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How does capital affect bank performance during financial crises?[☆]

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ABSTRACT

This paper empirically examines how capital affects a bank's performance (survival and market share) and how this effect varies across banking crises, market crises, and normal times that occurred in the US over the past quarter century. We have two main results. First, capital helps small banks to increase their probability of survival and market share at all times (during banking crises, market crises, and normal times). Second, capital enhances the performance of medium and large banks primarily during banking crises. Additional tests explore channels through which capital generates these effects. Numerous robustness checks and additional tests are performed.

1. Introduction

The recent financial crisis raises fundamental issues about the role of bank equity capital, particularly from the standpoint of bank survival. Not surprisingly, public outcries for more bank capital tend to be greater after financial crises, and post-crisis reform proposals tend to focus on how capital regulation should adapt to prevent future crises. Various such proposals have been put forth recently (e.g., Kashyap, Rajan, and Stein, 2008; BIS, 2010;

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Acharya, Mehran, and Thakor, 2011; Admati, DeMarzo, Hellwig, and Pfleiderer, 2011; Calomiris and Herring, 2011; Hart and Zingales, 2011). An underlying premise in these proposals is that externalities exist due to the safety net provided to banks and, thus, social efficiency can be improved by requiring banks to operate with more capital, especially during financial crises. Bankers, however, often argue that holding more capital would jeopardize their performance and lead to less lending. The academic literature suggests that this bankers' perspective needs to be more nuanced (e.g., Aiyar, Calomiris, and Wieladek, 2012; Jiménez, Ongena, Peydró, and Saurina, 2012; Osborne, Fuertes, and Milne, 2012), but has pointed out some negative consequences of more capital as well (e.g., Diamond and Rajan, 2001). Given the divergent views in the literature, the issue of the effects capital has on bank performance, the magnitude of these effects, and how they might differ across different types of crises and normal times boils down to an empirical question, one that we confront in this paper. In particular, the goal of this paper is to empirically examine the effects of bank capital on two dimensions of bank performance—probability of survival and market share—during different types of financial crises and normal times.

Survival and market share are two key performance issues that concern bank managers. Bank survival is central not only in strategic decisions made by banks, but also in decisions made by regulators concerned about banking stability. Market share is an important goal for most firms (e.g., Aghion and Stein, 2008), and banks often assess their performance relative to each other on this basis. Knowing how bank capital affects bank performance, both during financial crises and normal times, is also of paramount importance for regulators contemplating micro- and macroprudential banking regulation.[2] In particular, comprehending whether higher capital has a significant effect on a bank's survival likelihood and how this effect differs depending on bank size and the nature of the crisis are important details for regulators who are weighing the level and other specifics of capital requirements to achieve a desired level of banking stability. Even though the battle for market share is a zero-sum game, it matters to regulators because it affects bank behavior. For example, if higher capital impeded a bank's pursuit of market share, it might encourage higher leverage and greater banking fragility, something of concern to regulators. These issues also matter for how banking theory evolves, because it helps bring about a better appreciation for the reasonableness of assumptions about the channels through which bank capital affects various aspects of bank performance.

Most theories predict that capital enhances a bank's survival probability. Holding fixed the bank's asset and liability portfolios, higher capital mechanically implies a higher likelihood of survival. A deeper justification is provided by incentive-based theories such as Holmstrom and Tirole (1997), Acharya, Mehran, and Thakor (2011), Allen, Carletti, and Marquez (2011), Mehran and Thakor (2011), and Thakor (2012). In these models, either capital strengthens the bank's incentive to monitor its relationship borrowers, reducing the probability of default, or it attenuates asset-substitution moral hazard, or it lessens the attractiveness of innovative but risky products that elevate the probability of financial crises. However, some theories suggest that under certain circumstances increasing bank capital could be counterproductive because it perversely increases bank risk taking (e.g., Koehn and Santomero, 1980; Besanko and Kanatas, 1996). Nonetheless, the reviews in Freixas and Rochet (2008) suggest that the scales are tilted in favor of the prediction that capital has a salutary effect on the probability of survival. The view that capital strengthens a bank's competitive position in asset and liability markets, which can also improve its odds of survival, is also buttressed by the empirical evidence in papers such as Calomiris and Mason (2003) and Calomiris and Wilson (2004).

Recent banking theories also suggest a positive relation between capital and market share (e.g., Allen, Carletti, and Marquez, 2011; Mehran and Thakor, 2011). The empirical evidence suggests that higher-capital banks are able to compete more effectively for deposits and loans (e.g., Calomiris and Powell, 2001; Calomiris and Mason, 2003; Calomiris and Wilson, 2004; Kim, Kristiansen, and Vale, 2005), providing some support. In contrast, the literature on the interaction between a nonfinancial firm's leverage and its product-market dynamics argues that more highly-levered firms compete more aggressively for market share, suggesting that the relation between capital and market share could be negative (e.g., Brander and Lewis, 1986).

Thus, while existing theories provide valuable insights that guide the testable hypotheses we formulate in this paper, the predictions they produce conflict in some cases, pointing to the need for empirical mediation. Moreover, even when the theories strongly predict an effect in one direction, much is to be learned from documenting the sizes of various effects and how these vary in the cross section of banks, which again calls for empirical analysis. Furthermore, the theories generally do not distinguish between financial crises and normal times and do not distinguish between banks of different size classes, although these distinctions are important from a policy perspective and for the empirical tests in this paper.

For both survival and market share, we take our cue from the theories and formulate hypotheses that allow us to assess whether capital helps or hurts. The hypotheses are tested using data on virtually every US bank from 1984:Q1 until 2010:Q4. We examine small banks (gross total assets, or GTA, up to \$1 billion), medium banks (GTA exceeding \$1 billion and up to \$3 billion), and large banks (GTA exceeding \$3 billion) as three separate groups, because the effect of capital likely differs by bank size (e.g., Berger and Bouwman, 2009).[3] We also recognize that

[2] For example, one impetus for the global harmonization of capital requirements was the claim by US banks that Japanese banks were able to gain market share at the expense of US banks because they were subject to lower capital requirements (Group of Thirty, 1982). Thus, market-share arguments have also influenced regulatory thinking about capital requirements.

[3] Gross total assets, or GTA, equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). Total assets on Call Reports deduct these two

not all financial crises are alike. A crisis that originates in the banking sector could differ in impact from one that originates in the capital markets. To make this distinction, we define banking crises to be those that originated in the banking sector; and market crises to be those that originated outside banking in the financial markets. We study the effect of capital during banking crises, market crises, and normal times. We also examine the effect of capital during individual crises.

We test the effect of capital on bank survival using logit regressions. We regress the log odds ratio of the probability of survival on the bank's precrisis capital ratio interacted with a banking crisis dummy, a market crisis dummy, and a normal times dummy. Recognizing that coefficients on interaction terms in nonlinear models cannot be interpreted in the same way they are in linear models (Norton, Wang, and Ai, 2004), we use marginal effects to determine the effects of capital on survival. Our results indicate that capital enhances the survival probability of small banks at all times and, in the case of medium and large banks, only during banking crises.

The survival regressions also include a broad set of control variables to mitigate potential omitted-variable problems. The controls include not just proxies for risk and opacity, size and safety net protection, location, and profitability, but also for competition [including multimarket contact as in Evans and Kessides (1994); Degryse and Ongena (2007)], ownership (Berger, DeYoung, Genay, and Udell, 2000; Giannetti and Ongena, 2009; Mehran, Morrison, and Shapiro, 2011), and organizational structure and strategy (e.g., Degryse and Ongena, 2005, 2007; Bharath, Dahiya, Saunders, and Srinivasan, 2007; Degryse, Laeven, and Ongena, 2009).

We test the effect of capital on market share by defining market share in terms of the bank's share of aggregate gross total assets. We regress the percentage change in market share on the bank's average precrisis capital ratio interacted with the banking crisis, market crisis, and normal times dummies, and a set of control variables similar to the one mentioned above. Our results indicate that capital helps to increase market shares for small banks at all times and for medium and large banks only during banking crises.

We perform a variety of robustness checks. First, we use regulatory capital ratios instead of the equity-to-assets ratio to define capital. Second, we drop banks that could be considered to be too-big-to-fail (TBTF) to see if our large-bank conclusions are driven by the dominance of a few very large institutions. Third, we use an alternative cutoff to separate medium and large banks to examine the sensitivity of our results to the manner in which banks are classified by size. Fourth, we measure precrisis capital ratios averaged over the four quarters before the crisis or one quarter before the crisis instead of averaging them over the eight quarters before the crisis. Fifth, while the theories suggest a causal relation from capital to performance, we recognize that in practice both could be jointly determined. Although our main regression analyses use lagged capital to mitigate this potential endogeneity problem, we also address it more directly using an instrumental variable (IV) approach. Our main findings stand up to all these robustness checks. In an extra analysis, we investigate whether banks with higher precrisis capital ratios are able to improve their profitability.

In conducting these analyses, we aggregate across banking crises and treat them as a group, aggregate across market crises and treat them as a group, and group normal times together as well. We use this approach because we want to draw some general conclusions about how the role of capital differs across banking crises, market crises, and normal times, while minimizing the impact of the idiosyncratic circumstances surrounding a particular crisis. However, it is also useful to examine each crisis individually because doing so permits a more granular look at how the role of capital changes from one crisis to the next. We therefore also run the regressions separately for each of the five crises and normal times. The small-bank results based on examining crises individually are qualitatively similar to those when crises are grouped together, but the individual crisis analysis does yield additional insights for medium and large banks.

Having established the effects of capital on performance, we turn our attention to understanding the channels through which these effects work. The theories suggest higher-capital banks engage in more monitoring and invest in safer assets, so we identify three potential channels through which enhanced monitoring and safer investment policies could affect performance: growth in noncore funding, on-balance-sheet relationship loans, and off-balance-sheet guarantees.

Our results also raise new questions that we address through additional analyses designed to develop a more textured understanding of the effects of capital. First, to sharpen our understanding of the survival results, we examine whether the manner of exit for nonsurviving banks [mergers and acquisitions (M&As) without government assistance, M&As with assistance, and outright failure or change of charter] is related to their precrisis capital ratios. Second, we assess whether the impact of capital on market share differs across banks with different growth strategies (organic growth versus growth via M&As).

The results of all these analyses can be summarized as follows. First, higher precrisis capital is associated with a higher survival probability for small banks at all times (banking crises, market crises, and normal times) regardless of whether crises are considered individually or grouped together. This result holds whether capital is defined as total equity or as regulatory capital. For medium and large banks, this result holds only for banking crises, in particular the credit crunch of the early 1990s. During the recent crisis, unprecedented regulatory intervention that primarily benefited medium and large banks seems to have substituted for precrisis bank capital. Second, for banks that do not survive a crisis, precrisis capital affects the manner of exit. Banks with higher capital are less likely to exit via a government-assisted

(*footnote continued*)
reserves, which are held to cover potential credit losses. We add these reserves back to measure the full value of the loans financed.

M&A and more likely to exit via an unassisted M&A. Third, higher precrisis capital is associated with a gain in market share for small banks at all times and for medium and large banks during banking crises, regardless of whether crises are considered in groups or individually. For small and medium banks, the market-share effect is stronger when growth is organic, whereas for large banks the effect is stronger when growth is via M&As. Fourth, the effects of capital appear to be manifested through all three channels we examine. Banks with higher capital before a crisis show higher growth in noncore funding, on-balance-sheet relationship loans, and off-balance-sheet guarantees during the crisis. Interestingly, this seems to hold for small banks at all times, and for medium and large banks primarily during banking crises, precisely the cases in which capital helps banks survive and improve their market shares. Finally, for small banks, higher precrisis capital is associated with higher profitability at all times, and for medium and large banks only during financial crises.

Our approach is a significant departure from the existing empirical literature, which typically does not differentiate among bank size classes and studies either the credit crunch of the early 1990s (e.g., Estrella, Park, and Peristiani, 2000) or the recent subprime lending crisis (e.g., Beltratti and Stulz, 2012; Berger, Imbierowicz, and Rauch, 2012; Cole and White, 2012). Our results strongly suggest that the distinction among size classes and between different types of financial crises as well as the contrast with normal times is important. Specifically, we find that higher capital seems to unambiguously benefit small banks in all circumstances. It enhances their survival probability and market share during banking crises, market crises, and normal times, whether the individual episodes are grouped together or considered one at a time. Capital helps medium and large banks largely during banking crises, but these results are more circumstance-dependent. Our interpretation is that size could be a source of economic strength for a bank, just like capital, and that each has diminishing marginal value. Hence, capital offers the greatest benefit to small banks, which could be viewed as being endangered at all times, while medium and large banks are challenged mainly during banking crises. This is consistent with the fact that small banks have steadily lost market share to medium and large banks and survived less often since the mid-1980s.

The remainder of this paper is organized as follows. Section 2 develops the empirical hypotheses. Section 3 explains our approach, discusses the financial crises and normal times, describes the variables and the sample, and provides summary statistics. Section 4 discusses the main results based on grouping banking crises, grouping market crises, and grouping normal times. Section 5 includes the robustness tests. Section 6 revisits the main results and robustness checks by analyzing individual crises. Section 7 examines three channels through which capital could affect performance. Section 8 contains the additional analyses. Section 9 concludes.

2. Development of the empirical hypotheses

In this section, we review existing theories to formulate our empirical hypotheses about the effects of bank capital on the survival probability and market share of banks during crises and normal times.

2.1. Survival

Hypothesis 1. Capital enhances the bank's survival probability during financial crises and normal times.

Many theories suggest that capital improves a bank's survival probability. First, one set of theories emphasizes the role of capital as a buffer to absorb shocks to earnings (e.g., Repullo, 2004; Von Thadden, 2004). While various theories suggest that the bank's portfolio, screening, and monitoring choices are influenced by the bank's capital structure, if they are held fixed, then this buffer role immediately implies that higher capital increases the survival probability. This is the mechanical effect of higher capital. Second, another set of theories focuses on the incentive effects of capital. This includes theories based on screening, monitoring, and asset-substitution moral hazard. In the screening-based theory of Coval and Thakor (2005), a minimum amount of capital is essential to the very viability of the bank. The monitoring-based papers include Holmstrom and Tirole (1997), Allen, Carletti, and Marquez (2011), and Mehran and Thakor (2011). A key result in these papers is that higher bank capital induces higher levels of borrower monitoring by the bank, thereby reducing the probability of default or otherwise improving the bank's survival odds indirectly by increasing the surplus generated by the bank–borrower relation. The asset-substitution moral hazard theories argue that capital attenuates the excessive risk-taking incentives induced by limited liability and government protection, and that banks with more capital optimally choose less risky portfolios (e.g., Freixas and Rochet, 2008; Acharya, Mehran, and Thakor, 2011). Similarly, if the bank insiders in Calomiris and Kahn (1991) had more equity capital in the bank, their project-choice incentives would improve and a depositor-initiated run would be less likely, thereby promoting stability.

Some theories seem to suggest that Hypothesis 1 might not hold. Koehn and Santomero (1980) and Calem and Rob (1999) suggest that banks could increase their portfolio risk when capital is sufficiently high such that their overall risk of failure is increased. Besanko and Kanatas (1996) argue that higher capital may hurt bank safety because the benefit of reduced asset-substitution moral hazard could be more than offset by the cost of lower effort exerted by insiders whose ownership could be diluted at higher capital.[4] On balance, however, we believe that most theories, especially the more recent ones, predict that capital positively affects bank survival.

[4] One might argue that Diamond and Rajan (2001) also imply that higher capital could hurt bank survival. They argue that capital weakens the bank's incentive to collect repayments from borrowers, thereby reducing loan liquidity. This suggests that if an interim liquidity shock hits, more highly-levered banks could be more likely to survive because they can counter such shocks more effectively through asset sales. Diamond and Rajan (2000) have a similar model with the possibility of bankruptcy for the bank, and in that model, capital increases the bank's chances of survival.

These papers do not focus on financial crises per se, but do consider the possibility of bank failure.[5] However, because a bank's likelihood of survival is lower during a crisis, it follows that the effect of capital on survival could be even stronger during a crisis, particularly in light of regulatory discretion in closing banks, forcing them into assisted M&As, or otherwise resolving problem institutions based on their capital ratios.[6]

Bank survival could also be affected by deposit insurance. On the one hand, deposit insurance is a subsidy to banks that could help them survive because it enables them to raise funds at close to the risk-free rate and improve profitability. It also deters bank runs (Diamond and Dybvig, 1983).[7] On the other hand, deposit insurance is a put option, so that banks with such insurance have moral-hazard incentives to maximize asset volatility (Merton, 1977).[8] While one might argue that the effect of capital on survival is likely to be stronger in the absence of deposit insurance, it is nonetheless a fact that deposit insurance is incomplete (banks rely on significant amounts of uninsured debt) and failure is a possibility for virtually any bank (except those considered too-big-to-fail) despite deposit insurance and other de facto regulatory protection. As Farhi and Tirole (2012) argue, safety nets can perversely induce correlated behavior by banks that increases systemic risk. Ruckes (2004) suggests that deposit insurance results in lax screening and lower credit standards during economic booms. Thus, the role of bank capital in impinging on the probability of a bank's survival remains even with deposit insurance.

The empirical literature on bank failure focuses primarily on banking crises during which many banks failed. Studies of the early 1990s credit crunch generally find that higher capital was associated with a lower probability of failure (e.g., Cole and Gunther, 1995; Estrella, Park, and Peristiani, 2000; Wheelock and Wilson, 2000). These papers differ from ours in numerous ways. First, they focus on only one banking crisis, whereas we consider multiple banking crises, market crises, and normal times. Second, they do not address endogeneity concerns. Third, they do not examine the effect of capital on market share. Fourth, they do not split banks into different size categories, and hence, their results should be viewed as small-bank results because of the preponderance of small banks. A few papers have focused on the recent subprime lending crisis. Cole and White (2012) use proxies for the CAMELS components and other factors to explain bank failures during 2009.[9] They find that capital is one of the factors explaining failure. Berger, Imbierowicz, and Rauch (2012) focus on the role of corporate governance on bank failures during the subprime lending crisis, but they also find that capital reduces the probability of default. These papers, like the credit crunch papers, also focus on only one crisis and, therefore, lack the comprehensive multiple-crises analysis that is our central focus, and they do not split banks into size classes either. Beltratti and Stulz (2012) examine what explains bank performance during the recent subprime lending crisis and find that capital is one of the determinants. Fahlenbrach, Prilmeier, and Stulz (2012) show that banks with higher market leverage and poorer stock performance during the Russian debt crisis had worse stock returns during the subprime lending crisis. However, these two papers use samples of large publicly-traded banks instead of using banks of all sizes and ownership status as we do, examine one or two crises instead of five crises, and focus on stock performance instead of survival and market share.

2.2. Market share

Hypothesis 2. Capital enhances the bank's market share during financial crises and normal times.

The theories on the effect of capital on market share have differing predictions. In Holmstrom and Tirole (1997), Allen and Gale (2004), Boot and Marinc (2008), Allen, Carletti, and Marquez (2011), and Mehran and Thakor (2011), banks derive a competitive advantage from higher capital. These papers imply that higher-capital banks end up with higher market shares. This prediction also has some empirical support. Calomiris and Powell (2001) and Calomiris and Mason (2003) find that capital affected deposit supply positively in Argentina in the 1990s and during the Great Depression, respectively. Calomiris and Wilson (2004) study New York banks during the 1920s and 1930s, and they find that higher-capital banks were able to compete more effectively for risky loans.

A literature that focuses on the relation between leverage and market share for nonfinancial firms (e.g., Brander and Lewis, 1986; Lyandres, 2006) suggests that Hypothesis 2 might not hold. This literature shows that more highly-levered firms are more aggressive in their product-market-expansion strategies and, hence, suggests that capital and market share are negatively correlated.

Deposit insurance could also be a mediating variable in the effect of capital on market share. Several theories

[5] Morrison and White (2005) is an exception. Studying both adverse selection and moral hazard, they show that regulators' optimal response to crises of confidence could be to tighten capital requirements.

[6] The benefits of higher capital could be weaker if regulators delay closure of troubled banks because of regulatory career concerns (Boot and Thakor, 1993) or because regulators perceive a high value associated with avoiding failure as, for example, happened during the recent subprime lending crisis (Veronesi and Zingales, 2010).

[7] Allen, Carletti, and Leonello (2011) emphasize that deposit insurance is effective in preventing bank runs only if it is fully credible, and that this might not hold during a crisis. Hellmann, Murdock, and Stiglitz (2000) argue that it makes little difference whether a formal deposit-insurance system exists, because banks tend to be bailed out in the event of a crisis.

[8] However, adding random audits, auditing costs, and upfront payment for the full cost of deposit insurance, Merton (1978) shows that banks will not always maximize asset volatility. Gropp, Gruendl, and Guettler (2010) show empirically that banks with government protection take more risk, consistent with the moral hazard theory of deposit insurance (see also Carletti, 2008).

[9] CAMELS is an acronym for Capital adequacy, Asset quality, Management, Earnings, Liquidity and Sensitivity to market risk, that is used by bank supervisors to rate banks during on-site examinations.

suggest that deposit insurance intensifies competition for deposits (e.g., Matutes and Vives, 1996; Hakenes and Schnabel, 2010). In such a setting, capital would still be of importance, however, especially for raising uninsured deposits and subordinated debt, both of which could affect the bank's market share.

These theories do not focus on crises, so the predictions about the effect of capital on market share should be viewed as applying during normal times. However, the competitive advantage of capital is likely to be more pronounced during financial crises, particularly banking crises, for several reasons. First, the bank's customers are likely to be more sensitive to the bank's capital during a crisis, making it easier for better-capitalized banks to take customers away from lesser-capitalized peers. Second, banks with more capital could have greater flexibility to make certain types of loans that may be unavailable to lower-capital banks because of regulatory and market constraints during crises. Third, banking crises are generally associated with numerous bank failures and near failures. Failing and near-failing banks tend to be bought by competitors, and such M&As have to be approved by bank regulators. Because regulatory approval depends in part on the acquiring bank's capital, banks with higher capital ratios are better positioned to buy their troubled brethren and, hence, improve their market shares.

3. Methodology, variables, and data

This section first explains our empirical approach, describes the financial crises and normal times, and details the performance measures. Next, it discusses the key exogenous variables and the control variables. Finally, it describes the sample and provides summary statistics.

Empirically, we examine the effect of capital (and other bank conditions) measured prior to a crisis on bank performance during a crisis. We measure capital before a crisis for two reasons. First, because it is not known a priori when a crisis will strike, the interesting question is whether banks that have higher capital going into a crisis benefit from these higher capital ratios during a crisis. Second, this approach mitigates endogeneity concerns because lagged capital and current performance are less likely to be jointly determined.

3.1. Empirical approach and description of financial crises and normal times

Our analyses focus on crises that occurred between 1984:Q1 and 2010:Q4. They include two banking crises (crises that originated in the banking sector) and three market crises (crises that originated outside banking in the financial markets). The banking crises are the credit crunch of the early 1990s (1990:Q1–1992:Q4) and the recent subprime lending crisis (2007:Q3–2009:Q4). The market crises are the 1987 stock market crash (1987:Q4); the Russian debt crisis and Long-Term Capital Management (LTCM) bailout of 1998 (1998:Q3–1998:Q4); and the bursting of the dot.com bubble and the September 11 terrorist attacks of the early 2000s (2000:Q2–2002:Q3). The Appendix describes these crises in detail.

Our hypotheses focus on the effect of a bank's precrisis capital on its performance during a crisis. A key issue is how to measure precrisis capital. In our main analyses, we average each bank's capital ratio over the eight quarters before the crisis to reduce the impact of outliers. In robustness checks, we alternatively define the precrisis period as the four quarters before a crisis or the quarter before a crisis, and the results are robust (see Section 5.4). Our survival and market share analyses then link this average precrisis capital to whether a bank survived a crisis and the bank's change in market share (defined below).

While we highlight above how we examine the effect of precrisis capital on bank performance during a crisis, we still have to address how we measure normal times. A naïve approach would be to simply view all noncrisis quarters as such. However, if so, it is not clear then how to examine the effect of pre-normal times capital on bank performance during normal times. To ensure that we analyze actual crises and normal times in a comparable way, we create "fake" crises to represent normal times. To construct these fake crises, we use the two longest time periods between actual financial crises over our entire sample period. These periods are between the credit crunch and the Russian debt crisis, and between the bursting of the dot.com bubble and the subprime lending crisis. In each case, we designate the first eight quarters between two crises as "pre-fake crisis" and the last eight quarters as "post-fake crisis" and the remaining quarters in the middle as the fake crisis. This treatment of the first eight quarters as precrisis is consistent with our analysis of the banking and market crises. We thus end up with a six-quarter fake crisis period between the credit crunch and the Russian debt crisis (from 1995:Q1 to 1996:Q2) and a three-quarter fake crisis period between the dot.com bubble and the subprime lending crisis (from 2004:Q4 to 2005:Q2).[10] A timeline of the banking crises, market crises, and normal times is shown in Fig. 1.[11]

Our main approach pools the data to treat banking crises as a group, market crises as a group, and normal times as a group. We discuss the methodology for this approach here. In Section 6, we examine each crisis and normal times individually.

Because we have two banking crises, three market crises, and two normal time periods (the fake crises), we have up to seven observations per bank. Using these data, we run the following logit survival regressions and ordinary least squares (OLS) market share

[10] Results are qualitatively similar if we instead use five- or four-quarter crisis periods for the first fake crisis, and two- or one-quarter crisis periods for the second fake crisis (not shown for brevity).

[11] One precrisis period contains an earlier crisis. The period that precedes the third market crisis (bursting of the dot.com bubble) contains the second market crisis (Russian debt crisis). Importantly, we perform two robustness checks in which the precrisis periods are shortened to one and four quarters (see Section 5.4). No overlap exists in these robustness checks. We find results that are similar to the main results.

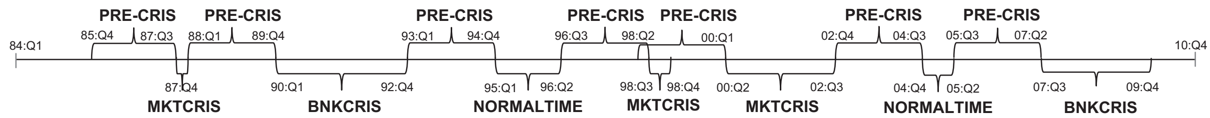

Fig. 1. Timeline. This figure shows the banking crises (BNKCRIS), market crises (MKTCRIS), and normal times (NORMALTIME) that occurred during our sample period from 1984:Q1 until 2010:Q4. It also shows the eight-quarter precrisis periods (PRE-CRIS).

regressions:

$$SURVIVAL_{i,t} = log\left(\frac{Prob(SURV_{i,t})}{1-Prob(SURV_{i,t})}\right) = \alpha_1 + \alpha_2 * EQRAT_{i,pre-t}*BNKCRIS_t + \alpha_3 * EQRAT_{i,pre-t}*MKTCRIS_t + \alpha_4 * EQRAT_{i,pre-t}*NORMALTIME_t + A_1 * X_{i,pre-t} \quad (1)$$

and

$$\%\Delta MKTSHARE_{i,t} = \beta_1 + \beta_2 * EQRAT_{i,pre-t}*BNKCRIS_t + \beta_3 * EQRAT_{i,pre-t}*MKTCRIS_t + \beta_4 * EQRAT_{i,pre-t}*NORMALTIME_t + B_1 * Y_{i,pre-t} \quad (2)$$

where $SURV_{i,t}$ measures whether bank i survived crisis or normal time period t, $t \in \{1,2,3,4,5,6,7\}$. Specifically, *SURV* is a dummy that equals one if the bank is in the sample one quarter before a crisis started and is still in the sample one quarter after the crisis, and zero otherwise.[12] Banks that were merged within a bank holding company are not classified as non-survivors because it unclear whether these consolidations occur because these banks are troubled or not. $\%\Delta MKTSHARE_{i,t}$ is the percentage change in bank i's market share of aggregate gross total assets (GTA). GTA is a traditional measure of size that focuses on the bank's on-balance-sheet activities.[13] Market share is calculated as the bank's GTA divided by the industry's GTA. Market shares are not merger-adjusted because M&As are a key way for banks to increase their market shares. In our analysis, a bank's market share rises if it acquires another bank. Merger-adjusting market shares would take out this effect. To establish whether banks improve their competitive positions during banking crises, market crises, and normal times, we define each bank's percentage change in market share, *%ΔMKTSHARE*, as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, normalized by its average precrisis market share and multiplied by one hundred. To mitigate the influence of outliers, this variable is winsorized at the 3% level. $EQRAT_{i,pre-t}$ is the bank's capital ratio, measured as the ratio of equity capital to GTA, averaged over the eight quarters before crisis or normal time period t. $CRISBNK_t$, $CRISMKT_t$, and $NORMALTIME_t$ are dummy variables that equal one if t is a banking crisis, market crisis, or normal time period, respectively, and zero otherwise. This approach allows us to contrast the effect of capital during banking, market crises, and normal times. $X_{i,pre-t}$ and $Y_{i,pre-t}$ are sets of control variables measured over the precrisis period (see Section 3.2).

Because each bank enters up to seven times in these regressions, all regressions are estimated with robust standard errors, clustered by bank, to control for heteroskedasticity as well as possible correlation between observations of the same bank in different years. The regressions also include individual crisis and normal times dummies, which act as time fixed effects.

The literature documents differences by bank size in terms of portfolio composition (e.g., Kashyap, Rajan, and Stein, 2002; Berger, Miller, Petersen, Rajan, and Stein, 2005). As in Berger and Bouwman (2009), we split the sample into small banks (GTA up to \$1 billion), medium banks (GTA exceeding \$1 billion and up to \$3 billion), and large banks (GTA exceeding \$3 billion), and run all regressions separately for these three sets of banks. Our definition of small banks conforms to the usual notion of community banks. The \$3 billion cutoff for GTA divides the remaining observations roughly in half.

3.2. Control variables

To avoid a potential omitted variables problem, the survival regressions contain a broad set of control variables *X*, which includes proxies for risk and opacity, size and safety net protection, ownership, organizational structure and strategy, competition, location, and profitability. The market share regressions contain a set of controls *Y*, which excludes profitability from *X*. We discuss the control variables in turn. Each variable is averaged over the eight-quarter precrisis period, except when noted otherwise.

3.2.1. Risk and opacity

Banks with riskier and more opaque portfolios could be less likely to survive (e.g., Ng and Rusticus, 2011), and could also find it harder to improve their market shares. We include the following proxies.

CREDIT_RISK: Credit risk, defined as the bank's Basel I risk-weighted assets divided by GTA, is used as a measure of bank risk taking (e.g., Logan, 2001; Berger, Bouwman, Kick, and Schaeck, 2012). Risk-weighted assets, a weighted

[12] We obtain similar results if we use a slightly longer time window and require that the bank is still in the sample four quarters after the crisis (not shown for brevity).

[13] A potential shortcoming of this measure is that it treats all assets identically, neglecting the qualitative asset transformation nature of the bank's activities (e.g., Bhattacharya and Thakor, 1993), and ignoring off-balance sheet activities (e.g., Boot, Greenbaum, and Thakor, 1993; Holmstrom and Tirole, 1997; Kashyap, Rajan, and Stein, 2002). Alternatively, we measure a bank's competitive position as the bank's market share of overall bank liquidity creation, where the amount of liquidity created by each bank is calculated using the Berger and Bouwman (2009) preferred liquidity creation measure, and obtain similar results (not shown for brevity). The advantage of using liquidity creation as a measure of bank output is that it is based on all the bank's on- and off-balance-sheet activities. Drawbacks of this approach are that its conclusions are sensitive to the manner in which we define liquidity creation as well as the assignments of weights to the various components of liquidity creation.

sum of the bank's assets and off-balance-sheet activities designed to measure credit risk, is the denominator in the Basel I risk-based capital requirements. Because these requirements became effective only in December 1990 and were reported in Call Reports only from that moment onward, we use a Federal Reserve Board program to construct risk-weighted assets from the beginning of our sample period.

LOAN_CONCENTRATION: A bank's loan portfolio concentration is measured as a Herfindahl-Hirschman Index (HHI) of the following six loan categories: commercial real estate, residential real estate, construction and industrial, consumer, agriculture, and other. The larger is the HHI, the more concentrated (and potentially risky) is the loan portfolio.

COMMERCIAL_REAL_ESTATE: Commercial real estate development involves long gestation periods, cyclicality, and high leverage. Cole and White (2012) find that commercial real estate is an important determinant of bank failure during the recent crisis. We therefore include commercial real estate divided by GTA.

BROKERED_DEPOSITS: Instead of attracting deposits from local customers, banks can obtain large deposits from deposit brokers. Such deposits are expensive, and the funds are typically invested in high-risk activities to cover the high interest costs.[14] Brokered deposits are often used to grow quickly. Rossi (2010) suggests that brokered deposits do not directly explain bank failure, but Federal Deposit Insurance Corporation (2011) and Cole and White (2012) suggest otherwise. We include brokered deposits divided by GTA.

TRADING_ASSETS: Trading assets are assets held for resale. While these assets are transparent and liquid, trading positions are easy to change, which makes them hard to monitor. Trading has therefore been called banks' "dark side" of liquidity (e.g., Myers and Rajan, 1998; Morgan, 2002). To capture its effect, we add trading assets divided by GTA to the regressions.

CASH_HOLDINGS: Cash and marketable securities are the most liquid assets. High cash holding can reduce liquidity risk for banks and could help them survive, but they can also be associated with agency problems (Jensen, 1986). We include cash plus marketable securities divided by GTA.

3.2.2. Size and safety net protection

SIZE: Bank size is controlled for by including the log of GTA. In addition, we run regressions separately for small, medium, and large banks. Bank size is expected to have a positive effect on the probability of survival, because it is well-known that larger banks have higher survival odds than smaller banks. In contrast, the coefficient on bank size is expected to be negative for all size classes in the market share regressions, because the law of diminishing marginal returns suggests that it is more difficult for bigger banks (that already have larger market shares) to improve their market shares.

CORE_DEPOSITS: Core deposits are considered to be a stable source of funding. For that reason, banks that rely more on core deposits could be more likely to survive. However, as highlighted in Section 2, deposit insurance associated with core deposits could cause additional risk taking due to an enhanced moral hazard incentive (e.g., Carletti, 2008; Gropp, Gruendl, and Guettler, 2010) and due to increased competition for deposits (Matutes and Vives, 1996; Hakenes and Schnabel, 2010). We therefore calculate the amount of each bank's core deposits using the Uniform Bank Performance Report (UBPR) definition as the sum of transaction deposits, savings deposits, and small (denominations less than $100,000) time deposits.[15] We include core deposits divided by GTA.

SUPERVISOR: To capture potential differences in the quality of oversight and leniency of supervisors, we create three supervisory dummies: SUPERVISOR_OCC (for national banks), SUPERVISOR_FED (for state banks that are members of the Federal Reserve System), and SUPERVISOR_FDIC (for state nonmember banks). We include only the latter two in the regressions to avoid collinearity.

3.2.3. Ownership

BHC_MEMBER: To control for bank holding company (BHC) status, we include a dummy variable that equals one if the bank was part of a bank holding company at any time in the eight quarters preceding the crisis, and zero otherwise. BHC membership is expected to help a bank survive and strengthen its competitive position because the holding company is required to act as a source of strength to all the banks it owns, and may also inject equity voluntarily when needed. Houston, James, and Marcus (1997) find that bank loan growth depends on BHC membership.

BLOCK_OWNERSHIP: Institutional block owners have incentives to monitor management and seem to positively affect the actions of firms in which they own a stake (e.g., McConnell and Servaes, 1990; Gillan and Starks, 2000). In banks, however, while evidence is scarce, higher institutional ownership seems to be associated with greater risk taking (e.g., Mehran, Morrison, and Shapiro, 2011). We obtain data on institutional ownership of the bank's highest holder from the 13-F filings from Thomson Financial. We add up the ownership stakes of blockholders (i.e., ownership positions of at least 5%) and assign it to each bank owned by that high holder. Block ownership is zero for the vast majority of banks because they are not publicly traded.

FOREIGN_OWNERSHIP: In emerging markets, foreign banks tend to be associated with improved performance and increased stability of the banking sector, in part because they reduce problems of related lending (Giannetti and

[14] A statute governing brokered deposits was enacted in 1989. According to Section 29 of the Federal Deposit Insurance Act: well capitalized banks may accept and offer rates on brokered deposits without restriction; adequately capitalized banks are allowed to pay for brokered deposits up to 75 basis points over the average interest rate paid for the deposits in the bank's normal market area; and undercapitalized banks are not allowed to accept brokered deposits.

[15] This definition was in place over our entire sample period. As of March 31, 2011, the definition was revised to reflect the Federal Deposit Insurance Corporation's deposit insurance increase from $100,000 to $250,000.

Ongena, 2009). In contrast, Berger, DeYoung, Genay, and Udell (2000) find that foreign banks are generally less efficient than domestic banks in the US. We therefore include the percentage of foreign ownership.

3.2.4. Organizational structure and strategy

Stein (2002) argues that centralized organizations are complex and tend to rely on hard information, and that decentralized organizations are less complex and rely more on soft information. This suggests that, in addition to bank size, organizational structure and various aspects of distance could affect performance. While we cannot measure the geographic distance between each bank and its customers (as do Degryse and Ongena, 2005, 2007; Bharath, Dahiya, Saunders, and Srinivasan, 2007; Degryse, Laeven, and Ongena, 2009), we can create variables that capture other dimensions of distance.

HQ_DEPOSITS: The fraction of deposits in a bank's headquarters (defined as the office with the highest amount of deposits) is a measure of bank centrality. Banks that are more centralized are less complex and have shorter communication lines, which could affect performance.

BRANCHES / ASSETS: Banks that have more branches per dollar of assets are more complex.

NR_STATES: Banks that are active in multiple states have more complex organizational structures that cover longer distances. We include the log of the number of states in which the bank has branches.

3.2.5. Competition

While some theories suggest that increased competition reduces franchise value and increases the likelihood of failure (e.g., Keeley, 1990), others argue it induces banks to take less risk and reduces the likelihood of failure (e.g., Boyd and De Nicolo, 2005), and Martinez-Miera and Repullo (2010) suggest the relation may be U-shaped. The empirical literature also finds that competition affects banks' market shares, their ability to survive, and the stability of the banking sector (e.g., Beck, Demirguc-Kunt, and Levine, 2006; Beck, 2008).

LOCAL_MKT_POWER: We control for local market power by including the bank-level Herfindahl-Hirschman Index (HHI) of deposit concentration for the local markets in which the bank is present.[16] From 1984 to 2004, we define the local market as the Metropolitan Statistical Area (MSA) or non-MSA county in which the offices are located. After 2004, we use the new local market definitions based on Core Based Statistical Area (CBSA) and non-CBSA county.[17] The larger is HHI, the greater is a bank's market power.

MULTI_MKT_CONTACT: Banks that operate in multiple markets interact with other multi-market banks in different markets. While some theories argue that multi-market contact facilitates collusion (e.g., Bernheim and Whinston, 1990), others suggest that it promotes local competition (e.g., Mester, 1987). To capture its effect, we follow Evans and Kessides (1994), Degryse and Ongena (2007), and Degryse, Laeven, and Ongena (2009) and construct a (market-level) multi-market contact measure as the actual market overlap of all bank pairs divided by the maximum possible overlap.[18] Because our unit of observation is a bank, we calculate bank-level multi-market contact by deposit-weighting each market-level multi-market contact and summing over all the bank's markets.

3.2.6. Location

METRO_MKTS: Competition may be fiercer in metropolitan areas. The number of metropolitan markets (MSAs and CBSAs) as a fraction of all markets in which a bank is active is therefore included in the regressions.

HOUSE_PRICE_INDEX_GROWTH: While in the mid-1980s only 20% of bank assets were exposed to real estate, by 2008 that exposure had more than doubled (Krainer, 2009). Because real estate is used as collateral, changes in real estate prices could affect bank performance. To measure its impact, we obtain two state-level House Price Indices (HPIs) from the Federal Housing Finance Agency: a "purchase only" index (based on purchases) and an "all transactions" index (based on purchases and appraisals).[19] Because bank behavior is affected by purchases, not mere appraisals, the purchase only index is most appropriate for our purpose, but is available only from 1991 onward. For each state, we therefore create an index using all transactions data until 1990 and purchase only data from 1991 onward. For each bank, house price index growth is then calculated as the growth in a state-level HPI times the fraction of the bank's deposits in that state, summed across all states.

[16] While our focus is on the change in banks' competitive positions measured in terms of their GTA market shares, we control for local market power measured as the bank-level HHI based on local market deposit shares. This is a standard measure of competition used in antitrust analysis and research in the US. Deposits are used for this purpose because it is the only variable for which location is known.

[17] When appropriate, we use New England County Metropolitan Areas (NECMAs) instead of MSAs. CBSA collectively refers to Metropolitan Statistical Areas and newly-created Micropolitan Statistical Areas. Areas based on these new standards were announced in June 2003. For recent years, the Summary of Deposits data needed to construct HHI are available on the Federal Deposit Insurance Corporation's website based only on the new definition. It is not possible to use the new definition for our entire sample period.

[18] To illustrate, suppose there are three banks (A, B, and C) and four markets (1, 2, 3, and 4). Suppose bank A is active in markets 1, 2, 3, and 4; B is active in 1 and 2; and C in 1. In market 1, the actual overlap equals the overlaps of $A\&B+A\&C+B\&C=2+1+1=4$, and the maximum overlap equals (number of markets $*$ number of banks in the market $*$ number of banks in the market minus 1)/2$=4*3*(3-1)/2=12$. Market 1's multi-market contact then equals $4/12=0.33$ (there are three banks in market 1 and they overlap in 1/3 of all markets). Similarly, in market 2, the actual overlap equals the overlap of $A\&B=2$, and the maximum overlap equals $3*2*(2-1)/2=4$, yielding a multi-market contact of $2/4=0.5$ (there are two banks in market 2 and they overlap in half of all markets). In markets 3 and 4, the actual overlap is zero because only one bank is active in each of these two markets, and the multi-market contact therefore equals zero.

[19] These HPIs are based on conforming single-family properties purchased or securitized by the Federal National Mortgage Association (Fannie Mae) or the Federal Home Loan Mortgage Corporation (Freddie Mac). The S&P/Case-Shiller National Home Price Index cannot be used for our purposes because of its more limited geographic reach. It does not have valuation data from thirteen states.

3.2.7. Profitability

ROE: The survival regressions also include a measure of profitability because banks that are more profitable before the crisis could be more likely to survive crises. We use a bank's return on equity (ROE), net income divided by stockholders equity, for this purpose. ROE is a comprehensive profitability measure, because banks must allocate capital against every off-balance sheet activity in which they engage. Hence, net income and equity both reflect the bank's on- and off-balance-sheet activities. We obtain similar results when return on assets (ROA) is used instead (not shown for brevity).

3.3. Sample and summary statistics

For every bank in the US, we obtain quarterly Call Report data from 1984:Q1 to 2010:Q4. We keep a bank-quarter in the sample if the bank: has commercial real estate or commercial and industrial loans outstanding; has deposits; and has gross total assets exceeding $25 million.

Table 1, Panel A, contains summary statistics on all regression variables for the three bank size categories (small, medium, and large) and for banking crises, market crises, and normal times. All financial values are put into real 2010:Q4 dollars [using the implicit gross domestic product (GDP) price deflator] before size classes are constructed. The sample includes 57,243 small-bank, 1,946 medium-bank, and 1,400 large-bank observations.

Table 1, Panel B, shows some additional summary statistics on bank capital, our key variable of interest, to illuminate the determinants of cross-sectional heterogeneity in capital ratios. Specifically, we take some of the key variables from Panel A and split banks (by size class and time period) into two groups on the basis of the value of that variable to examine how capital differs across these two groups. Not surprisingly, within each size class, bigger banks (above median SIZE) operate with less capital. While riskier (above median CREDIT_RISK or LOAN_CONCENTRATION) medium and large banks hold more capital than their less risky counterparts, this is surprisingly not true for small banks. Within each size class, banks that are part of a BHC (BHC_MEMBER=yes) operate with far less capital than those that are not, which reflects the fact that these banks have the option to raise additional capital from their parent if needed. Within each size class, banks with institutional block ownership (positive BLOCK_OWNERSHIP) and high multi-market contact (above median MULTI_MKT_CONTACT) operate with less capital, while those that are more centralized (above median HQ_DEPOSITS) hold more capital. While these are merely summary statistics, and identifying the determinants of capital is not our main goal, these patterns are nonetheless interesting and shed light on why banks display nontrivial heterogeneity in capital ratios, a fact that is important for understanding how differences in capital drive differences in bank performance.

4. Main regression results based on grouping banking crises, market crises, and normal times

In this section, we discuss the main results based on grouping banking crises, market crises, and normal times. We first examine the effect of capital on survival and then analyze its effect on market share.

4.1. Does capital affect the bank's ability to survive during crises and normal times?

Before presenting the survival results, it is important to discuss a methodological issue related to the main variables of interest in our logit regressions being interaction terms. In linear regressions, any interaction effect is fully captured by the coefficient on the interaction term. This does not hold in nonlinear models as emphasized by Norton, Wang, and Ai (2004) and Powers (2005). Strikingly, to evaluate an interaction effect in a nonlinear model, one cannot look at the sign, magnitude, or significance of the coefficient on the interaction term. In our logit model of survival, the effects of capital during banking crises, market crises, and normal times depend not just on the interaction terms but also on the other coefficients and the values of explanatory variables at which they are evaluated. To ensure our inferences are correct, we use the Norton, Wang, and Ai (2004) methodology to calculate the correct marginal effects and t-statistics.[20]

Table 2 presents the survival findings for small, medium, and large banks. Panel A contains the regression parameters. The coefficients on the capital–crisis interaction terms should be ignored in this panel. Panel B shows the marginal effects of the main variables of interest.

Two main results are apparent. First, higher capital helps small banks to improve their odds of survival at all times (during banking crises, market crises, and normal times). Second, higher capital helps medium and large banks improve the probability of surviving banking crises (significant for large banks). These results generally support the hypothesis that capital helps banks survive.

These findings have sensible economic interpretations. Capital is the main line of defense against negative shocks. For small banks, capital is important at all times, because they face shocks more often than medium and large banks, and they have limited (and relatively costly) access to the financial market in the event of unanticipated needs.[21] In fact, the number of small banks has been dwindling since the mid-1980s. Hence, higher capital enhances the probability of survival for such banks at all times. This finding is consistent with the theoretical papers that predict that higher capital increases a bank's survival

[20] Instead of using their proposed Stata "inteff" command, which can handle only one interaction term, we used the more flexible "margins" command. We thank Maarten Buis for help with this issue.

[21] The regulatory environment forms another impediment: because any bank with more than five hundred shareholders is required to register with the Securities and Exchange Commission (SEC), many small banks carefully maintain their shareholder base below this number because they want to avoid the costs and hassle of registering. The JOBS Act signed into law in April 2012 relaxes this constraint by increasing the threshold at which small banks have to register with the SEC from five hundred to two thousand shareholders. See Wall Street Journal (2012).

Table 1
Summary statistics.

Panel A contains means and standard deviations (in square brackets) on all the regression variables used to examine the effect of precrisis capital ratios on banks' ability to survive crises and increase their market shares during such crises. We distinguish between banking crises (the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (see Section 3.1). Panel B contains additional summary statistics on banks' precrisis capital ratios before banking crises, market crises, and normal times.

Summary statistics are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion). GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

SURVIVAL is a dummy that equals one if the bank is in the sample one quarter before such a crisis started and is still in the sample one quarter after the crisis, and zero otherwise. %ΔMKTSHARE, the percentage change in the bank's GTA market share, is measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred.

All independent variables are measured as averages over the eight quarters prior to a crisis (except as noted). EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. CREDIT_RISK is credit risk, defined as the bank's Basel I risk-weighted assets divided by GTA. LOAN_CONCENTRATION is a loan portfolio concentration Herfindahl-Hirschman Index. COMMERCIAL_REAL_ESTATE is commercial real estate divided by GTA. BROKERED-DEPOSITS is brokered deposits divided by GTA. TRADING_ASSETS is trading assets divided by GTA. CASH_HOLDINGS is cash and marketable securities divided by GTA. SIZE is the log of GTA. CORE_DEPOSITS is the sum of transaction deposits, savings deposits, and small time deposits divided by GTA. SUPERVISOR_FED and SUPERVISOR_FDIC are dummies that equal one if the Federal Reserve and the Federal Deposit Insurance Corporation are the primary supervisor of the bank, respectively; both dummies are used in regressions (left out category: SUPERVISOR_OCC, the Office of the Comptroller of the Currency is the primary supervisor). BHC_MEMBER is a dummy variable that equals one if the bank has been part of a bank holding company over the eight quarters before the crisis. BLOCK_OWNERSHIP is the combined ownership of all institutional blockholders. FOREIGN_OWNERSHIP is the combined ownership stake of all foreign owners. HQ_DEPOSITS is the fraction of deposits in the bank's main office. BRANCHES / ASSETS is the number of branches per dollar of assets. NR_STATES is the log of the number of states in which the bank has branches. LOCAL_MKT_POWER is a bank-level Herfindahl-Hirschman Index based on bank deposits (the only variable for which geographic location is publicly available). We first establish the Herfindahl-Hirschman Index of the local markets in which the bank has deposits and then weight these market indices by the proportion of the bank's deposits in each of these markets. MULTI_MKT_CONTACT is a measure of the degree to which a bank interacts with other banks in different markets. METRO_MKTS is the number of metropolitan markets (as a fraction of all markets) in which a bank is active. HOUSE_PRICE_INDEX_GROWTH is a (deposit-weighted) measure of the growth in house prices in the states in which the bank operates. PROFITABILITY is return on equity, measured as net income divided by equity capital. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

Panel A: Summary statistics on the regression variables

	Banking crises			Market crises			Normal times		
Variables	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks
Dependent variables									
SURVIVAL	0.949	0.884	0.917	0.984	0.965	0.977	0.978	0.968	0.983
	[0.220]	[0.321]	[0.275]	[0.127]	[0.184]	[0.149]	[0.147]	[0.175]	[0.129]
%ΔMKTSHARE	0.052	0.051	0.065	0.039	0.114	0.111	0.012	0.072	0.085
	[0.191]	[0.183]	[0.204]	[0.156]	[0.192]	[0.196]	[0.157]	[0.188]	[0.198]
Main independent variable									
EQRAT	0.100	0.088	0.083	0.097	0.084	0.076	0.101	0.093	0.089
	[0.051]	[0.045]	[0.044]	[0.038]	[0.040]	[0.028]	[0.035]	[0.044]	[0.037]
Control variables									
Risk and opacity									
CREDIT_RISK	0.633	0.745	0.799	0.607	0.686	0.767	0.614	0.679	0.709
	[0.135]	[0.144]	[0.176]	[0.118]	[0.137]	[0.178]	[0.131]	[0.164]	[0.168]
LOAN_CONCENTRATION	0.131	0.193	0.163	0.112	0.151	0.147	0.129	0.169	0.153
	[0.098]	[0.127]	[0.129]	[0.076]	[0.114]	[0.132]	[0.089]	[0.120]	[0.148]
COMMERCIAL_REAL_ESTATE	0.178	0.264	0.185	0.138	0.166	0.113	0.181	0.222	0.147
	[0.139]	[0.170]	[0.148]	[0.095]	[0.118]	[0.077]	[0.123]	[0.151]	[0.118]
BROKERED_DEPOSITS	0.013	0.032	0.044	0.004	0.010	0.020	0.008	0.019	0.028
	[0.047]	[0.076]	[0.109]	[0.024]	[0.042]	[0.053]	[0.035]	[0.059]	[0.082]
TRADING_ASSETS	0.001	0.002	0.009	0.000	0.001	0.009	0.000	0.001	0.012
	[0.007]	[0.023]	[0.039]	[0.006]	[0.004]	[0.033]	[0.005]	[0.007]	[0.049]
CASH_HOLDINGS	0.322	0.241	0.253	0.342	0.297	0.276	0.341	0.300	0.292
	[0.158]	[0.124]	[0.128]	[0.138]	[0.128]	[0.129]	[0.153]	[0.156]	[0.151]

Size and safety net protection									
SIZE	11.530	14.227	15.996	11.455	14.202	16.042	11.570	14.161	16.050
	[0.874]	[0.335]	[1.053]	[0.827]	[0.355]	[1.033]	[0.850]	[0.345]	[1.064]
CORE_DEPOSITS	0.726	0.634	0.550	0.751	0.662	0.557	0.750	0.664	0.577
	[0.116]	[0.151]	[0.191]	[0.098]	[0.156]	[0.199]	[0.099]	[0.157]	[0.203]
SUPERVISOR_FED	0.632	0.573	0.324	0.614	0.461	0.269	0.645	0.536	0.334
	[0.481]	[0.491]	[0.468]	[0.484]	[0.495]	[0.440]	[0.476]	[0.494]	[0.470]
SUPERVISOR_FDIC	0.091	0.098	0.181	0.089	0.120	0.188	0.097	0.121	0.182
	[0.286]	[0.292]	[0.384]	[0.282]	[0.319]	[0.387]	[0.292]	[0.319]	[0.379]
Ownership									
BHC_MEMBER	0.708	0.853	0.923	0.704	0.880	0.949	0.724	0.839	0.932
	[0.447]	[0.349]	[0.262]	[0.444]	[0.313]	[0.216]	[0.440]	[0.362]	[0.243]
BLOCK_OWNERSHIP	0.430	2.781	5.086	0.475	2.621	3.969	0.351	3.257	4.207
	[2.438]	[5.845]	[7.314]	[2.582]	[5.084]	[6.304]	[2.194]	[6.337]	[5.926]
FOREIGN_OWNERSHIP	0.472	2.728	9.363	0.595	5.280	9.149	0.370	3.058	8.384
	[6.429]	[15.332]	[27.785]	[7.312]	[21.146]	[27.096]	[4.928]	[14.832]	[24.534]
Organizational structure and strategy									
HQ_DEPOSITS	0.789	0.371	0.348	0.805	0.353	0.350	0.760	0.336	0.319
	[0.238]	[0.250]	[0.285]	[0.231]	[0.260]	[0.295]	[0.245]	[0.229]	[0.294]
BRANCHES / ASSETS	0.026	0.013	0.010	0.027	0.014	0.010	0.026	0.014	0.009
	[0.017]	[0.009]	[0.007]	[0.016]	[0.009]	[0.007]	[0.016]	[0.009]	[0.007]
NR_STATES	0.699	0.760	0.923	0.696	0.718	0.863	0.698	0.742	0.916
	[0.054]	[0.180]	[0.472]	[0.033]	[0.101]	[0.356]	[0.050]	[0.143]	[0.428]
Competition									
LOCAL_MKT_POWER	0.214	0.155	0.151	0.229	0.173	0.170	0.227	0.175	0.175
	[0.141]	[0.079]	[0.070]	[0.140]	[0.070]	[0.072]	[0.137]	[0.074]	[0.078]
MULTI_MKT_CONTACT	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Location									
METRO_MKTS	0.661	0.861	0.814	0.461	0.748	0.685	0.455	0.744	0.689
	[0.456]	[0.247]	[0.270]	[0.478]	[0.317]	[0.324]	[0.471]	[0.327]	[0.316]
HOUSE_PRICE_INDEX_GROWTH	0.038	0.039	0.044	0.043	0.059	0.061	0.052	0.059	0.051
	[0.040]	[0.044]	[0.045]	[0.040]	[0.051]	[0.052]	[0.038]	[0.059]	[0.056]
Profitability									
PROFITABILITY	0.090	0.107	0.122	0.091	0.133	0.147	0.111	0.138	0.153
	[0.106]	[0.124]	[0.103]	[0.110]	[0.107]	[0.103]	[0.080]	[0.074]	[0.086]
Number of observations	16,135	603	412	25,676	774	576	15,433	570	412

Table 1 (*continued*)

Panel B: Additional summary statistics on capital

Banks split by	EQRAT before banking crises			EQRAT before market crises			EQRAT before normal times		
	Small banks (%)	Medium banks (%)	Large banks (%)	Small banks (%)	Medium banks (%)	Large banks (%)	Small banks (%)	Medium banks (%)	Large banks (%)
SIZE									
Bigger	9.09	8.99	7.86	9.10	8.47	7.30	9.53	9.50	8.59
Smaller	10.93	8.54	8.79	10.38	8.28	7.82	10.62	9.02	9.26
CREDIT_RISK									
High	9.30	8.94	8.46	9.06	8.37	7.81	9.55	9.31	9.34
Low	10.72	8.59	8.19	10.42	8.37	7.30	10.60	9.21	8.50
LOAN_CONCENTRATION									
High	9.43	8.88	8.83	9.16	8.55	7.97	9.53	9.53	9.33
Low	10.58	8.65	7.82	10.32	8.20	7.14	10.63	8.99	8.52
BHC_MEMBER									
Yes	9.34	8.36	8.23	9.21	8.02	7.42	9.68	8.98	8.67
No	11.64	11.14	9.76	11.06	11.03	9.50	11.16	10.70	12.33
BLOCK_OWNERSHIP									
Positive	8.02	8.01	7.36	8.07	7.73	7.20	8.99	8.67	8.16
Zero	10.09	9.03	9.13	9.83	8.67	7.89	10.12	9.54	9.69
HQ_DEPOSITS									
High	11.01	8.95	8.35	11.48	8.53	7.64	10.85	9.51	9.31
Low	9.00	8.58	8.30	9.03	8.22	7.48	9.30	9.01	8.54
MULTI_MKT_CONTACT									
High	10.01	8.71	8.10	9.63	8.27	7.41	9.88	9.20	8.64
Low	10.01	8.83	8.55	9.85	8.47	7.70	10.27	9.31	9.21

Table 2
The effect of the bank's precrisis capital ratio on its ability to survive banking crises, market crises, and normal times.

Panel A shows the results of logit regressions that examine how precrisis capital ratios affect banks' ability to survive banking crises (BNKCRIS: the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (MKTCRIS: the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (NORMALTIME) (see Section 3.1). Given that interaction effects in nonlinear models cannot be evaluated by looking at the sign, magnitude, or significance of the coefficients on the interaction terms, Panel B shows the marginal effects (of capital during banking crises, market crises, and normal times) following Norton, Wang, and Ai (2004). Panel C contains the predicted probability of not surviving banking crises, market crises, and normal times, at different precrisis capital ratios. Panel D shows tests of the equality of the effect of capital for different types of crises.

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion). GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

The dependent variable is $SURVIVAL_i$, $log(Prob(SURV_i)/(1-Prob(SURV_i)))$, where *SURV* is a dummy that equals one if the bank is in the sample one quarter before the crisis started and is still in the sample one quarter after the crisis, and zero otherwise.

The key exogenous variables (EQRAT*BNKCRIS, EQRAT*MKTCRIS, and EQRAT*NORMALTIME) and control variables are averaged over the eight quarters before a crisis. EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. All control variables are as defined in Table 1. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics are in parentheses in Panels A and B. *p* values are shown in Panel D. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: SURVIVAL: Regression parameters

Variables	Small banks	Medium banks	Large banks
EQRAT*BNKCRIS	8.036***	6.714	19.905***
	(5.75)	(0.94)	(2.63)
EQRAT*MKTCRIS	9.816***	4.155	28.327
	(5.27)	(0.62)	(1.56)
EQRAT*NORMALTIME	5.525**	5.528	25.276
	(2.35)	(0.65)	(1.33)
CREDIT_RISK	−0.315	−0.540	−0.476
	(−0.78)	(−0.52)	(−0.24)
LOAN_CONCENTRATION	−1.058***	−2.355*	1.294
	(−2.79)	(−1.75)	(0.57)
COMMERCIAL_REAL_ESTATE	−1.624***	−2.859***	−2.373
	(−5.95)	(−3.06)	(−1.55)
BROKERED_DEPOSITS	−2.274***	−2.109	−3.691*
	(−4.87)	(−1.49)	(−1.94)
TRADING_ASSETS	−6.390**	15.392	31.484
	(−2.52)	(0.54)	(1.31)
CASH_HOLDINGS	0.062	−2.225	0.702
	(0.17)	(−1.49)	(0.35)
SIZE	0.111*	0.194	0.066
	(1.83)	(0.57)	(0.24)
CORE_DEPOSITS	1.510***	3.323***	1.228
	(5.76)	(3.62)	(0.97)
SUPERVISOR_FDIC	0.067	0.242	0.425
	(1.05)	(0.88)	(0.97)
SUPERVISOR_FED	−0.033	−0.037	−0.097
	(−0.34)	(−0.10)	(−0.21)
BHC_MEMBER	0.228***	0.472	0.969*
	(3.49)	(1.39)	(1.65)
BLOCK_OWNERSHIP	−0.002	0.065*	0.002
	(−0.16)	(1.81)	(0.07)
FOREIGN_OWNERSHIP	−0.006*	0.001	−0.004
	(−1.91)	(0.21)	(−0.69)
HQ_DEPOSITS	0.297	1.371*	2.033*
	(1.47)	(1.67)	(1.84)
BRANCHES / ASSETS	0.188	−12.210	−10.321
	(0.07)	(−0.59)	(−0.26)
NR_STATES	−0.439	1.494*	0.766
	(−0.78)	(1.76)	(1.41)
LOCAL_MKT_POWER	1.182***	5.521**	3.925
	(3.70)	(2.22)	(0.75)
MULTI_MKT_CONTACT	−70.044***	−149.044	20.940
	(−2.79)	(−1.34)	(0.11)
METRO_MKTS	−0.419***	−0.069	−2.949***
	(−5.19)	(−0.13)	(−3.82)
HOUSE_PRICE_INDEX_GROWTH	0.591	−1.678	8.483
	(0.84)	(−0.75)	(1.56)
PROFITABILITY	4.473***	4.600***	4.126**
	(21.15)	(4.63)	(2.40)
Constant	2.135*	−2.176	−0.917
	(1.96)	(−0.43)	(−0.17)
Number of observations	57,243	1,946	1,400

Panel B: SURVIVAL: Marginal effects of capital during banking crises, market crises, and normal times

	Small banks	Medium banks	Large banks
BNKCRIS	0.29***	0.47	0.70**
	(5.96)	(0.99)	(2.32)
MKTCRIS	0.07***	0.04	0.10
	(5.41)	(0.62)	(1.34)
NORMALTIME	0.10***	0.11	0.22
	(3.55)	(0.91)	(1.36)

Panel C: Predicted probability of not surviving banking crises, market crises, and normal times at different capital ratios

	Banking crises			Market crises			Normal times		
	Small banks (%)	Medium banks (%)	Large banks (%)	Small banks (%)	Medium banks (%)	Large banks (%)	Small banks (%)	Medium banks (%)	Large banks (%)
EQRAT:									
Average minus 1 standard deviation	4.9	4.3	3.9	5.9	4.3	4.7	6.6	4.9	5.2
Average	10.0	8.8	8.3	9.7	8.4	7.6	10.1	9.3	8.9
Average plus 1 standard deviation	15.1	13.2	12.7	13.5	12.4	10.4	13.6	13.6	12.6
Predicted probability of nonsurvival when EQRAT is at:									
Average minus 1 standard deviation	1.18	1.94	0.69	1.20	2.06	0.59	1.13	1.91	0.48
Average	0.79	1.44	0.29	0.83	1.75	0.26	0.93	1.51	0.19
Average plus 1 standard deviation	0.52	1.07	0.12	0.57	1.48	0.12	0.77	1.19	0.08

Panel D: Tests of the equality of the effect of capital for different types of crises

	Small banks	Medium banks	Large banks
p value: Effect of capital during BNKCRIS=effect of capital during NORMALTIME	0.00***	0.39	0.07*
p value: Effect of capital during MKTCRIS=effect of capital during NORMALTIME	0.14	0.50	0.34
p value: Effect of capital during BNKCRIS=effect of capital during MKTCRIS	0.00***	0.38	0.06*

probability. Medium and large banks can rely on financial market access and on correspondent and other interbank relations as risk-mitigation sources in addition to their on-balance-sheet capital to survive negative shocks. As a result, capital is less pivotal for survival during normal times for these banks than it is for small banks. However, banking crises create stresses for all banks, and financial market access and interbank relations could offer inadequate protection against negative shocks during these times. Hence, capital may be important for survival for medium and large banks during banking crises. The market crisis results suggest that such crises do not pose much of a survival threat for medium and large banks. Given the access that these banks have to the interbank lending market (e.g., federal funds) that itself is unlikely to be adversely impacted by a market crisis, capital might not be critical for these banks to survive market crises.

Table 2, Panel C, is used to judge the economic significance of our findings. The top part shows the average capital ratio and the average capital ratio plus or minus one standard deviation of small, medium, and large banks over the eight quarters before banking crises, market crises, and normal times. The bottom part shows the predicted probability of nonsurvival at these capital ratios. As can be seen, a small, medium, or large bank with an average capital ratio (10.0%, 8.8%, and 8.3%, respectively) had a probability of not surviving banking crises of 0.79%, 1.44%, and 0.29%, respectively. Reducing (increasing) capital by one standard deviation increases (reduces) these probabilities of nonsurvival by about 75% (50%) on average.

It is also interesting to examine whether the effect of capital on survival is significantly different across the different types of crises. We use Wald tests for this purpose. Table 2, Panel D, contains the results. For small banks, while capital helps these banks to survive at all times, the effect is significantly stronger during banking crises than during normal times and market crises. For large banks, similar results are obtained. For medium banks, the effects are not significantly different from each other. Thus, the effect of capital seems strongest during banking crises for banks of most sizes.

Turning to the control variables, we find that the coefficients largely have the predicted signs. For small banks, more core deposits, being part of a BHC, greater market power, and higher profitability helps them survive. Small banks are less likely to survive if they have more concentrated portfolios, more commercial real estate, more brokered deposits, more trading assets, greater foreign ownership, more multi-market contact, and a higher fraction of their activities in metropolitan markets. Some of these variables are significant as well for medium and large banks,

Table 3
The effect of the bank's precrisis capital ratio on its market share during banking crises, market crises, and normal times.

Panel A shows how precrisis bank capital ratios affect banks' market shares during banking crises (BNKCRIS: the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (MKTCRIS: the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (NORMALTIME) (see Section 3.1). Panel B shows tests of the equality of the effect of capital for different types of crises.

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion). GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

The dependent variable is %ΔMKTSHARE, the percentage change in the bank's GTA market share measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred.

The key exogenous variables (EQRAT*BNKCRIS, EQRAT*MKTCRIS, and EQRAT*NORMALTIME) and control variables are averaged over the eight quarters before a crisis. EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. All control variables are as defined in Table 1. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics based on robust standard errors are in parentheses in Panel A. *p* values are shown in Panel B. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: %ΔMKTSHARE: Regression parameters

Variables	Small banks	Medium banks	Large banks
EQRAT*BNKCRIS	1.203***	0.697***	1.062***
	(28.82)	(3.95)	(3.92)
EQRAT*MKTCRIS	0.595***	−0.062	0.569
	(15.00)	(−0.51)	(1.58)
EQRAT*NORMALTIME	0.293***	0.076	0.524
	(5.48)	(0.32)	(1.36)
CREDIT_RISK	0.027**	−0.025	−0.116*
	(2.27)	(−0.62)	(−1.96)
LOAN_CONCENTRATION	−0.128***	0.043	0.092
	(−8.72)	(0.69)	(1.26)
COMMERCIAL_REAL_ESTATE	0.179***	0.179***	0.104
	(16.97)	(4.31)	(1.61)
BROKERED_DEPOSITS	0.220***	−0.036	0.295***
	(6.92)	(−0.37)	(3.27)
TRADING_ASSETS	−0.377***	−0.687***	−0.035
	(−3.23)	(−3.11)	(−0.19)
CASH_HOLDINGS	−0.209***	−0.057	−0.023
	(−18.46)	(−1.10)	(−0.28)
SIZE	−0.018***	−0.154***	−0.012
	(−10.16)	(−11.47)	(−1.40)
CORE_DEPOSITS	−0.179***	0.011	−0.007
	(−16.49)	(0.27)	(−0.13)
SUPERVISOR_FDIC	−0.002	−0.001	−0.037**
	(−0.99)	(−0.10)	(−2.38)
SUPERVISOR_FED	0.008***	0.023	−0.012
	(2.82)	(1.55)	(−0.77)
BHC_MEMBER	−0.007***	0.043***	0.021
	(−3.55)	(3.57)	(0.75)
BLOCK_OWNERSHIP	0.001***	0.000	−0.001
	(3.41)	(0.53)	(−1.48)
FOREIGN_OWNERSHIP	−0.001***	−0.000	−0.000
	(−2.85)	(−1.20)	(−1.34)
HQ_DEPOSITS	−0.036***	0.036	0.012
	(−6.33)	(1.28)	(0.30)
BRANCHES / ASSETS	−0.108	0.683	0.096
	(−1.44)	(1.02)	(0.08)
NR_STATES	0.042***	0.029	0.036**
	(2.79)	(1.01)	(2.21)
LOCAL_MKT_POWER	−0.000	0.163**	−0.054
	(−0.01)	(2.34)	(−0.59)
MULTI_MKT_CONTACT	14.261***	−2.266	10.252
	(14.07)	(−0.51)	(1.32)
METRO_MKTS	0.051***	0.006	0.006
	(26.24)	(0.36)	(0.25)
HOUSE_PRICE_INDEX_GROWTH	0.545***	0.362***	0.537***
	(28.34)	(3.98)	(5.30)
Constant	0.261***	2.069***	0.183
	(8.24)	(10.00)	(0.99)
Number of observations	57,243	1,946	1,400
Adjusted R^2	0.21	0.16	0.06

Panel B: Tests of the equality of the effect of capital for different types of crises

	Small banks	Medium banks	Large banks
p value: Effect of capital during BNKCRIS = effect of capital during NORMALTIME	0.00***	0.04**	0.20
p value: Effect of capital during MKTCRIS = effect of capital during NORMALTIME	0.00***	0.60	0.93
p value: Effect of capital during BNKCRIS = effect of capital during MKTCRIS	0.00***	0.00***	0.26

typically in the same direction. Several risk variables affect these banks to a lesser extent, likely because they have more sophisticated risk management systems and are less endangered generally.

4.2. *Does capital affect the market shares of banks during crises and normal times?*

Table 3, Panel A, presents the results from regressing the percentage change in a bank's market share (%ΔMKTSHARE) during crises on the bank's precrisis capital ratio interacted with the crisis dummies, plus control variables. As before, results are shown separately for banks of different sizes. The *t*-statistics are based on robust standard errors clustered by bank. Because these are linear regressions, the effects of capital during banking crises, market crises, and normal times are fully captured by the coefficients on the interaction terms.

We find two main results. First, higher capital helps small banks to improve their market shares at all times (during banking crises, market crises, and normal times). Second, higher capital helps medium and large banks improve their market shares during banking crises only. These results generally support the hypothesis that capital helps banks to improve their market shares.

We can again interpret these results in the context of the theories. Capital is essential to survival for small banks, as discussed earlier. These banks engage largely in relationship lending, and long-term bank–borrower relationships are crucial for relationship banking to create value (e.g., Ongena and Smith, 2001; Bae, Kang, and Lim, 2002; Bharath, Dahiya, Saunders, and Srinivasan, 2007). This means that relationship borrowers gravitate toward high-capital banks, because higher capital leads to a higher survival probability for small banks at all times (see Section 4.1). In addition, Song and Thakor (2007) show that banks that make relationship loans prefer to finance with "stable funds" because this increases the likelihood that such loans will not be terminated prematurely. Thus, it is not surprising that higher capital benefits small banks in terms of gaining market share at all times. During banking crises, capital also helps improve the market shares of medium and large banks. In contrast, during market crises and normal times, capital does not significantly affect these banks, possibly because it is relatively easy for them to turn to the interbank market, which might not experience stress during such times, to ensure uninterrupted relationships with their borrowers. This means that while capital may offer medium and large banks a benefit during market crises and normal times, this benefit might be no greater than that before such times.

To judge the economic significance of these results, we focus first on the effect of capital during banking crises. The coefficients on the EQRAT∗BNKCRIS interaction terms imply that a one standard deviation increase in EQRAT would lead to a 0.373, 0.175, and 0.238 standard deviation change in %Δ*MKTSHARE* for small, medium, and large banks, respectively, during such crises. The corresponding figures for EQRAT∗MKTCRIS and EQRAT∗NORMALTIME are (0.194, −0.016, and 0.118) and (0.085, 0.019, and 0.119), respectively. These results seem economically significant for banks of all sizes during banking crises and for small banks also during market crises and normal times.

We use Wald tests to examine whether the effect of capital on market share is significantly different across the different types of crises. Table 3, Panel B, shows that for small banks, the positive effect of capital on market shares is significant at all times, but it is significantly stronger during banking crises than during market crises, and significantly stronger during market crises than during normal times. For medium banks, this effect is significantly stronger during banking crises than during market crises or normal times. For large banks, the effects of capital are not significantly different during banking crises, market crises, and normal times.

Turning to the control variables in Panel A, we find that small banks with more credit risk, more commercial real estate, more brokered deposits, Federal Reserve supervision, greater block ownership, greater multi-market contact, active in more states and more metropolitan areas, and stronger growth in housing prices are more likely to improve their competitive positions. In contrast, small banks with more concentrated portfolios, more trading assets, more cash, more core deposits, greater foreign ownership, and a higher fraction of deposits in the main office are less likely to improve their market shares. Some variables significantly impact medium and large banks' market shares as well, generally in the same direction. Two surprising exceptions include credit risk (helps small banks gain market share but hurts large banks) and BHC membership (a negative impact for small banks, but a positive effect for medium banks). Among banks of all size classes, the coefficient on bank size is negative (significant for small and medium banks), likely because it is harder for larger banks to increase their percentage market share.

5. Robustness checks

This section presents a number of robustness checks. Our findings are generally qualitatively similar to the main results. The same control variables as used in the main regressions are included with some exceptions noted below. To preserve space, we present only the results of interest. Our (nonlinear) survival regressions show marginal effects to ensure correct inference (see Section 4.1) during banking crises, market crises, and normal times, while our (linear) market share regressions show the coefficients on the capital–crisis interaction terms.

5.1. Use regulatory capital ratios

One may wonder to what extent the main results are specific to our choice of the definition of capital, EQRAT, the ratio of equity capital to assets. To examine this issue, we rerun our regressions using regulatory capital ratios. Basel I introduced two risk-based capital ratios, the Tier 1 and Total risk-based capital ratios. Because these ratios became fully effective only as of December 1990, we use each bank's ratio of equity capital to GTA before this date and its Tier 1 risk-based capital ratio from that moment onward. We obtain similar results when we use the Total risk-based capital ratio instead of the Tier 1 capital ratio.[22]

Table 4, Panel A, shows the results. They are broadly similar to the main results (see Tables 2 and 3) except that for small banks, we find no effect on survival during normal times; for medium banks, the effect of capital on survival becomes significant during banking crises while the effect on market share loses significance (*t*-statistic 1.62); for large banks, capital now helps survival during normal times as well.

We also run all the robustness checks presented in the rest of this section using regulatory capital and obtain results that are similar to the main results (not shown for brevity). Nonetheless, we believe that our choice of using EQRAT in the main regressions is appropriate. The regulatory ratios mix capital with credit risk, which is already controlled for in our regressions. We prefer to focus on the effect of capital per se.

5.2. Exclude too-big-to-fail banks

Very large banks may be considered too-big-to-fail (TBTF). For these banks, capital might not provide the benefits we highlight because such banks know they will be supported if needed. To make sure that our large-bank results are not overly influenced by TBTF banks, we rerun our main analyses for large banks while excluding these banks. No official definition of TBTF exists, so we use two alternative definitions. First, in every quarter, we deem all banks with GTA exceeding $50 billion to be TBTF, consistent with the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 definition of systemically-important banks. Second, we classify the 19 largest banks in each period as TBTF. This is inspired by the government's disclosure in early 2009 that the 19 largest banks had to undergo stress tests, and would be assisted with capital injections if they could not raise capital on their own. This effectively made them TBTF.

Table 4, Panel B, contains the results. While the marginal effects of capital on survival are similar to the large-bank results presented in Table 2, the market share coefficients are bigger than those presented in Table 3 and significance is found in similar cases. These results suggest that the presence of TBTF banks weakened our main results to some extent, but they leave our main conclusion unchanged.

5.3. Use an alternative size cutoff

In our main analyses, small banks have GTA up to $1 billion; medium banks have GTA between $1 billion and $3 billion; and large banks have GTA exceeding $3 billion. Our small-bank definition captures community banks, while the remaining observations were split roughly in half by choosing a $3 billion cutoff (see also Berger and Bouwman, 2009). One may wonder to what extent the medium and large bank results are driven by our choice of the $3 billion cutoff. We rerun our analyses using a $5 billion cutoff, which reclassifies around 30% of our large banks as medium banks.

Table 4, Panel C, shows the results for medium and large banks using this alternative cutoff. As can be seen, the results are similar to the main results.

5.4. Measure capital ratios at alternative times before the crisis

Our main results are based on regression specifications that include every bank's capital ratio averaged over the eight quarters before a crisis. Eight-quarter averages have the advantage that they are not very sensitive to the effects of outliers. As robustness checks, we rerun our regressions while measuring bank capital averaged over the four quarters before a crisis or in the quarter before a crisis.[23]

Table 4, Panel D, contains the results. Clearly, the survival and market share results are similar to the main results. An exception is the effect of capital on small banks' competitive position during normal times. The effect is not significant anymore when capital is averaged over the four quarters before the crisis, and it even turns negative when capital is measured in the quarter before the crisis.

5.5. Use an instrumental variable analysis

A potential endogeneity issue clouds the interpretation of our main results. The theories suggest a causal link from

[22] Prior to 1996, all banks with assets over $1 billion had to report this information, but small banks only had to report their risk-based capital positions if they believed that their capital was less than 8% of adjusted total assets. In these cases, we use a Federal Reserve program to construct those banks' risk-based capital ratios based on publicly-available Call Report data.

[23] As explained above, we only keep bank-quarter observations if the bank has gross total assets exceeding $25 million. We measure pre-crisis data over the eight quarters before a crisis, so this effectively means that a bank is in the sample if it has data in at least one of those eight quarters. Because some small banks hover around this cutoff, a few observations drop out of the small-bank sample when we restrict attention to banks with data in the four quarters or one quarter before each crisis.

Table 4
Robustness.

This table presents the results of checks to establish the robustness of our results. Panel A uses regulatory capital ratios instead of the equity-to-assets ratio. Panel B drops too-big-to-fail banks from the large-bank sample. Panel C uses an alternative cutoff separating medium and large banks. Panel D measures precrisis capital ratios alternatively one quarter before the crisis starts or averaged over the four quarters before the crisis. Panel E deals with the potential endogeneity issues related to capital by using instrumental variable regressions. Panel F shows an extra analysis – the effect of precrisis profitability on profitability.

The crises include banking crises (BNKCRIS: the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (MKTCRIS: the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (NORMALTIME) (see Section 3.1).

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion), unless otherwise noted. GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

SURVIVAL is a dummy that equals one if the bank is in the sample one quarter before such a crisis started and is still in the sample one quarter after the crisis, and zero otherwise. %ΔMKTSHARE, the percentage change in the bank's GTA market share is measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred. ΔPROFITABILITY, the change in profitability, is measured as the bank's average return on equity (ROE; net income divided by GTA) during a crisis minus its average ROE over the eight quarters before the crisis.

Because the interaction effects in our (nonlinear) survival regressions cannot be evaluated by looking at the sign, magnitude, or significance of the coefficients on the interaction terms, we show the marginal effects of capital following Norton, Wang, and Ai (2004). In contrast, the interaction effects in the (linear) market share regressions can be evaluated by looking at the coefficients on the interaction terms.

To preserve space, we present only the marginal effects (survival regressions) and the coefficients on the interaction terms (market share regressions) although all the control variables (see Table 1) are included in the regressions. The market share regressions do not include profitability. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics based on robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Robustness – Use regulatory capital ratios

	SURVIVAL			%ΔMKTSHARE		
Key variables	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks
TIER1RAT*BNKCRIS	0.14***	0.94*	0.62**	0.459***	0.351	0.535***
	(3.64)	(1.83)	(2.29)	(12.70)	(1.62)	(3.54)
TIER1RAT*MKTCRIS	0.02***	0.00	0.02	0.164***	0.043	−0.006
	(3.80)	(0.14)	(0.75)	(8.33)	(0.58)	(−0.03)
TIER1RAT*NORMALTIME	−0.01	0.00	0.10***	0.052***	0.076	0.111
	(−0.82)	(0.07)	(2.52)	(2.74)	(0.80)	(0.49)
Number of observations	57,240	1,946	1,400	57,240	1,946	1,400
Adjusted R^2				0.20	0.15	0.06

Panel B: Robustness – Exclude too-big-to-fail banks

	Large banks (drop banks with GTA > $50 billion)		Large banks (drop the 19 largest banks each quarter)	
Key variables	SURVIVAL	%ΔMKTSHARE	SURVIVAL	%ΔMKTSHARE
EQRAT*BNKCRIS	0.68**	1.228***	0.71**	1.180***
	(2.31)	(3.96)	(2.33)	(3.83)
EQRAT*MKTCRIS	0.13	0.581	0.14	0.527
	(1.32)	(1.58)	(1.33)	(1.40)
EQRAT*NORMALTIME	0.21	0.580	0.22	0.582
	(1.50)	(1.48)	(1.48)	(1.51)
Number of observations	1,288	1,288	1,271	1,271
Adjusted R^2		0.07		0.07

Panel C: Robustness – Use an alternative cutoff between medium and large banks of $5 billion

	SURVIVAL		%ΔMKTSHARE	
Key variables	Medium banks	Large banks	Medium banks	Large banks
EQRAT*BNKCRIS	0.54	0.62**	0.670***	1.430***
	(1.27)	(2.20)	(4.49)	(3.01)
EQRAT*MKTCRIS	0.04	0.18	0.060	−0.031
	(0.91)	(1.58)	(0.37)	(−0.06)
EQRAT*NORMALTIME	0.13	0.42	0.231	0.169
	(1.09)	(0.96)	(0.95)	(0.32)
Number of observations	2,356	990	2,356	990
Adjusted R^2			0.11	0.06

Table 4 (*continued*)

Panel D: Robustness – Measure precrisis capital ratios at different points before a crisis

Key variables	SURVIVAL Small banks	SURVIVAL Medium banks	SURVIVAL Large banks	%ΔMKTSHARE Small banks	%ΔMKTSHARE Medium banks	%ΔMKTSHARE Large banks
Use the average capital ratio over four (instead of eight) quarters before the crisis						
EQRAT_ave4Q*BNKCRIS	0.32***	0.41	0.69**	1.052***	0.626***	0.991***
	(5.83)	(0.99)	(2.41)	(24.11)	(3.62)	(3.55)
EQRAT_ave4Q*MKTCRIS	0.07***	0.02	0.14	0.390***	−0.146	0.405
	(5.58)	(0.36)	(1.27)	(10.18)	(−1.07)	(0.88)
EQRAT_ave4Q*NORMALTIME	0.09***	0.08	0.22	0.066	−0.046	0.306
	(2.86)	(0.70)	(1.53)	(1.24)	(−0.22)	(0.78)
Number of observations	57,153	1,946	1,400	57,153	1,946	1,400
Adjusted R^2				0.20	0.16	0.06
Measure capital one quarter before the crisis (instead of the average capital ratio over eight quarters before the crisis)						
EQRAT_1Q*BNKCRIS	0.42***	0.51	0.73***	0.918***	0.597***	0.900***
	(6.80)	(1.18)	(2.57)	(17.11)	(3.51)	(2.82)
EQRAT_1Q*MKTCRIS	0.08***	0.02	0.13	0.116***	−0.194	0.276
	(5.47)	(0.39)	(1.33)	(3.04)	(−1.23)	(0.62)
EQRAT_1Q*NORMALTIME	0.09**	0.09	−0.07	−0.232***	−0.209	0.213
	(2.27)	(0.62)	(−0.20)	(−4.49)	(−1.36)	(0.56)
Number of observations	56,895	1,946	1,400	56,895	1,946	1,400
Adjusted R^2				0.19	0.16	0.06

Panel E: Robustness – Instrumental variable analysis

	SURVIVAL Small banks	SURVIVAL Medium banks	SURVIVAL Large banks	%ΔMKTSHARE Small banks	%ΔMKTSHARE Medium banks	%ΔMKTSHARE Large banks
Hausman endogeneity test (p value)	0.09*	0.58	0.12	0.00***	0.60	0.12

Key variables in second-stage IV regressions	SURVIVAL Small banks	%ΔMKTSHARE Small banks
EQRAT*BNKCRIS	2.044**	1.510**
	(2.44)	(2.04)
EQRAT*MKTCRIS	0.863	4.406***
	(1.17)	(4.54)
EQRAT*NORMALTIME	0.897	8.682**
	(0.36)	(2.42)
Number of observations	30,018	30,018

Panel F: Extra analysis – Effect on profitability

Key variables	ΔPROFITABILITY Small banks	ΔPROFITABILITY Medium banks	ΔPROFITABILITY Large banks
EQRAT*BNKCRIS	0.107***	0.075	0.177*
	(7.42)	(0.93)	(1.91)
EQRAT*MKTCRIS	0.091***	0.146**	0.439***
	(6.23)	(2.38)	(2.85)
EQRAT*NORMALTIME	0.078***	0.106	−0.009
	(4.91)	(1.34)	(−0.08)
Number of observations	57,243	1,946	1,400
Adjusted R^2	0.08	0.23	0.18

capital to performance. But we know that in practice, capital is an endogenous choice variable for a bank, so the bank's market share and likelihood of survival could impact the bank's capital choice. This issue is addressed partly in our analysis because capital is lagged relative to the dependent variables. However, this might not be enough because of intertemporal rigidities in some of these variables. It may therefore be difficult to know if we have detected causality or mere correlation. To address this, we now use an instrumental variable approach.

If our survival and market share regressions included capital per se (instead of capital–crisis interaction terms), we could simply select an instrument for capital. Because our regressions include capital interacted with three crisis dummies (EQRAT*BNKCRIS, EQRAT*MKTCRIS, and EQRAT*NORMALTIME), we have three potentially endogenous variables and need an instrument for each interaction term.[24] We employ three instruments in each regression. For reasons explained below, we employ different instruments for banks of different sizes. Specifically, for small and medium banks, we use SENIORS, the fraction of people aged 65 and over in the markets in which a bank is active, interacted with the three crisis dummies; for large banks, we use EFF-TAX, the effective state income tax rate a bank has to pay, interacted with the three crisis dummies.

This instrumentation strategy assumes that SENIORS and EFF-TAX are correlated with the amount of capital (instrument relevance), but do not directly affect performance (exclusion restriction). Both variables, used by Berger and Bouwman (2009) as instruments for capital, seem to meet these conditions. Consider SENIORS first. Seniors own larger equity portfolios than the average family. Furthermore, using US data, Coval and Moskowitz (1999) find that investors have a strong preference for investing close to home. This preference is greater for firms that are smaller, more highly levered, and those producing goods that are not traded internationally. This evidence suggests that banks, particularly small and medium banks, operating in markets with more seniors have easier access to equity financing and hence will operate with higher capital ratios [see Berger and Bouwman (2009) for empirical evidence]. We calculate the fraction of seniors using market-level population data from the 1990, 2000, and 2010 decennial Censuses, and we apply these fractions to bank data from 1985 to 1994, 1995 to 2004, and 2005 to 2010, respectively. If a bank operates in multiple markets, we use the bank's deposit-weighted-average fraction of seniors across its markets.

Although the exclusion restriction is an identifying restriction that cannot be tested, one may worry that it is not satisfied. For example, the fraction of seniors in the bank's markets could directly affect bank survival through the political process. If seniors dislike bank default more than young people do, they would lobby politicians more actively. While this is a possibility, we are not aware of any theories that predict this or of any empirical or anecdotal evidence supporting this.[25] Another concern is that the fraction of seniors could directly affect market shares. Seniors may have a preference for certain bank services and be more loyal than younger customers. Even if true, however, it would apply to all banks serving a market with a given fraction of seniors, so it is difficult to see how operating in a market with more seniors would endow a bank with a stronger competitive advantage relative to other banks operating in the same market, and thus with greater market share.

While SENIORS (interacted with three crisis dummies) can be used for small and medium banks, it is not as attractive for large banks because these banks are unlikely to be locally-based when it comes to raising equity. For this reason, we use EFF-TAX (interacted with three crisis dummies) for large banks. Because interest on debt is tax-deductible and dividend payments are not, banks that operate in states with higher income tax rates are expected to have lower equity ratios, all else equal (e.g., Ashcraft, 2008; Berger and Bouwman, 2009). Similar to Ashcraft (2008), we define EFF-TAX as the effective income tax rate to be paid on $1 million in pretax income. If a bank operates in multiple states, we use the bank's weighted-average state income tax rate, calculated using the bank's share of deposits in each state as weights.

Because ordinary least squares is preferred to instrumental variable regressions if we do not have an endogeneity problem, we perform Hausman tests for endogeneity. As shown in Table 4, Panel E, we do not reject the null that the three potentially endogenous variables are exogenous for medium and large banks, suggesting that our original analyses were appropriate for these banks. However, we do find evidence of endogeneity for small banks and therefore perform instrumental variable regressions only for those banks.

Since our small-bank survival regressions have three endogenous variables, we run three first-stage regressions. We regress EQRAT*BNKCRIS on all the exogenous variables used in our survival regressions plus the three instruments (SENIORS interacted with the three crisis dummies; first-stage regression #1), and do the same using EQRAT*MKTCRIS (first-stage regression #2) and EQRAT*NORMALTIME (first-stage regression #3). In similar vein, we also run three first-stage regressions for our small-bank market share regressions. The survival and market share first-stage regressions are slightly different because the survival regressions include profitability as a control variable while the market share regressions do not.

Importantly, when EQRAT*BNKCRIS is the endogenous variable (first-stage regression #1), the coefficient on the corresponding instrument (SENIORS*BNKCRIS) is highly significant. We obtain similar results for the other two endogenous variables in first-stage regressions #2 and #3 (not shown for brevity).

If the instruments are weak (the correlation with the endogenous regressors is low), IV estimates are biased toward the OLS estimates in finite samples (e.g., Bound, Jaeger, and Baker, 1995; Staiger and Stock, 1997). To verify that this is not a problem, we calculate the Angrist-Pischke first-stage *F*-statistic of excluded instruments for every first-stage regression to test the hypothesis that all instrument coefficients are zero (Angrist and Pischke, 2009). The

[24] It is not correct to view EQRAT as the endogenous right-hand-side variable, create a predicted value of EQRAT in the first stage, and then interact it with the three crisis dummies in the second stage. Wooldridge (2002, p. 236) and Angrist and Pischke (2009, pp. 190–192) call this the "forbidden regression."

[25] While small-bank lobbying tends to be done by associations such as the Independent Community Bankers of America, which has around five thousand members, individual shareholders could also lobby politicians. Evidence on lobbying by age category is hard to obtain, but we are not aware of any evidence or theoretical argument that older individuals lobby more. The American Association of Retired Persons (AARP), one of the most powerful lobbying groups in the US with more than forty million members, seems to focus primarily on issues related to enhancing the quality of life for seniors.

associated *p*-values range from 0.00 to 0.01, suggesting we do not have a weak instrument problem.

We run two small-bank second-stage regressions. We regress SURVIVAL on the predicted values of the three endogenous variables from the first stage and all the control variables and fixed effects, and we run a comparable regression using %ΔMKTSHARE as the dependent variable. Table 4, Panel E, shows the two second-stage regressions. Using instruments, we find that capital helps small banks survive banking crises only, and helps them improve their market shares at all times. Thus, most of our earlier results hold up in our instrumental variable analysis, and the analysis broadly confirms our main results.

5.6. Extra analysis: the effects of capital on profitability

Our results suggest that capital helps small banks to survive and improve their market shares at all times, and it helps medium and large banks during banking crises only. It is interesting to see if these benefits of capital help banks improve their profitability as well. Several theory papers suggest that higher capital should enhance profitability (e.g., Holmstrom and Tirole, 1997; Allen, Carletti, and Marquez, 2011; Mehran and Thakor, 2011), while others argue that it should (mechanically) lead to a reduced return on equity (e.g., Modigliani and Miller, 1963). Acharya and Mora (2011) find that banks bid more for deposits during a financial crisis, which could lower profitability. Berger (1995) finds that the relation between capital and earnings can be positive or negative but, like the theory papers, does not differentiate between financial crises and normal times.

We measure a bank's profitability using the bank's ROE.[26] To examine whether a bank improves its profitability during banking crises, market crises, and normal times, we focus on the change in ROE (ΔROE), defined as the bank's average profitability during these crises minus the bank's average ROE over the eight quarters before these crises. We regress ΔROE on the bank's precrisis capital ratio plus the same set of control variables that is included in the market share regressions.

Table 4, Panel F, contains the results. We have two main findings. First, capital enhances the profitability of small banks at all times (during banking crises, market crises, and normal times). Second, capital improves the profitability of medium and large banks during banking crises (not significant for medium banks) and market crises. Thus, capital generally improves bank profitability.

6. Regression results based on individual crises

The main regressions group the two banking crises together and the three market crises together. This approach facilitates drawing general conclusions about how the role of capital differs across banking crises and market crises, while minimizing the impact of the idiosyncratic circumstances surrounding a particular crisis. This is useful because the specific attributes of a crisis are unknown before the crisis strikes. Aggregating across banking crises and across market crises allows us to generate a comprehensive picture of specific types of crises, thereby leading to a better predictive framework for extrapolation for future crises.

However, an advantage of looking at individual crises is that it permits a more granular look at how the role of capital is affected by the specific circumstances of that crisis. That is, there is value in also understanding if the role of capital is influenced by the details of a given crisis, including its origins and the extent of government intervention. For example, each banking crisis has features that it shares with other banking crises but also features that were peculiar to that crisis. The credit crunch was attributed in part to the transition of capital requirements to Basel I's risk-based scheme (e.g., Hancock, Laing, and Wilcox, 1995; Thakor, 1996), whereas the subprime crisis was triggered in part by unexpectedly large defaults on subprime mortgages (e.g., Gorton and Metrick, 2012a, 2012b). In addition, the credit crunch took place during a period of intense industry consolidation, while the subprime lending crisis involved unprecedented intervention by the Federal Reserve and the Treasury. We therefore rerun the main regressions and the robustness checks separately for each of the five crises and normal times. We exclude the individual crisis dummies and drop some controls from our survival regressions to avoid collinearity. We drop these variables from the market share regressions for those size classes as well for consistency. The table indicates which control variables are included.[27]

Table 5 contains the main results based on individual crises. Capital helps small banks survive at virtually all times (both banking crises, two out of the three market crises, and during normal times) and helps them improve their market shares during every crisis and during normal times. In contrast, capital helps medium and large banks survive only one of the banking crises (the credit crunch) and also helps them improve their competitive position during both banking crises.

The robustness checks using individual crises yield results that are very similar to the main individual crisis results (not shown for brevity; the results are available upon request).[28]

These results suggest that capital is a significant facilitator for small banks during every crisis and during normal times. It benefited medium and large banks in

[26] If a bank's capital to GTA ratio is less than 1%, we calculate ROE as net income divided by 1% of GTA. For observations for which equity is between 0% and 1% of GTA, dividing by equity would result in extraordinarily high values. For observations for which equity is negative, the conventionally-defined ROE would not make economic sense. We do not drop these negative-equity observations because they are likely informative of banks' ability to survive crises.

[27] The survival regressions are run only for cases in which there are a sufficient number of non-survivors. As a result, regressions are not run for medium and large banks during CRIS1, and for large banks during CRIS3. These cases are indicated as n/a.

[28] The individual crisis IV results for small banks show that the instrument is positively and significantly related to capital in four out of five crises (not significant during the recent crisis). In the second stage, capital is positively related to survival and market share in virtually every crisis, but not always significant.

Table 5
Individual crises.

This table shows how precrisis bank capital ratios affect banks' ability to survive and enhance their market shares during the five individual crises (CRIS1: the 1987 stock market crash; CRIS2: the credit crunch of the early 1990s; CRIS3: the Russian debt crisis and Long-Term Capital Management bailout in 1998; CRIS4: bursting of the dot.com bubble and September 11; and CRIS5: the recent subprime lending crisis) and normal times (NORMALTIME) (see Section 3.1).

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion), unless otherwise noted. GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

SURVIVAL is a dummy that equals one if the bank is in the sample one quarter before such a crisis started and is still in the sample one quarter after the crisis, and zero otherwise. %ΔMKTSHARE, the percentage change in the bank's GTA market share is measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred. EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. The survival regressions are run only for cases in which there are a sufficient number of non-survivors. As a result, regressions are not run for medium and large banks during CRIS1, and for large banks during CRIS3. These cases are indicated as n/a.

To preserve space, we present only the coefficients on EQRAT. All regressions include the following common control variables: CREDIT_RISK, LOAN_CONCENTRATION, COMMERCIAL_REAL_ESTATE, CASH_HOLDINGS, SIZE, CORE_DEPOSITS, HQ_DEPOSITS, BRANCHES / ASSETS, and LOCAL_MKT_POWER. In addition, the small-bank regressions include BROKERED_DEPOSITS, TRADING_ASSETS, and MULTI_MKT_CONTACT; the medium-bank regressions include METRO_MKTS and MULTI_MKT_CONTACT; and the large-bank regressions include BROKERED_DEPOSITS and TRADING_ASSETS. Table 1 contains definitions of these variables. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics based on robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	SURVIVAL						%ΔMKTSHARE					
Key variables	CRIS1	CRIS2	CRIS3	CRIS4	CRIS5	NORMAL TIME	CRIS1	CRIS2	CRIS3	CRIS4	CRIS5	NORMAL TIME
Small banks												
EQRAT	20.841**	10.221***	1.818	10.405***	5.601***	9.556***	0.962***	1.138***	0.215***	0.739***	1.176***	0.266***
	(2.55)	(5.86)	(0.62)	(4.79)	(3.95)	(4.27)	(22.17)	(19.41)	(4.94)	(13.09)	(30.64)	(7.01)
Number of observations	10,755	9,811	7,798	7,146	6,340	15,447	10,755	9,811	7,798	7,146	6,340	15,447
Adjusted R^2							0.13	0.12	0.15	0.21	0.30	0.13
Medium banks												
EQRAT	n/a	24.065*	29.094	5.516	0.512	7.486	−0.102	0.776*	−0.628	−0.461	0.558***	0.020
	n/a	(1.91)	(0.65)	(0.69)	(0.11)	(0.82)	(−0.54)	(1.68)	(−1.57)	(−1.18)	(2.70)	(0.11)
Number of observations	275	283	270	238	323	574	275	283	270	238	323	574
Adjusted R^2							0.15	0.18	0.17	0.16	0.12	0.16
Large banks												
EQRAT	n/a	65.647**	n/a	14.956	12.073	26.419	0.258	0.988**	−1.518**	0.780	0.691*	0.397
	n/a	(2.19)	n/a	(0.78)	(1.13)	(0.97)	(0.33)	(2.22)	(−1.98)	(1.23)	(1.94)	(1.33)
Number of observations	211	231	194	176	189	421	211	231	194	176	189	421
Adjusted R^2							0.14	0.09	0.05	0.01	0.12	0.04

terms of market share during both banking crises, but affected their survival during the credit crunch, but not the subprime lending crisis. This may not be surprising because the government interventions during the subprime lending crisis were predominantly aimed at larger institutions. Our results are consistent with the view that such government assistance partially substituted for precrisis bank capital. Thus, while our main results for small banks are unaffected, our conclusion for medium and large banks becomes more nuanced. Capital helps these banks primarily during banking crises in which government intervention is limited.

7. Three channels through which capital may affect bank performance

Having established that capital affects bank performance, we now turn our attention to the channels through which this effect operates. The theories discussed in Section 2 suggest that capital affects bank performance because higher-capital banks engage in more monitoring and invest in safer assets. We identify three potential channels through which enhanced monitoring and safer investment policies may affect performance: (percentage growth in) noncore funding (%ΔNONCOREFUNDS), on-balance-sheet relationship loans (%ΔRELSHIPLOANS), and off-balance-sheet guarantees (%ΔOBSGUARANTEES).

To the extent that higher capital induces lower bank risk, banks with higher capital could experience cheaper and greater access to noncore funding, an uninsured funding source that may be critical in times of distress, but can also dry up quickly, as the recent subprime lending crisis showed. Noncore funding counterparties and customers may use a bank's capital ratio to assess its creditworthiness and probability that it will repay its obligations. Better access to noncore funding could, in turn, enhance the bank's survival probability and market share. We calculate noncore funding as total liabilities minus stockholders equity and core deposits (as defined in Section 3.2).

More monitoring and safer investments associated with higher capital could also improve a bank's ability to make relationship loans (e.g., Boot and Thakor, 2000). This may be because relationship borrowers, who benefit from long-term interactions with the bank, would prefer a bank with higher capital and higher odds of survival, all else equal. This might not only improve the bank's lending margins, but also enhance loan volume, thereby increasing market share. Moreover, it would provide the balance-sheet stability that is valuable for survival. If we had loan-level data, we could construct a relationship loan measure based on duration and scope, two dimensions deemed important in the relationship lending literature (e.g., Boot, 2000; Ongena and Smith, 2000; Degryse and Ongena, 2007). If we had firm-level data, we could calculate the bank's share of the firm's total debt (e.g., Presbitero and Zazzaro, 2011). Because we only have Call Report data, we use a more crude measure and view total loans excluding loans to depository institutions, foreign governments, and states as relationship loans.

Buyers of off-balance-sheet guarantees are more likely to buy claims from less risky, more reputable banks. Boot, Greenbaum, and Thakor (1993) predict this, and higher financial capital stochastically elevates reputational capital in their model. This suggests that higher-capital banks could gain a competitive advantage over lower-capital peers through this off-balance-sheet channel as well. We calculate off-balance-sheet guarantees as the sum of loan commitments and commercial and standby letters of credit.

To assess whether capital affects performance through these three channels, we regress each channel on the three capital–crisis interaction terms plus the same controls as those included in the main regressions. Based on the discussion above, we should find that higher precrisis capital ratios help banks increase their noncore funding, on-balance-sheet relationship loans, and off-balance-sheet guarantees, and this effect is likely to be stronger during financial crises than during normal times.

Table 6, Panel A, contains summary statistics, and Panel B shows the results. As expected, banks with more precrisis capital show higher growth in noncore funding, relationship loans, and off-balance-sheet guarantees during the crisis. Interestingly, this seems to hold for small banks at all times, and for medium and large banks primarily during banking crises—the cases in which capital helps banks survive and improve their market shares.

8. Additional analyses

We perform two additional analyses to deepen our understanding of how capital affects bank performance.

8.1. The effects of capital on the manner of exit

We first examine the manner of exit for nonsurviving banks to see whether they are also related to precrisis capital ratios. To address this, we focus on observations for which SURV equals zero, i.e., banks that were alive one quarter before the crisis, but ceased to exist one quarter after the crisis.

Table 7, Panel A, contains summary statistics. As can be seen, 926 of our sample banks exited during banking crises, 461 exited during market crises, and 365 exited during normal times (i.e., during the fake crises). The data show that banks exit in one of the following three ways. First, they were acquired or merged without government assistance. Depending on bank size, regular M&As accounted for 26–47% of all exits during banking crises; 81–86% during market crises, and 83–100% during normal times. Second, banks ceased to exist because they were acquired or merged with government assistance. Not surprisingly, such deals were especially prevalent during banking crises, accounting for 48–61% of all exits during those crises. During market crises and normal times, only 0–9% and 0–2%, respectively, merge with assistance. Third, banks ceased to exist because they failed outright or simply changed their charters. In the latter case, banks merely begin to operate under a new charter. Unfortunately, the data do not allow us to distinguish between outright failure and change of charter. We therefore provide only summary statistics but do not perform any further analyses for this category. This type of nonsurvival was not very prevalent. During banking crises, market crises, and normal times, the percentages ranged from 5–13%, 6–15%, and 0–17%, respectively.

To examine whether conditional on not surviving a crisis, the bank's precrisis capitalization affects the likelihood of exit via M&A without or with assistance, we run the following logit regressions:

$$EXIT\_UNASSIST_i = \log\left(\frac{Prob(UNASSIST_i)}{1-Prob(UNASSIST_i)}\right) = \alpha_6 + \beta_6 * EQRAT_i + B_6 * Z_i \tag{4}$$

and

$$EXIT\_ASSIST_i = \log\left(\frac{Prob(ASSIST_i)}{1-Prob(ASSIST_i)}\right) = \alpha_7 + \beta_7 * EQRAT_i + B_7 * Z_i \tag{5}$$

where $UNASSIST_i$ and $ASSIST_i$ are dummy variables that equal one if bank i was in the sample during the last quarter before a crisis but ceased to exist by the first quarter after the crisis because it merged or was acquired without assistance, and merged or was acquired with government assistance, respectively. $EQRAT_i$ is as defined above. Z_i is a set of control variables (see Table 7 for a list) which, to prevent collinearity, includes fewer variables than the main set X_i. The regressions are run only for cases in which there are a sufficient number of M&As. As a result, regressions are not run for medium and large banks (with or without assistance) during market crises and normal times, and for small banks (with assistance) during normal times. These cases are indicated below as n/a.

Table 7, Panel B, contains the results. The EXIT_UNASSIST regressions show that banks with higher capital ratios are *more* likely to be acquired via M&A without assistance during

Table 6

Three channels through which capital may affect performance: noncore funding, relationship loans, and off-balance-sheet guarantees.

This table examines three channels through which capital could affect performance: growth in noncore funding, on-balance-sheet relationship loans, and off-balance-sheet guarantees. Panel A shows summary statistics on the three channels. Panel B regresses the three channels on precrisis capital ratios.

The crises include banking crises (BNKCRIS: the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (MKTCRIS: the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (NORMALTIME) (see Section 3.1).

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion), unless otherwise noted. GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

NONCOREFUNDS is noncore funds (liabilities minus core deposits, the latter is the sum of transaction deposits, savings deposits, and small time deposits). RELSHIPLOANS is on-balance-sheet relationship loans (all loans excluding loans to depository institutions, foreign governments, and states). OBSGUARANTEES is off-balance-sheet guarantees (sum of loan commitments and commercial and standby letters of credit). Percentage changes (%Δ) are measured as the bank's average value during a crisis minus its average value over the eight quarters before the crisis, divided by its precrisis value.

SURVIVAL is a dummy that equals one if the bank is in the sample one quarter before such a crisis started and is still in the sample one quarter after the crisis, and zero otherwise. %ΔMKTSHARE, the percentage change in the bank's GTA market share is measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred.

EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. To preserve space, Panel B presents only the coefficients on the interaction terms although all the control variables (see Table 1) are included in the regressions. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics based on robust standard errors are in parentheses in Panel B. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Summary statistics on the three channels

	Small banks	Medium banks	Large banks
Banking crises			
%ΔNONCOREFUNDS (mean)	0.183	0.128	0.082
%ΔRELSHIPLOANS (mean)	0.144	0.149	0.145
%ΔOBSGUARANTEES (mean)	0.854	0.484	0.373
Market crises			
%ΔNONCOREFUNDS (mean)	0.214	0.329	0.286
%ΔRELSHIPLOANS (mean)	0.134	0.220	0.211
%ΔOBSGUARANTEES (mean)	0.341	0.378	0.297
Normal times			
%ΔNONCOREFUNDS (mean)	0.268	0.312	0.284
%ΔRELSHIPLOANS (mean)	0.146	0.200	0.222
%ΔOBSGUARANTEES (mean)	0.355	0.340	0.320

Panel B: Regression results

	%ΔNONCOREFUNDS			%ΔRELSHIPLOANS			%ΔOBSGUARANTEES		
Key variables	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks
EQRAT*BNKCRIS	3.113***	0.747***	1.844***	1.523***	0.969***	1.655***	3.401***	3.463*	3.846***
	(37.40)	(3.18)	(4.06)	(27.72)	(4.63)	(4.68)	(15.20)	(1.93)	(3.49)
EQRAT*MKTCRIS	1.975***	1.191***	1.825**	0.711***	−0.355**	0.978**	2.257***	0.773	1.302
	(24.82)	(2.80)	(2.47)	(12.63)	(−2.13)	(2.41)	(10.62)	(0.77)	(1.06)
EQRAT*NORMALTIME	1.404***	0.702	2.154**	0.378***	0.113	0.705	1.400***	0.361	1.292
	(11.60)	(1.12)	(2.45)	(5.15)	(0.36)	(1.18)	(6.15)	(0.29)	(1.32)
Number of observations	57,243	1,946	1,400	57,243	1,946	1,400	54,969	1,937	1,389
Adjusted R^2	0.20	0.24	0.18	0.20	0.19	0.10	0.17	0.14	0.11

Table 7
The effect of capital on the manner of exit.

This table examines whether precrisis capital affects a bank's likelihood of exiting in three ways during crises. The crises include banking crises (the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (see Section 3.1).

Panel A presents summary statistics on the frequency of exit via UNASSIST, ASSIST, and FAILURE/CHARTER, which are dummy variables that equal one if the bank exited via non-government-assisted mergers and acquisitions (M&As), government-assisted M&As, and outright failures or changes in charter, respectively, and zero otherwise. Panel B shows the results of logit regressions for the first two types of exit. $EXIT\_UNASSIST_i$ is $log(Prob(UNASSIST_i)/(1-Prob(UNASSIST_i)))$ and $EXIT\_ASSIST_i$ is $log(Prob(ASSIST_i)/(1-Prob(ASSIST_i)))$. The regressions are run only for cases in which there are a sufficient number of M&As. As a result, regressions are not run for medium and large banks (with or without assistance) during market crises and normal times, and for small banks (with assistance) during normal times. These cases are indicated as n/a.

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion). GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. To preserve space, Panel B presents only the coefficients on the key exogenous variables although the following control variables (for definitions, see Table 1) are included in the regressions: CREDIT_RISK, LOAN_CONCENTRATION, COMMERCIAL_REAL_ESTATE, BROKERED-DEPOSITS, SIZE, CORE_DEPOSITS, BHC_MEMBER, BRANCHES / ASSETS, LOCAL_MKT_POWER, METRO_MKTS, MULTI_MKT_CONTACT, and PROFITABILITY. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics are in parentheses in Panel B. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Summary statistics – Frequency of the three ways of exit

	Small banks			Medium banks			Large banks		
Exit during	UNASSIST	ASSIST	FAILURE/ CHARTER	UNASSIST	ASSIST	FAILURE/ CHARTER	UNASSIST	ASSIST	FAILURE/ CHARTER
Banking crises									
Fraction of number of observations	0.47	0.48	0.05	0.26	0.61	0.13	0.35	0.59	0.06
Number of observations	822	822	822	70	70	70	34	34	34
Market crises									
Fraction of number of observations	0.86	0.09	0.06	0.81	0.04	0.15	0.85	0.00	0.15
Number of observations	421	421	421	27	27	27	13	13	13
Normal times									
Fraction of number of observations	0.91	0.02	0.07	0.83	0.00	0.17	1.00	0.00	0.00
Number of observations	340	340	340	18	18	18	7	7	7

Panel B: The effect of the bank's precrisis capital ratio on the likelihood of exiting in a specific manner

	Small banks		Medium banks		Large banks	
Exit during	EXIT_UNASSIST	EXIT_ASSIST	EXIT_UNASSIST	EXIT_ASSIST	EXIT_UNASSIST	EXIT_ASSIST
Banking crises						
EQRAT	3.677*	−5.605***	5.514	−51.661*	139.865*	−15,747.827***
	(1.91)	(−2.73)	(0.35)	(−1.82)	(1.67)	(−11.28)
Market crises						
EQRAT	4.545	−16.656	n/a	n/a	n/a	n/a
	(0.95)	(−1.59)	n/a	n/a	n/a	n/a
Normal times						
EQRAT	−18.172***	n/a	n/a	n/a	n/a	n/a
	(−2.78)	n/a	n/a	n/a	n/a	n/a

banking crises (significant for small and large banks) and market crises (small banks only; not significant). This could reflect the fact that capital is at a premium especially during banking crises, so banks with higher capital fetch higher prices and this reduces the takeover resistance of the managers in these banks.

The EXIT_ASSIST regressions show that banks of all sizes with higher capital ratios are significantly *less* likely to be acquired with government assistance during banking crises. This is not surprising because government assistance is typically provided to acquirers when they take over severely undercapitalized banks. The effect is almost significant for small banks during market crises.

8.2. The effects of capital on banks' coxmpetitive position for banks with different growth strategies

Banks have different growth strategies. While some grow organically, others actively engage in M&As. It is interesting to see if our finding (capital helps small banks improve their market shares at all times and helps medium and large banks to strengthen their competitive

Table 8
The effect of capital on banks with different growth strategies.

This table examines how precrisis capital impacts market shares of banks with different growth strategies. The crises include banking crises (BNKCRIS: the credit crunch of the early 1990s and the recent subprime lending crisis), market crises (MKTCRIS: the 1987 stock market crash; the Russian debt crisis and Long-Term Capital Management bailout in 1998; and the bursting of the dot.com bubble and September 11), and normal times (NORMAL TIME) (see Section 3.1).

Results are shown for small banks [gross total assets (GTA) up to $1 billion], medium banks (GTA exceeding $1 billion and up to $3 billion), and large banks (GTA exceeding $3 billion). GTA equals total assets plus the allowance for loan and the lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

Panel A contains summary statistics for two subsamples – banks that grow via mergers and acquisitions (M&As) versus organically during a crisis. Panel B regresses %ΔMKTSHARE on precrisis capital plus controls for these two subsamples. %ΔMKTSHARE, the percentage change in the bank's GTA market share is measured as the bank's average market share during a crisis minus its average market share over the eight quarters before the crisis, divided by its precrisis market share, and multiplied by one hundred.

EQRAT is the equity capital ratio, calculated as equity capital as a proportion of GTA. To preserve space, Panel B presents only the coefficients on the key exogenous variables although all the control variables except for profitability (see Table 1) are included in the regressions. All dollar values are expressed in real 2010:Q4 dollars using the implicit gross domestic product price deflator.

t-statistics are in parentheses in Panel B. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Summary statistics – Mean change in market share of banks that grow via M&As versus organically

	Banks that grow via M&As during the crisis			Banks that grow organically during the crisis		
%ΔMKTSHARE	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks
Banking crises						
%ΔMKTSHARE (mean)	0.242	0.139	0.115	0.040	0.029	0.030
Number of observations	937	120	150	15,214	486	270
Market crises						
%ΔMKTSHARE (mean)	0.283	0.273	0.209	0.037	0.097	0.096
Number of observations	280	84	87	25,419	699	494
Normal times						
%ΔMKTSHARE (mean)	0.225	0.196	0.148	0.009	0.058	0.070
Number of observations	212	58	84	15,235	516	337

Panel B: The effect of the bank's precrisis capital ratio on its market share for banks that grow via M&As versus organically

	%ΔMKTSHARE of banks that grow via M&As during the crisis			%ΔMKTSHARE of banks that grow organically during the crisis		
Key variables	Small banks	Medium banks	Large banks	Small banks	Medium banks	Large banks
EQRAT*BNKCRIS	0.324*	−0.245	1.297*	1.221***	0.714***	1.120***
	(1.65)	(−0.48)	(1.76)	(28.74)	(4.32)	(3.88)
EQRAT*MKTCRIS	−0.677	−1.138	0.672	0.593***	−0.030	0.588
	(−1.63)	(−1.41)	(0.34)	(15.02)	(−0.28)	(1.63)
EQRAT*NORMALTIME	−0.460	3.727*	3.050	0.297***	−0.001	0.453
	(−1.07)	(1.71)	(1.46)	(5.57)	(−0.01)	(1.17)
Number of observations	1,429	260	319	55,814	1,686	1,081
Adjusted R^2	0.15	0.14	0.05	0.22	0.19	0.08

position during banking crises only) differs between banks with these two strategies. To examine this, we split banks into two groups: banks that made at least one M&A during the crisis versus banks that did not.

Table 8, Panel A, contains summary statistics on these two groups. Less than 1% of the small banks engage in M&As, while the percentages for medium and large banks are far higher.[29] Not surprisingly, on average, banks that engaged in M&As during crises showed far bigger increases in their market shares (11.5–27.3%) than those that did not (0.9–9.7%).

Table 8, Panel B, shows the regression results. For banks that grow organically, the results are very similar to our main results. For acquiring banks, capital only helps small and large banks during banking crises, and medium banks during normal times. The generally weaker effects for acquiring banks are unexpected and suggest that capital may be crucial in the M&A process except during banking crises.

9. Conclusion

Guided by the existing theories, this paper empirically addresses the impact of capital on bank survival and market share during financial crises and normal times. Our two main results are as follows. First, capital helps to enhance the survival probabilities and market shares of small banks at all times (during banking crises, market crises, and normal times), regardless of whether crises are grouped or studied individually. Second, capital helps

[29] Small-bank executives often indicate reluctance to making M&As because issuing new shares to pay for the target would trigger a need for SEC registration if the number of shareholders increased to over five hundred. Because the JOBS Act, signed into law in April 2012, increases the registration threshold from five hundred to two thousand shareholders, growing via M&As will be more attractive for small banks in the future. See Wall Street Journal (2012)

medium and large banks primarily during banking crises, and largely during the one with relatively limited government intervention, the credit crunch of the early 1990s. These findings are generally robust.[30] The effects of precrisis capital appear to be manifested through growth in noncore funding, relationship lending and off-balance-sheet guarantees.

Our analysis sheds light on the economic roles of capital and on how they vary in the cross section of banks depending on bank size (small, medium, and large) and time period (banking crisis, market crisis, or normal time). In particular, it suggests substitutability between bank size and bank capital and illuminates some of the reasons for this. One implication is that future theoretical and empirical explorations of the economic role of bank capital, and the associated regulatory implications, ought to pay attention to bank size and the differences in bank incentives engendered by size heterogeneity, as well as to the time period during which one examines the role of capital.

Appendix A. Description of the banking and market crises that occurred in the US (1984:Q1–2010:Q4)

A.1 Two banking crises

Credit crunch (1990:Q1–1992:Q4): During the first three years of the 1990s, bank commercial and industrial lending declined in real terms, particularly for small banks and for small loans. The ascribed causes of the credit crunch include a fall in bank capital from the loan loss experiences of the late 1980s (e.g., Peek and Rosengren, 1995), the increases in bank leverage requirements and implementation of Basel I risk-based capital standards during this time period (e.g., Hancock, Laing, and Wilcox, 1995; Thakor, 1996), an increase in supervisory toughness evidenced in worse examination ratings for a given bank condition, and reduced loan demand because of macroeconomic and regional recessions (e.g., Bernanke and Lown, 1991). The existing research provides some support for each of these hypotheses.

Subprime lending crisis (2007:Q3–2009:Q4): The subprime lending crisis has been characterized by turmoil in financial markets as banks have experienced difficulty in selling loans in the syndicated loan market and in securitizing loans. The supply of liquidity by banks dried up, as did the provision of liquidity in the interbank market. Many banks experienced substantial losses in capital. Massive loan losses at Countrywide resulted in a takeover by Bank of America. Bear Stearns suffered a fatal loss of confidence among its financiers and was sold at a fire-sale price to J.P. Morgan Chase, with the Federal Reserve guaranteeing $29 billion in potential losses. Washington Mutual, the sixth-largest bank, became the biggest bank failure in the US financial history. J.P. Morgan Chase purchased the banking business while the rest of the organization filed for bankruptcy. IndyMac Bank was seized by the Federal Deposit Insurance Corporation (FDIC) after it suffered substantial losses and depositors had started to run on the bank. The FDIC sold all deposits and most of the assets to OneWest Bank, FSB, and incurred an estimated loss of about $13 billion. The Federal Reserve also intervened in some unprecedented ways in the market. It extended its safety-net privileges to investment banks and one insurance company (AIG), intervened in the commercial paper market, and began holding mortgage-backed securities and lending directly to investment banks. The Treasury initially set aside $250 billion out of its $700 billion bailout package [Troubled Asset Relief Program (TARP)] to enhance capital ratios of selected financial institutions. In all, the Treasury invested in 707 financial institutions through the Capital Purchase Program component of TARP, including $125 billion in $10 billion and $25 billion increments to each of nine large financial institutions at the inception of the program in October 2008. Some institutions used these funds to acquire lesser-capitalized peers. For example, PNC Bank used TARP funds to acquire National City Bank, and Bank of America bought Merrill Lynch. During 2009, 140 US banks failed, and the Federal Deposit Insurance Corporation Bank Insurance Fund fell into a deficit position. By the first quarter of 2010, much of the TARP funds invested in financial institutions had been repaid, and order had been restored to most of the financial markets, although small banks continued to fail at a high rate.

A.2. Three market crises

Stock market crash (1987:Q4): On Monday, October 19, 1987, the stock market crashed, with the S&P500 index falling about 20%. During the years before the crash, the level of the stock market had increased dramatically, causing some concern that the market had become overvalued.[31] A few days before the crash, two events occurred that may have helped precipitate the crash. Legislation was enacted to eliminate certain tax benefits associated with financing M&As, and information was released that the trade deficit was above expectations. Both events seemed to have added to the selling pressure, and a record trading volume on October 19, in part caused by program trading, overwhelmed many systems.

Russian debt crisis and Long-Term Capital Management bailout (1998:Q3–1998:Q4): Since its inception in March 1994, hedge fund Long-Term Capital Management (LTCM) followed an arbitrage strategy that was avowedly market-neutral, designed to make money regardless of whether prices were rising or falling. When Russia defaulted on its sovereign debt on August 17, 1998, investors fled from other government paper to the safe haven of US treasuries. This flight to liquidity caused an unexpected

[30] Given our findings, it may seem surprising that banks often resist calls for higher capital (Mishkin, 2000), although most banks hold capital well in excess of regulatory minimums (Berger, DeYoung, Flannery, Lee, and Oztekin, 2008). While outside the scope of our paper, there could be several reasons for resistance: managerial hubris (Roll, 1986), which may include underestimating the probability of banking crises, especially when times are good; private benefits related to the government safety net; and forced departure from privately-optimal capital structure choices (Mehran and Thakor, 2011).

[31] E.g., Wall Street Journal (1987, p. 1).

widening of spreads on supposedly low-risk portfolios. By the end of August 1998, LTCM's capital had dropped to $2.3 billion, less than 50% of its December 1997 value, with assets standing at $126 billion. In the first three weeks of September, LTCM's capital dropped further to $600 million without shrinking the portfolio. Banks began to doubt its ability to meet margin calls. To prevent a potential systemic meltdown triggered by the collapse of the world's largest hedge fund, the Federal Reserve Bank of New York organized a $3.5 billion bailout by LTCM's major creditors on September 23, 1998. In 1998:Q4, several large banks had to take substantial write-offs due to losses on their investments.

Bursting of the dot.com bubble and September 11 terrorist attack (2000:Q2–2002:Q3): The dot.com bubble was a speculative stock price bubble that was built up during the mid- to late-1990s. During this period, many internet-based companies, commonly referred to as "dot.coms," were founded. Rapidly increasing stock prices and widely available venture capital created an environment in which many of these companies seemed to focus largely on increasing market share. At the height of the boom, many dot.coms were able to go public and raise substantial amounts of money even if they had never earned any profits, and in some cases had not even earned any revenues. On March 10, 2000, the Nasdaq composite index peaked at more than double its value just a year before. After the bursting of the bubble, many dot.coms ran out of capital and were acquired or filed for bankruptcy (examples of the latter include WorldCom and Pets.com). The US economy started to slow down and business investments began falling. The September 11, 2001 terrorist attacks may have exacerbated the stock market downturn by adversely affecting investor sentiment. By 2002:Q3, the Nasdaq index had fallen by 78%, wiping out $5 trillion in market value of mostly technology firms.

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