,i}/(1 - P_{t,i}))$, not on $P_{t,i}$, with the magnitude of the impact depending on the slope of the cumulative distribution function evaluated at $\beta'x_{t,i}$. Therefore, the magnitude of the change depends on the initial values of the variables and their coefficients. This is ideal, given the focus of this paper.

Differently from most of the existing studies, we are interested in the effect of market concentration on banking instability mediated by the variables identified in the theoretical literature. To do so, we augment our baseline logit model with interaction terms between the mediating variables and concentration, and evaluate the interaction effects of our mediators at

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6 Since observations within each country group may also be correlated, we relax the assumption that errors are independent within each country observations. We present robustness tests below.
different levels of concentration, i.e. we estimate the marginal effects of the mediators *conditional upon* different selected percentiles of the concentration distribution.

3. **Empirical Results**

3.1. **Main findings**

We begin our empirical strategy by employing a binary logit specification as in other studies (e.g., Beck et al., 2006) to estimate the probability of a systemic *and* non-systemic banking crisis depending on the four mediators, concentration and a standard set of control variables. Results are reported in Table 3, column (1).

The results, computed at the mean, show that all but one of the mediating variables enter the regression significantly. The ROA is negative and statistically significant, in line with the hypothesis that countries with more profitable banks are less prone to financial instability. At the same time, we find that the real lending rate enters positively and significantly, consistently with the view that high lending rates make borrowers riskier, leading to a higher probability of banking crisis. On the other hand, cross-border financial activity (our measure of diversification) enters with a significant positive coefficient, therefore supporting the ‘too-big-to-fail’ argument. Larger and more diversified banks may be induced to take higher risks, leading to higher banking system instability. The (log) number of banks enters with the positive sign, in line with the view that a relatively small number of banks may be easier to monitor, thus enhancing stability. However, this variable is not significant at standard confidence intervals. Interestingly and as expected, we find no evidence for a distinct significative effect of concentration on financial stability.
Though our variables of interest are the mediators through which concentration is expected to affect financial stability, we find that exchange rate depreciation and current account balance enter negatively and significantly, suggesting that an appreciation of the currency, probably leading to overinvestment in non-tradable sectors, and vulnerability to capital outflows are predictors of banking system instability. We also find that inflation and credit growth enter the regression positively and significantly, suggesting that inflationary bursts and a domestic credit boom are associated with banking problems.

To gauge additional insights on the relationship between our mediators, concentration and financial stability, Table 3, column (1), presents a test for joint significance of the effects of the mediators (ROA, real lending rate, cross-border financial activity and number of banks) as well as a test for joint significance of all these regressors along with our concentration variable. The Wald test for joint significance supports the hypothesis that the mediators have a significant collective impact on banking crisis probability. In Table 4 we present the marginal effects of the mediating variables calculated at selected percentiles of the concentration distribution. One interesting feature of the results reported in Table 4 is that at various levels of concentration the marginal effects of ROA (column (1)), real lending rate (column (2)), cross-border financial activity (column (3)) and (log) number of banks (column (4)) tend to be significant with opposite sign, i.e. the marginal effect of ROA is negative, while the marginal effects of real lending rate, cross-border financial activity and number of banks are positive.

To investigate whether one mediator or group of mediators dominates over the other, Table 4, column (5), reports the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero along with the estimated standard errors. Negative and significant values of the test statistic would signal that the null hypothesis can be rejected and that profitability dominates.
Similarly, positive and significant values of the test statistic would signal that the null hypothesis can be rejected and that the cost of credit, diversification and the ease of monitoring individually or as a group dominate. Results show that the test statistic is never significant along the entire concentration variable distribution, implying that the effects of the mediators with opposite sign cancel each other out with no significant impact on banking system instability.

All in all, we find robust evidence that our mediating variables significantly affect the likelihood of banking crisis in the way suggested by the theory. However, our results also show that no mediator or group of mediators dominates over the other at different levels of concentration so the net effect of the competing mediating variables on financial stability is not different from zero. Our intuition is that the effects of the mediators on banking system instability depend upon the level of concentration, with the magnitude and net effect conditional upon the degree of concentration itself. To test for this, we add to the regression model interaction terms between the four mediators and the concentration variable.

Estimation results for this model, along with a test for joint significance of the effects of concentration working via our proxies for the mediators (ROA, real lending rate, cross-border financial activity and number of banks) as well as a test for joint significance of all these regressors, are reported in Table 3, column (2). Given our interest in evaluating the effects that concentration has on banking instability via the mediators, we calculate the total (i.e. direct and indirect) marginal effects of the four mediating variables computed at different percentiles of concentration (Ai and Norton, 2003). Results, reported in Table 5, suggest that the four mediators are at work simultaneously, and have an impact on the probability of crisis that crucially changes with the level of concentration. Table 5, column (1) shows that the profitability variable, proxied by the ROA, is negatively related to banking system instability: the lower the level of concentration in
the banking sector, the higher the positive effect of bank profitability and the lower the likelihood of a banking crisis. The marginal effect of the ROA is always negative, its magnitude decreases with the level of concentration and becomes insignificant at relatively high levels of concentration. Table 5, column (2), shows that the cost of credit mediator is at work as well. The real lending rate is positively related to our banking crisis dummy, implying that more concentrated banking systems lead to a higher cost of money for borrowers, thereby increasing fragility in the system. The marginal effect of the real lending rate is always positive, its magnitude increases with the levels of concentration and is statistically insignificant at relatively low levels of concentration. Table 5, column (3), presents results for the diversification variable. Except for very low levels of concentration, the cross-border financial activity used as a proxy for diversification is positively related to banking instability, implying that the higher the concentration of the banking market, the more banks become diversified and the more likely is the banking system to experience a crisis. The magnitude of this mediator increases with the level of concentration and is significant only at relatively high levels of concentration. Finally, Table 5, column (4), shows that the (log) number of banks, which proxies the ease of monitoring mediator, is positively related to instability: the higher the level of concentration, the more complex it becomes to supervise banks, increasing the likelihood of crisis. The coefficient of the (log) number of banks is always positive, its magnitude increases with the level of concentration, and is always statistically significant, except for very low and very high levels of concentration.

Table 5 also shows that for concentration values between the 30th and the 60th percentile of its distribution ─ corresponding to in-sample concentration ratios of 55 percent and 73 percent, respectively ─ the marginal effects of ROA, real lending rate and number of banks are all significant with opposite sign, i.e. the marginal effect of ROA is positive, while the marginal
effects of real lending rate and (log) number of banks are both negative. To gauge a clearer conclusion about what effects dominate, Table 5, column (5), reports the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero along with the estimated standard errors. Results show that the test statistic is significant and with the positive sign only at the 60th percentile of the concentration distribution, implying that the cost of credit and the ease of monitoring both dominate over the profitability mediator. For intermediate levels of concentration, i.e. between the 30th and the 50th percentile, the effects with opposite sign cancel each other out with no significant effect of the mediators on banking system instability.

We can also examine how the interaction effect of our mediators with concentration changes the effect of concentration on stability with the help of a chart. Graphical presentations are a very informative adjunct to numerical statistical results in the context of logit models with interactions terms (Greene, 2010). Figure 1 shows the effects of our model for profitability (panel 1), the cost of credit (panel 2), diversification (panel 3), and the ease of monitoring (panel 4). In particular, in Figure 1 the direct and total, i.e. mediated by concentration, marginal effects of the mediators on the probability of banking crisis are plotted on the vertical axis as a function of selected percentiles of the concentration distribution. The interaction effect is the change in the marginal effect of the mediators with respect to changes in concentration levels, which is the distance between the two curves in each of the panels.

Overall, results in Table 5 and reported Figure 1 show that the effects of the mediators through which concentration is expected to affect banking system instability change with the level of concentration, with the net cumulative effect crucially depending upon the level of concentration itself. In the left tail of the concentration distribution (20th percentile and below), further increasing concentration in the banking sector reduces financial instability via profitability.
When concentration is in its right tail (60th percentile and above), further increasing concentration increases financial instability via the *cost of credit*, *diversification* and the *ease of monitoring*. For intermediate levels of concentration (between the 30th percentile and the 50th percentile), the mediators cancel each other out and the structure of the banking market has no meaningful impact on financial stability. Our results provide, therefore, support for both the ‘concentration-stability’ view and the ‘concentration-fragility’ view: higher concentration enhances stability on the one hand but reduces it on the other, with the net effect of the mediators crucially depending upon the initial levels of concentration.

### 3.2. Robustness tests

Our results may be driven by a number of modeling choices, including the variables used as proxies for the mediators, the measure of concentration used, the sample period and the econometric specification. This section presents results from several robustness checks.

First, we use different proxies for the mediating variables. Our results may reflect the specific variables selected to proxy for the different mediators through which concentration affects banking system instability. Therefore, we run our regression and calculate marginal effects at different values of concentration using the following alternative variables: return on equity (ROE) for *profitability*; the deflated lending rate for the *cost of credit* variable; a measure of income diversification such as the Herfindahl Hirschman Index for *diversification* (Mercieca et al., 2007); and (log) bank size, a proxy of bank complexity, for the *ease of monitoring* mediator. Results, which are reported in Tables 6—9, broadly confirm our findings: for relatively low levels of

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7 A lower HHI of income diversification signals higher diversification and hence we would expect a negative sign for this variable if the results of the baseline proxy for the *diversification* variable (cross-border financial activity) were confirmed.
concentration, increasing concentration reduces the probability of banking crises through \textit{profitability}; for relatively high levels of concentration, increasing concentration makes the banking system more fragile. However, while results confirm a strong effect of the cost of credit, they provide somewhat weaker evidence that both \textit{diversification} and the \textit{ease of monitoring} are at play as well.

As additional robustness check, we investigate the sensitivity of our results to using an alternative indicator of market concentration: the share of banking system assets held by the five largest banks. Table 10 reports the results, which confirm our findings. We also investigate the robustness of our results to a different sample period. Specifically, given that one-third of crisis episodes in our sample are related to the GFC, we investigate whether our results are driven by the GFC. In Table 11, we run our regression dropping all observations after 2007. We continue to find that \textit{profitability} is at play for relatively low levels of concentration, while the cost of credit, \textit{diversification} and the \textit{ease of monitoring} are at play for relatively high levels of concentration.

A final test concerns the model specification. So far, we have allowed for heteroscedasticity of errors and corrected for it, assuming that errors are independent. However, given that we use panel data, the within-country error terms may be correlated with each other. To control for the fact that omitted country-level characteristics might cause correlation of the error terms within-countries, we allow for clustering within countries. Results, presented in Table 12, confirm our main findings.\footnote{We also estimate a logit model with random country effects and use alternative estimators such as probit, cloglog and LPM. Results, which are not reported for brevity but are available upon request, do not differ significantly from our main findings.}
4. Concluding remarks

This paper presented a unified empirical framework to investigate the mediators through which bank concentration impacts financial stability, and tested for their effects at different levels of concentration. Using data for 68 countries during 1997-2015, we estimated a logit model where interaction effects between our proxies for the mediators and our concentration measure are included and evaluated at different levels of concentration.

Our results show that the mediators through which concentration affects banking system stability operate simultaneously with varying magnitude and net effect that crucially depend upon the initial levels of concentration. For levels of concentration up to the 20th percentile of its distribution, corresponding to a concentration ratio of 47 percent in our sample, *profitability* dominates and increasing concentration reduces the likelihood of banking crisis. When concentration hits a given threshold, which we estimate at around the 60th percentile of its distribution, or an in-sample concentration ratio of 73 percent, the *cost of credit, diversification* and the *ease of monitoring* prevail, and increasing concentration increases crisis probability. For concentration values between these thresholds, corresponding to concentration ratios between 55 percent and 66 percent, the mediators cancel each other out and concentration does not significantly affect financial stability.

Our findings, which are in line with recent studies that have uncovered the presence of non-monotonicities in the relationship between banking market structure and financial stability (Berger et al., 2009; Bretschger et al., 2012; Beck et al., 2013; Carbó Valverde et al., 2013; Jimenez et al., 2013; Cuestas et al., 2017), suggest that an intermediate degree of concentration may be optimal from a welfare perspective. However, we warn against a normative use. The optimal level of
concentration would be subject to significant cross-country heterogeneity (i.e. function of financial
development, quality of regulation etc., see Beck et al., 2013), making it hard to make a certain
degree of bank concentration as a universal policy objective. Nonetheless, our results suggest that
entry/exit rules, merger review processes and activity restrictions should give greater emphasis on
profitability, intermediation efficiency, business models and the number of players in the market.
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The figure shows the effects of profitability (panel 1), the cost of credit (panel 2), diversification (panel 3), and the ease of monitoring (panel 4). In particular, the marginal effects of the mediators on the probability of banking crisis are plotted as a function of selected percentiles of concentration. The direct effects are computed based on the logit model reported in Table 3, column (1) while the total effects are calculated based on the model presented in Table 3, column (2).
| Variable                  | Obs  | Mean   | Std. Dev. | Min   | Max  |
|---------------------------|------|--------|-----------|-------|------|
| Banking crisis            | 1,292| 0.03   | 0.18      | 0.00  | 1.00 |
| Log GDP per capita        | 1,292| 9.03   | 1.38      | 5.52  | 11.43|
| GDP growth                | 1,292| 3.61   | 3.47      | -7.82 | 15.24|
| FX depreciation           | 1,289| 5.76   | 21.78     | -16.95| 206.48|
| Inflation                 | 1,292| 7.54   | 13.16     | -5.26 | 115.53|
| Current account balance   | 1,287| -0.43  | 6.67      | -19.12| 24.74|
| Credit growth             | 1,247| 7.46   | 14.34     | -40.14| 76.66|
| Concentration3            | 1,263| 67.07  | 20.46     | 17.29 | 100.00|
| Concentration5            | 1,261| 79.56  | 16.96     | 23.18 | 100.00|
| ROA                       | 1,272| 1.00   | 1.33      | -5.97 | 5.76 |
| ROE                       | 1,272| 11.77  | 13.70     | -74.30| 67.23|
| Real lending rate         | 1,270| 6.45   | 9.47      | -32.54| 55.43|
| Nominal lending rate      | 1,204| 14.59  | 14.31     | 1.04  | 95.97|
| Cross-border financial activity | 1,231 | 60.68 | 92.33 | 1.51 | 809.87 |
| Income diversification index | 1,274 | 58.38 | 9.18 | 50.00 | 97.18 |
| Log #banks                | 1,292| 3.85   | 1.22      | 1.31  | 8.79 |
| Log bank size             | 1,277| 21.14  | 1.70      | 15.26 | 25.28 |
Table 2 – Correlation matrix

|                                | Banking crisis | Log GDP per capita | GDP growth | FX depreciation | Inflation | Current account balance | Credit growth | Concentration3 | Concentration5 | ROA | ROE | Real lending rate | Nominal lending rate | Cross-border financial activity | Income diversification index | Log #banks | Log bank size |
|--------------------------------|----------------|-------------------|------------|----------------|-----------|------------------------|---------------|-----------------|----------------|-----|-----|------------------|-------------------------|-----------------------------|-----------------------------|-----------|-------------|
| Banking crisis                 | 1              |                   |            |                |           |                        |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| Log GDP per capita             | -0.0049        | 1                 |            |                |           |                        |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| GDP growth                     | 0.0210         | -0.3042*          | 1          |                |           |                        |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| FX depreciation                | -0.0268        | -0.1203*          | -0.1647*   | 1              |           |                        |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| Inflation                      | 0.0294         | -0.2681*          | 0.0654*    | 0.6143*        | 1         |                        |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| Current account balance        | -0.0502*       | 0.2478*           | 0.0263     | -0.0154        | -0.0163   | 1                      |               |                 |                |     |     |                  |                         |                             |                             |           |             |
| Credit growth                  | 0.0675*        | -0.1024*          | 0.3768*    | -0.1127*       | -0.0796*  | -0.0818*               | 1             |                 |                |     |     |                  |                         |                             |                             |           |             |
| Concentration3                 | -0.0443        | 0.1564*           | -0.0232    | -0.0234        | -0.0402   | 0.1064*                | 0.029         | 1               |                |     |     |                  |                         |                             |                             |           |             |
| Concentration5                 | -0.0616*       | 0.1031*           | -0.0338    | -0.0279        | -0.0338   | 0.0615*                | 0.0271        | 0.9425*        | 1              |     |     |                  |                         |                             |                             |           |             |
| ROA                            | -0.0491*       | -0.2436*          | 0.3152*    | -0.1199*       | -0.0766*  | 0.2800*                | -0.0641*      | -0.0570*       | 1              |     |     |                  |                         |                             |                             |           |             |
| ROE                            | -0.0226        | -0.1873*          | 0.3044*    | -0.0316        | 0.1718*   | -0.0738*               | 0.2747*       | -0.0018        | -0.0093        | 0.7735* | 1   |                  |                         |                             |                             |           |             |
| Real lending rate              | 0.0241         | -0.1500*          | -0.0636*   | -0.1296*       | -0.3400*  | -0.0282*               | 0.1016*       | -0.0520*       | -0.0489*        | 0.001  | -0.0823* | 1                  |                         |                             |                             |           |             |
| Nominal lending rate           | 0.0486*        | -0.3809*          | 0.0022     | 0.4879*        | 0.6619*   | -0.1601*               | -0.0004       | -0.0018        | -0.0077*        | 0.0954* | 0.0744* | 0.4352*           | 1                      |                             |                             |           |             |
| Cross-border financial activity| 0.0436         | 0.3950*           | -0.1051*   | -0.0666*       | -0.1385*  | 0.0687*                | -0.0512*      | 0.1275*        | 0.1115*         | -0.1421* | -0.1028* | -0.0817*          | -0.1788*               | 1                           |                             |           |             |
| Income diversification index   | -0.0378        | -0.1055*          | 0.0114     | -0.0067        | -0.0198   | -0.0132                | -0.0517*      | 0.0696*        | 0.0782*         | -0.0074  | -0.0182 | -0.0218           | -0.0336                 | -0.0467                      | 1                           |           |             |
| Log #banks                     | 0.0386         | 0.5256*           | -0.1135*   | -0.0515*       | -0.1368*  | 0.2196*                | -0.0077*      | -0.2602*       | -0.3834*        | -0.1713* | -0.1346* | -0.1581*          | -0.2722*               | 0.2157*                     | -0.1032                     | 1          |             |
| Log bank size                  | -0.0073        | 0.6569*           | -0.1970*   | -0.2541*       | -0.3945*  | 0.2055*                | -0.1003*      | -0.0001        | -0.0067         | -0.2570* | -0.2206* | -0.1157*          | -0.4762*               | 0.0842*                     | 0.0613*                     | 0.3833* | 1           |

* Indicates significance at the 10% level.
Table 3 – The impact of the mediators on banking system instability

|                                | (1)     |          | (2)     |          |
|--------------------------------|---------|----------|---------|----------|
|                                | dy/dx   | s.e.     | dy/dx   | s.e.     |
| Log GDP per capita             | 0.0000  | 0.0001   | 0.0000  | 0.0001   |
|                                | 0.0069  | 0.0069   | 0.0047  | 0.0046   |
| GDP growth                     | 0.0011  | 0.0001   | 0.0047  | 0.0046   |
| FX depreciation                | -0.0229*** | 0.0079  | -0.0219** | 0.0085   |
| Inflation                      | 0.0176*** | 0.0051  | 0.0179*** | 0.0056   |
| Current account balance        | -0.0091*   | 0.0049  | -0.0115** | 0.0051   |
| Credit growth                  | 0.0100*** | 0.0034  | 0.0103*** | 0.0034   |
| Concentration                  | -0.0054  | 0.0005   | -0.0073  | 0.0005   |
| ROA                            | -0.0110*** | 0.0035  | -0.0092** | 0.0038   |
| Real lending rate              | 0.0065**  | 0.0027  | 0.0101*** | 0.0038   |
| Cross-border financial activity| 0.0053*   | 0.0030  | 0.0035   | 0.0034   |
| Log #banks                     | 0.0075   | 0.0053   | 0.0141** | 0.0063   |

ROA; Real lending rate; Cross-border financial activity; Log #banks
15.33*** 17.46***
0.0041 0.0016
Concentration; ROA; Real lending rate; Cross-border financial activity; Log #banks
23.45*** 20.39***
0.0003 0.0011
ROA X Concentration; Real lending rate X Concentration; Cross-border financial activity X Concentration; Log #banks X Concentration
5.13
0.2741
Concentration; ROA; Real lending rate; Cross-border financial activity; Log #banks; ROA X Concentration; Real lending rate X Concentration; Cross-border financial activity X Concentration; Log #banks X Concentration
25.14***
0.0028

Observations: 1,162 1,162
Log pseudolikelihood: -164.17 -161.38
Wald chi2: 42.55 49.12
Prob > chi2: 0.0000 0.0000
Pseudo R2: 0.0914 0.1068

The logit probability model estimated in specification (1) is Banking Crisis \( \text{Country} = j, \text{Time} = t \) = \( \alpha + \beta_1 \text{Log GDP per capita}_{j,t-1} + \beta_2 \text{Real GDP growth}_{j,t-1} + \beta_3 \text{FX depreciation}_{j,t-1} + \beta_4 \text{Inflation}_{j,t-1} + \beta_5 \text{Current account balance}_{j,t-1} + \beta_6 \text{Credit growth}_{j,t-1} + \beta_7 \text{Concentration}_{j,t-1} + \beta_8 \text{ROA}_{j,t-1} + \beta_9 \text{Real lending rate}_{j,t-1} + \beta_{10} \text{Cross-border financial activity}_{j,t-1} + \beta_{11} \text{Log #banks}_{j,t-1} \). The dependent variable is a crisis dummy that takes on the value of one if there is a banking crisis and the value of zero otherwise. Log GDP per capita is the real GDP per capita expressed in log. GDP growth is the rate of growth of real GDP. FX depreciation is rate of change of the exchange rate. Inflation is the rate of change of the GDP deflator. Credit growth is the real growth of domestic credit. Concentration is calculated as the fraction of assets held by the three largest banks in each country. ROA is the return on assets of the banking system in each country. Real lending rate is the interest rate charged by the banking sector to the private sector adjusted for inflation. Cross-border financial activity is the sum of banks’ gross external assets and liabilities relative to total banking system assets. Log #banks is the log of the number of banks. Crisis observations after the initial year of crisis take on the value of zero.

Specification (2) includes interaction terms between concentration and ROA, Real lending rate, Cross-border financial activity and Log #banks, respectively. All independent variables are lagged by one period. We present the marginal effects (dy/dx) of the logit regressions calculated at the mean. White’s heteroskedasticity consistent standard errors given in italic. We also present a test for joint significance of the effects of concentration working via ROA, Real lending rate, Cross-border financial activity and Log #banks, as well as a test for joint significance of all these regressors. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
## Table 4 – Marginal effects of the mediators (direct effects)

| Percentile (%) | ROA (dy/dx, s.e.) | Real lending rate (dy/dx, s.e.) | Cross-border financial activity (dy/dx, s.e.) | Log #banks (dy/dx, s.e.) | Test for difference in coefficients (1)+(2)+(3)+(4) Coeff. s.e. |
|----------------|---------------------|---------------------------------|-----------------------------------------------|--------------------------|----------------------------------------------------------|
| 10             | -0.0189** 0.0074    | 0.0110** 0.0048                 | 0.0092* 0.0055                               | 0.0129* 0.0075          | 0.0142 0.0110                                           |
| 20             | -0.0178*** 0.0065   | 0.0104** 0.0044                 | 0.0086* 0.0051                               | 0.0121 0.0075           | 0.0012 0.0080                                           |
| 30             | -0.0167*** 0.0059   | 0.0097** 0.0040                 | 0.0081* 0.0047                               | 0.0114 0.0074           | 0.0012 0.0075                                           |
| 40             | -0.0158*** 0.0055   | 0.0092** 0.0038                 | 0.0077* 0.0044                               | 0.0108 0.0075           | 0.0011 0.0071                                           |
| 50             | -0.0150*** 0.0053   | 0.0087** 0.0037                 | 0.0073* 0.0042                               | 0.0102 0.0075           | 0.0010 0.0068                                           |
| 60             | -0.0141*** 0.0052   | 0.0082** 0.0036                 | 0.0068* 0.0041                               | 0.0096 0.0075           | 0.0009 0.0064                                           |
| 70             | -0.0132** 0.0052    | 0.0077** 0.0036                 | 0.0064 0.0041                                | 0.0090 0.0075           | -0.0055 0.0047                                          |
| 80             | -0.0122** 0.0054    | 0.0071* 0.0037                  | 0.0059 0.0039                                | 0.0083 0.0075           | -0.0051 0.0045                                          |
| 90             | -0.0110* 0.0057     | 0.0064* 0.0038                  | 0.0053 0.0037                                | 0.0075 0.0075           | -0.0046 0.0042                                          |

Observations: 1,162
Log pseudolikelihood: -164.17
Wald chi2: 42.55
Prob > chi2: 0.0000
Pseudo R2: 0.0914

The logit probability model estimated is as in Table 3, specification (1). We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log #banks at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the two marginal effects equals zero, whenever the two estimated effects are both significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
Table 5 – Marginal effects of the mediators (total effects)

| Percentile (%) | (1) ROA | (2) Real lending rate | (3) Cross-border financial activity | (4) Log #banks | Test for difference in coefficients (1)+(2)+(3)+(4) |
|----------------|---------|-----------------------|-----------------------------------|----------------|---------------------------------------------|
|                | dy/dx   | dy/dx     | dy/dx    | dy/dx | Coeff. |
|                | s.e.    | s.e.      | s.e.     | s.e.  | s.e.  |
| 10             | -0.0233** | 0.0009 | -0.0018 | 0.0086 | - |
|                | 0.0115   | 0.0083 | 0.0127 | 0.0096 | - |
| 20             | -0.0203** | 0.0050 | 0.0003 | 0.0122 | - |
|                | 0.0081   | 0.0060 | 0.0101 | 0.0084 | - |
| 30             | -0.0176***| 0.0089*| 0.0022 | 0.0155*| 0.0068|
|                | 0.0060   | 0.0048 | 0.0079 | 0.0085 | 0.0093|
| 40             | -0.0158***| 0.0117**| 0.0036 | 0.0180*| 0.0140|
|                | 0.0053   | 0.0048 | 0.0065 | 0.0093 | 0.0104|
| 50             | -0.0141**| 0.0145***| 0.0050 | 0.02058*| 0.2096|
|                | 0.0057   | 0.0057 | 0.0053 | 0.0107 | 0.0131|
| 60             | -0.0126* | 0.0175**| 0.0064 | 0.0233*| 0.0282*|
|                | 0.0068   | 0.0072 | 0.0044 | 0.0126 | 0.0169|
| 70             | -0.0112  | 0.0205**| 0.0078* | 0.0262*| - |
|                | 0.0082   | 0.0093 | 0.0040 | 0.0150 | - |
| 80             | -0.0095  | 0.0244**| 0.0097**| 0.0299*| - |
|                | 0.0101   | 0.0121 | 0.0046 | 0.0181 | - |
| 90             | -0.0076  | 0.0291* | 0.0119* | 0.0344 | - |
|                | 0.0126   | 0.0154 | 0.0064 | 0.0217 | - |

Observations: 1,162
Log pseudolikelihood: -161.38
Wald chi2: 49.12
Prob > chi2: 0.0000
Pseudo R2: 0.1068

The logit probability model estimated is as in Table 3, specification (2). We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
### Table 6 – Marginal effects of the mediators: alternative proxy for profitability

| Percentile (%) | ROE dy/dx s.e. | Real lending rate dy/dx s.e. | Cross-border financial activity dy/dx s.e. | Log #banks dy/dx s.e. | Test for difference in coefficients (1)+(2)+(3)+(4) Coeff. s.e. |
|---------------|----------------|-----------------------------|------------------------------------------|----------------------|---------------------------------------------------|
| 10            | -0.0212* 0.0128 | -0.0008 0.0081              | 0.0006 0.0128                            | 0.0076 0.0100        | -                                                 |
| 20            | -0.0184** 0.0091 | 0.0038 0.0059               | 0.0022 0.0102                            | 0.0118 0.0086        | -                                                 |
| 30            | -0.0153*** 0.0064 | 0.0079 0.0048              | 0.0037 0.0080                            | 0.0158* 0.0087       | 0.0004 0.0096                                   |
| 40            | -0.0132** 0.0052 | 0.0110** 0.0048            | 0.0048 0.0066                            | 0.0188** 0.0095      | 0.0165 0.0107                                   |
| 50            | -0.0113** 0.0049 | 0.0140** 0.0055            | 0.0059 0.0054                            | 0.0217** 0.0109      | 0.0244* 0.0131                                  |
| 60            | -0.0094* 0.0055 | 0.0172** 0.0070            | 0.0071 0.0045                            | 0.0249* 0.0129       | 0.0327* 0.0168                                  |
| 70            | -0.0076 0.0067  | 0.0204** 0.0090            | 0.0083** 0.0041                          | 0.0282* 0.0152       | -                                                 |
| 80            | -0.0055 0.0085  | 0.0245** 0.0117            | 0.0098** 0.0047                          | 0.0323* 0.0183       | -                                                 |
| 90            | -0.0029 0.0108  | 0.0295** 0.0148            | 0.0116* 0.0065                           | 0.0376* 0.0216       | -                                                 |

Observations 1,162
Log pseudolikelihood -163.25
Wald chi2 56.33
Prob > chi2 0.0000
Pseudo R2 0.0965

The logit probability model estimated is as in Table 3, specification (2). We present the marginal effects (dy/dx) of the logit regression for ROE, Real lending rate, Cross-border financial activity, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
### Table 7 – Marginal effects of the mediators: alternative proxy for cost of credit

| Percentile (%) | ROA \( \frac{dy}{dx} \) s.e. | Nominal lending rate \( \frac{dy}{dx} \) s.e. | Cross-border financial activity \( \frac{dy}{dx} \) s.e. | Log #banks \( \frac{dy}{dx} \) s.e. | Test for difference in coefficients \((1)+(2)+(3)+(4)\) Coeff. s.e. |
|----------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|---------------------------------|
| 10             | -0.0234** 0.0101               | -0.0048 0.0138                  | 0.0083 0.0102                   | -                               |                                  |
| 20             | -0.0206** 0.0111               | -0.0006 0.0105                  | 0.0115 0.0089                   | -                               |                                  |
| 30             | -0.0179*** 0.0112** 0.0027    | 0.0140 0.0089                   | -0.0061 0.0070                  | 0.0123                         |
| 40             | -0.0160*** 0.0125** 0.0052    | 0.0159* 0.0096                  | 0.0109 0.0065                   |                                  |
| 50             | -0.0144** 0.0131** 0.0074    | 0.0177 0.0108                   | -0.0013 0.0065                  |                                  |
| 60             | -0.0128* 0.0137* 0.0096**    | 0.0195 0.0124                   | 0.0105 0.0087                   |                                  |
| 70             | -0.0113 0.0145* 0.01189***   | 0.0214 0.0145                   | -                               |                                  |
| 80             | -0.0097 0.0155 0.0147***     | 0.0239 0.0177                   | -                               |                                  |
| 90             | -0.0078 0.0169 0.0183**      | 0.0272 0.0221                   | -                               |                                  |

Observations: 1,102
Log pseudolikelihood: -159.46
Wald chi2: 64.4
Prob > chi2: 0.0000
Pseudo R2: 0.1062

The logit probability model estimated is as in Table 3, specification (2). We present the marginal effects \( \frac{dy}{dx} \) of the logit regression for ROA, Nominal lending rate, Cross-border financial activity, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
Table 8 – Marginal effects of the mediators: alternative proxy for diversification

| Percentile (%) | (1) dy/dx s.e. | (2) dy/dx s.e. | (3) dy/dx s.e. | (4) dy/dx s.e. | (5) Test for difference in coefficients (1)+(2)+(3)+(4) Coeff. s.e. |
|----------------|----------------|----------------|----------------|----------------|--------------------------------------------------|
| 10             | -0.0238* 0.0122| 0.0021 0.00844| 0.0088 0.01366| 0.0076 0.01046| -                                                 |
| 20             | -0.0206** 0.0086| 0.0052 0.00633| 0.0035 0.00994| 0.0119 0.00906| -                                                 |
| 30             | -0.0181*** 0.0063| 0.0079 0.00505| -0.0012 0.00775| 0.0157* 0.00905| -0.0024 0.00995                                   |
| 40             | -0.0165*** 0.0055| 0.0101** 0.0045| -0.0046 0.00775| 0.0187* 0.00975| 0.0122 0.01045                                    |
| 50             | -0.0151*** 0.0057| 0.0122** 0.0048| -0.0078 0.00725| 0.0217* 0.01115| 0.0187 0.01275                                    |
| 60             | -0.0139** 0.0068| 0.0145*** 0.0056| -0.0113 0.00835| 0.0250* 0.01295| 0.0256 0.01615                                    |
| 70             | -0.0126 0.00844| 0.0169** 0.0069| -0.0149 0.01035| 0.0286* -        | -0.0150 -                                       |
| 80             | -0.0112 0.01055| 0.0197** 0.0087| -0.0191 0.01325| 0.0327* -        | -0.0172 -                                       |
| 90             | -0.0095 0.01322| 0.0223** 0.0110| -0.0239 0.01745| 0.0374* -        | -0.0197 -                                       |

Observations 1,174
Log pseudolikelihood -162.22
Wald chi2 46.73
Prob > chi2 0.0000
Pseudo R2 0.1043

The logit probability model estimated is as in Table 3, specification (2). We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Income diversification index, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
Table 9 – Marginal effects of the mediators: alternative proxy for ease of monitoring

| Percentile | (1) Percentage ROA (dy/dx) | (2) Real lending rate (dy/dx) | (3) Cross-border financial activity (dy/dx) | (4) Log bank size (dy/dx) | (5) Test for difference in coefficients (1)+(2)+(3)+(4) (Coeff. s.e.) |
|------------|-----------------------------|-------------------------------|-------------------------------------------|----------------------------|-----------------------------------------------------------------|
| 10         | -0.0231**                   | 0.0034                        | -0.0013                                   | 0.0010                     | -                                                               |
|            | 0.0133                      | 0.0078                        | 0.0137                                    | 0.0154                     | -                                                               |
| 20         | -0.0198***                  | 0.0063                        | 0.0010                                    | 0.0023                     | -                                                               |
|            | 0.0077                      | 0.0056                        | 0.0107                                    | 0.0116                     | -                                                               |
| 30         | -0.0170***                  | 0.0087*                       | 0.0031                                    | 0.0034                     | -0.0083                                                         |
|            | 0.0055                      | 0.0045                        | 0.0082                                    | 0.0093                     | 0.0059                                                          |
| 40         | -0.0149***                  | 0.0103**                      | 0.0044                                    | 0.0042                     | -0.0046                                                         |
|            | 0.0051                      | 0.0045                        | 0.0065                                    | 0.0086                     | 0.0086                                                          |
| 50         | -0.0131**                   | 0.0117**                      | 0.0056                                    | 0.0048                     | -0.0014                                                         |
|            | 0.0057                      | 0.0051                        | 0.0052                                    | 0.0088                     | 0.0076                                                          |
| 60         | -0.0114*                    | 0.0130**                      | 0.0067                                    | 0.0055                     | 0.0016                                                          |
|            | 0.0068                      | 0.0062                        | 0.0041                                    | 0.0087                     | 0.0093                                                          |
| 70         | -0.0099                     | 0.0142*                       | 0.0077**                                  | 0.0060                     | -                                                               |
|            | 0.0080                      | 0.0075                        | 0.0036                                    | 0.0109                     | -                                                               |
| 80         | -0.0083                     | 0.0155                        | 0.0089**                                  | 0.0066                     | -                                                               |
|            | 0.0094                      | 0.0095                        | 0.0038                                    | 0.0127                     | -                                                               |
| 90         | -0.0066                     | 0.0170                        | 0.0101**                                  | 0.0074                     | -                                                               |
|            | 0.0111                      | 0.0120                        | 0.0049                                    | 0.0149                     | -                                                               |

Observations: 1,162
Log pseudolikelihood: -163.90
Wald chi2: 49.93
Prob > chi2: 0.0000
Pseudo R2: 0.0927

The logit probability model estimated is as in Table 3, specification (2). We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log bank size computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%. 
Table 10 – Marginal effects of the mediators: alternative measure of concentration

| Percentile (%) | ROA dy/dx s.e. | Real lending rate dy/dx s.e. | Cross-border financial activity dy/dx s.e. | Log #banks dy/dx s.e. | Test for difference in coefficients (1)+(2)+(3)+(4) Coeff. s.e. |
|----------------|----------------|-------------------------------|------------------------------------------|-----------------------|--------------------------------------------------|
| 10             | -0.0346***     | 0.0049                        | -0.0019                                  | 0.0072                | -                                                 |
|                | 0.0130         | 0.0071                        | 0.0139                                   | 0.0137                | -                                                 |
| 20             | -0.0242***     | 0.0089*                       | 0.0017                                   | 0.0149                | -0.0153**                                         |
|                | 0.0075         | 0.0050                        | 0.0092                                   | 0.0103                | 0.0074                                            |
| 30             | -0.0196***     | 0.0107**                      | 0.0033                                   | 0.0182                | -0.0089                                           |
|                | 0.0062         | 0.0047                        | 0.0073                                   | 0.0103                | 0.0066                                            |
| 40             | -0.0154**      | 0.0124**                      | 0.0048                                   | 0.0214*               | 0.0183                                            |
|                | 0.0060         | 0.0048                        | 0.0057                                   | 0.0113                | 0.0125                                            |
| 50             | -0.0115*       | 0.0141**                      | 0.0062                                   | 0.0246*               | 0.0272*                                            |
|                | 0.0066         | 0.0056                        | 0.0045                                   | 0.0133                | 0.0162                                            |
| 60             | -0.0086        | 0.0156**                      | 0.0074*                                  | 0.0273*               | -                                                 |
|                | 0.0074         | 0.0065                        | 0.0041                                   | 0.0155                | -                                                 |
| 70             | -0.0065        | 0.0166**                      | 0.0083**                                 | 0.0293*               | -                                                 |
|                | 0.0081         | 0.0073                        | 0.0041                                   | 0.0174                | -                                                 |
| 80             | -0.0043        | 0.0178**                      | 0.0093**                                 | 0.0316                | -                                                 |
|                | 0.0089         | 0.0083                        | 0.0046                                   | 0.0195                | -                                                 |
| 90             | -0.0028        | 0.0188**                      | 0.0010*                                  | 0.0333                | -                                                 |
|                | 0.0096         | 0.0090                        | 0.0051                                   | 0.0210                | -                                                 |

Observations 1,160
Log pseudolikelihood -159.40
Wald chi2 52.1
Prob > chi2 0.0000
Pseudo R2 0.1174

The logit probability model estimated is as in Table 3, specification (2). However, the concentration measure used is the share of banking system assets held by the five largest banks. We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
Table 11 – Marginal effects of the mediators: alternative sample period

| Percentile (%) | ROA \( dy/dx \) s.e. | Real lending rate \( dy/dx \) s.e. | Cross-border financial activity \( dy/dx \) s.e. | Log # banks \( dy/dx \) s.e. | Test for difference in coefficients \((1)+(2)+(3)+(4)\) Coeff. s.e. |
|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 10             | -0.0237 0.0178  | -0.0074 0.0148  | -0.0031 0.0216  | 0.0106 0.0171   | -               |
| 20             | -0.0211** 0.0112  | 0.0033 0.0088  | 0.0012 0.0155  | 0.0166 0.0142   | -               |
| 30             | -0.0193** 0.0080  | 0.0097 0.0072  | 0.0038 0.0119  | 0.0201 0.0142   | -               |
| 40             | -0.0181** 0.0071  | 0.0142* 0.0076  | 0.0056 0.0095  | 0.0226 0.0153  | -0.0038 0.0087 |
| 50             | -0.0172** 0.0074  | 0.0178* 0.0089  | 0.0071 0.0079  | 0.0245 0.0168  | 0.006 0.0106   |
| 60             | -0.0165* 0.0087   | 0.0213* 0.0108  | 0.0085 0.0066  | 0.0266 0.0186  | 0.0048 0.0131  |
| 70             | -0.0159 0.0103   | 0.0244* 0.0128  | 0.0098* 0.0058  | 0.0285 0.0204  | -               |
| 80             | -0.0152 0.0125   | 0.0279* 0.0146  | 0.0111* 0.0057  | 0.0306 0.0222  | -               |
| 90             | -0.0143 0.0149   | 0.0309* 0.0156  | 0.0123* 0.0065  | 0.0322 0.0233  | -               |

Observations 659
Log pseudolikelihood -100.37
Wald chi2 36.88
Prob > chi2  0.0013
Pseudo R2 0.1335

The logit probability model estimated is as in Table 3, specification (2). However, the sample period is 1997-2007. We present the marginal effects \((dy/dx)\) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log # banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
Table 12 – Marginal effects of the mediators: error terms clustered within countries

| Percentile (%) | (1) dy/dx | (2) dy/dx | (3) dy/dx | (4) dy/dx | (5) Test for difference in coefficients (1)+(2)+(3)+(4) |
|----------------|-----------|-----------|-----------|-----------|--------------------------------------------------|
|                | ROA       | Real lending rate | Cross-border financial activity | Log #banks | Coeff. |
| 10             | -0.023**  | 0.0009    | -0.0018   | 0.0086    | -       |
|                | 0.0115    | 0.0091    | 0.0110    | 0.0067    | -       |
| 20             | -0.0203** | 0.0050    | 0.0003    | 0.0122*   | -       |
|                | 0.0083    | 0.0071    | 0.0086    | 0.0065    | -       |
| 30             | -0.0176***| 0.0089    | 0.0022    | 0.0155**  | -0.0021 |
|                | 0.0063    | 0.0058    | 0.0065    | 0.0071    | 0.0085  |
| 40             | -0.0158***| 0.0117**  | 0.0036    | 0.0180*   | 0.0140  |
|                | 0.0057    | 0.0053    | 0.0050    | 0.0080    | 0.0114  |
| 50             | -0.0141** | 0.0145*** | 0.0050    | 0.0206**  | 0.0210  |
|                | 0.0061    | 0.0054    | 0.0037    | 0.0091    | 0.0234  |
| 60             | -0.0126*  | 0.0175*** | 0.0064**  | 0.0233**  | 0.0346* |
|                | 0.0072    | 0.0061    | 0.0026    | 0.0107    | 0.0169  |
| 70             | -0.0112   | 0.0205*** | 0.0078*** | 0.0262**  | -       |
|                | 0.0086    | 0.0073    | 0.0019    | 0.0124    | -       |
| 80             | -0.0095   | 0.0243*** | 0.0097*** | 0.0299**  | -       |
|                | 0.0107    | 0.0093    | 0.0026    | 0.0147    | -       |
| 90             | -0.0076   | 0.0291**  | 0.0119*** | 0.0344**  | -       |
|                | 0.0134    | 0.0117    | 0.0046    | 0.0172    | -       |

Observations 1,162
Log pseudolikelihood -161.38
Wald chi² 90.96
Prob > chi² 0.0000
Pseudo R² 0.1068

The logit probability model estimated is as in Table 3, specification (2). However, error terms are clustered within countries. We present the marginal effects (dy/dx) of the logit regression for ROA, Real lending rate, Cross-border financial activity, and Log #banks computed at different percentiles of the concentration variable, and the LM-type test statistic for the null hypothesis that the sum of the marginal effects equals zero, whenever the estimated effects are significant with opposite signs. White’s heteroskedasticity consistent standard errors are given in italic. Detailed variable definitions and sources are given in the data appendix.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.
### Appendix A: Description and sources of data

| Variable Name       | Definition                                                                 | Source                                              |
|---------------------|-----------------------------------------------------------------------------|----------------------------------------------------|
| Banking crisis      | Dummy takes on value of one during episodes identified as a systematic and non-systemic banking crises. | Reinhart and Rogoff (2009)                         |
| Log GDP per capita  | Log real GDP per capita.                                                    | World Development Indicators (World Bank)           |
| GDP growth          | Rate of growth of real GDP.                                                 | World Development Indicators (World Bank)           |
| Inflation           | Rate of change of GDP deflator.                                             | World Development Indicators (World Bank)           |
| Depreciation        | Nominal exchange rate depreciation (average of the year).                   | World Development Indicators (World Bank)           |
| Current account balance | Current account to GDP.                                                   | World Development Indicators (World Bank)           |
| Credit growth       | Rate of growth of domestic credit to the private sector adjusted for inflation as measured by the GDP deflator. | International Financial Statistics (IMF); European Central Bank; National central banks. |
| Concentration3      | Degree of concentration in the banking industry, calculated as the fraction of assets held by the three largest banks. | Global Financial Development Database (World Bank)   |
| Concentration5      | Degree of concentration in the banking industry, calculated as the fraction of assets held by the five largest banks. | Global Financial Development Database (World Bank)  |
| ROA                 | Commercial banks’ after-tax net income divided by yearly averaged assets.   | Global Financial Development Database (World Bank)  |
| ROE                 | Commercial banks’ after-tax net income divided by yearly averaged equity.    | Global Financial Development Database (World Bank)  |
| Real lending rate   | Lending interest rate charged by the banking sector to the private sector adjusted for inflation as measured by the GDP deflator. | World Development Indicators (World Bank); National central banks |
| Nominal lending rate| Lending interest rate charged by the banking sector to the private sector.   | World Development Indicators (World Bank); National central banks |
| Cross-border financial activity | Sum of banks’ gross external assets and liabilities relative to total banking system assets. | International Financial Statistics (IMF); Global Financial Development Database (World Bank) |
| Income diversification index | HHI of relative share of interest income and noninterest income to total banking revenue. | Global Financial Development Database (World Bank) |
| Log #banks          | Log number of banks (average).                                             | Financial Access Survey (IMF)                       |
| Log bank size       | Log total bank assets divided by the number of banks.                       | World Development Indicators (World Bank); Financial Access Survey (IMF) |
Appendix B: List of countries and crisis period

| Country                | Systemic crisis | Non systemic crisis | Country                | Systemic crisis | Non systemic crisis |
|------------------------|-----------------|---------------------|------------------------|-----------------|---------------------|
| Algeria                |                 |                     | Kenya                  |                 |                     |
| Angola                 |                 |                     | Korea, Rep.            | 1997            |                     |
| Argentina              | 2001            |                     | Malaysia               | 1997            |                     |
| Australia              |                 |                     | Mauritius              |                 |                     |
| Austria                | 2008            |                     | Mexico                 |                 |                     |
| Belgium                | 2008            | 1999                | Morocco                |                 |                     |
| Bolivia                |                 |                     | Myanmar                | 2002            |                     |
| Brazil                 |                 |                     | Netherlands            | 2008            |                     |
| Canada                 |                 |                     | New Zealand            |                 |                     |
| Central African Republic|                |                     | Nicaragua              | 2000            |                     |
| Chile                  |                 |                     | Nigeria                | 2009            | 1997                |
| China                  | 1998            | 1997                | Norway                 |                 |                     |
| Colombia               | 1998            |                     | Panama                 |                 |                     |
| Costa Rica             |                 |                     | Paraguay               | 2002            |                     |
| Cote d'Ivoire          |                 |                     | Peru                   | 1999            |                     |
| Denmark                | 2008            |                     | Philippines            | 1997            |                     |
| Dominican Republic     | 2003            |                     | Poland                 |                 |                     |
| Ecuador                |                 |                     | Portugal               | 2008            |                     |
| Egypt, Arab Rep.       |                 |                     | Romania                |                 |                     |
| El Salvador            | 1998            |                     | Russian Federation     | 1998            | 2008                |
| Finland                |                 |                     | Singapore              |                 |                     |
| France                 | 2008            |                     | South Africa           |                 |                     |
| Germany                | 2007            |                     | Spain                  | 2008            |                     |
| Ghana                  | 1997            |                     | Sri Lanka              |                 |                     |
| Greece                 | 2008            |                     | Sweden                 | 2008            |                     |
| Guatemala              | 2001, 2006      |                     | Switzerland            |                 |                     |
| Honduras               | 1999, 2001      |                     | Thailand               |                 |                     |
| Hungary                | 2008            |                     | Tunisia                |                 |                     |
| Iceland                | 2007            |                     | Turkey                 | 2000            | 2008                |
| India                  |                 |                     | United Kingdom         |                 |                     |
| Indonesia              | 1997            |                     | United States          |                 |                     |
| Ireland                | 2007            |                     | Uruguay                | 2002            |                     |
| Italy                  | 2008            |                     | Venezuela, RB          | 2009            |                     |
| Japan                  | 1997            |                     | Zambia                 |                 |                     |