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How Do Large Banking Organizations Manage Their Capital Ratios?

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Abstract: Large banking organizations in the U.S. hold significantly more equity capital than the minimum required by bank regulators. This capital cushion has built up during a period of unusual profitability for the banking system, leading some observers to argue that the capital merely reflects recent profits. Others contend that the banks deliberately choose target capital levels based on their risk exposures and their counterparties' sensitivities to default risk. In either case, the existence of "excess" capital makes it difficult to observe how banks manage their capital levels, particularly in response to regulatory changes (such as Basel II). We propose several hypotheses to explain this "excess" capital, and test these hypotheses using annual panel data for large, publicly traded U.S. bank holding companies (BHCs) from 1992 through 2006, and an innovative partial adjustment approach that allows both the target capital ratios and the speed of adjustment toward those targets to vary with firm-specific characteristics. We find evidence to suggest that large BHCs actively managed their capital ratios during our sample period. Our tests suggest that large BHCs choose target capital levels substantially above well-capitalized regulatory minima; that these targets increase with BHC risk but decrease with BHC size; that BHCs adjust toward these targets relatively quickly; and that adjustment speeds are faster for poorly capitalized BHCs, but slower (ceteris paribus) for BHCs under severe regulatory pressure.

JEL Classification Numbers: G21, G28, G32
Key words: Banks, Capital management, Capital regulation, Partial adjustment models.

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Introduction

Banking firms have long been subject to explicit or implicit limits on their permissible leverage. Bankers frequently argue that an excessively high equity capital ratio reduces their ability to compete because equity is more expensive than debt finance. Many researchers therefore expect that banks will operate close to their required minimum capital ratios. Since the early 1990s, however, the largest U.S. banking organizations have maintained ratios well in excess of regulatory minimums.

Large U.S. bank holding companies (BHCs) are subject to similar capital standards as individual banks.[1] To meet the Basel I capital guidelines, U.S. BHCs must have Tier 1 capital of 4% of risk-weighted assets (RWA) and total regulatory capital (Tier 1 plus Tier 2) exceeding 8% of RWA.[2] U.S. BHCs are also subject to a leverage requirement – most large BHCs must operate with Tier 1 capital equal to at least 3% or 4% of unweighted total assets (the "leverage ratio"), depending on the condition of the institution. It is widely believed that current supervisory procedures afford some discretionary benefits to institutions classified as "well capitalized" – those holding Tier 1 capital of at least 6% of RWA and total regulatory capital above 10% of RWA.

Since the mid-1990s, the typical large U.S. banking organization has substantially exceeded even these highest supervisory standards. For example, in late 2007 and early 2008, Citigroup raised about $20 billion of new capital and cut its dividend by 30% to offset losses from mortgages and other investments. Their goal was to help restore Citigroup's Tier 1 capital ratio to its desired 7.5% level, substantially above the "well capitalized" level of 6%. More generally, as of June 2007, the 67 BHCs with assets exceeding $10 billion had a mean Tier 1 leverage ratio of 7.63%, a Tier 1 risk-based ratio of 9.38%, and a total risk-based capital ratio of 11.97%. By all three measures, large U.S. BHCs hold substantially more capital

[1] Our data are for U.S. bank holding companies with total assets exceeding $150 million, and are obtained from the year-end FR-Y9C reports. Unless otherwise indicated, all capital data referred to in the text comes from these reports. For convenience, we refer to these companies alternatively as "banks," "firms," or "institutions."

[2] Definitions for Tier 1 capital, Tier 2 capital, and other risk-based capital terms are provided in the following section.

than required by the most restrictive supervisory standard.[3] Why?

A bank – or, indeed, any sort of firm – might stockpile more capital than it currently needs if it may confront costs or uncertainties of raising new equity on short notice. If capital becomes low, a bank can only raise capital quickly by selling new shares, which may entail significant transaction costs or share price reductions. In addition, the owners of a highly-levered firm transfer value to fixed income claimants (including the government safety net) when they raise new equity, as in the classic "debt overhang" situation (Myers 1977). Just as banks may wish to maintain high capital ratios to avoid such problem situations, it is also relatively easy to maintain or increase equity when earnings are high. Since dividend payments tend to be sticky, capital ratios may rise almost automatically with high earnings. Given the historically high profitability of U.S. banking since the early 1990s, some observers contend that banks increased their capital ratios simply because earnings were easily retained. According to this view, today's high bank capital ratios were not explicitly targeted, but simply reflect a long run of high profits.

These so-called "capital cushions" at large banking organizations – capital ratios that exceed the regulatory minima – have important implications for policy. Regulators are concerned that banks' capital cushions may move pro-cyclically. That is, banks might target higher capital ratios during recessions to mitigate insolvency risk, which would restrict the extension of credit and potentially exacerbate the recession. It is alternatively possible that banks target lower capital ratios during recessions in order to maintain lending relationships, raising bank default probabilities in the process. The existence of voluntary capital cushions also has implications for the efficacy of bank capital regulation. Are capital standards effective even if they do not always bind? If capital requirements were to rise, would banks raise their capital targets by a like amount? Or would they simply reduce their capital cushions and leave their capital targets unchanged? What are the implications of these behaviors on banks' default risk

[3] Many of the BHC-year observations in our sample showed risk-weighted capital ratios more than 600 basis points above the "well capitalized" standard. This proportion is 44.1% for the Tier 1 capital ratio and 19.2% for total regulatory capital ratio.

and/or on the influence of supervisors on banks' default risk? Without understanding banks' observed capital levels and capital cushions, it is hard to predict how they will respond to economic or supervisory changes.

The paper is organized as follows. In Section II, we describe current U.S. capital regulations and show that the vast majority of large BHCs in the U.S. substantially exceed the minimum capital requirements. In Section III, we offer some testable hypotheses to help explain these facts. Section IV decomposes the capital changes at large BHCs between 1992 and 2006 into three parts: retained earnings, shares issued to acquire other institutions, and shares issued for non-merger-related purposes. Banking companies earned high profits during the 1990s and early 2000s, and retained large portions of those earnings. However, our sample of large BHCs also *retired* equity shares in 12 of our 15 sample years, suggesting that banks actively managed their capital ratios.

In Section V we present a partial adjustment regression model with firm-specific speeds of adjustment. The model allows us to separate active capital management from passive capital build-ups. We hypothesize that a BHC's desired or target capital level depends on its riskiness, market value, growth strategy, size, and product mix, while the speed at which a BHC adjusts toward that target depends on its initial capital adequacy and any extraordinary supervisory or market pressures it may be under. Section VI describes our data set, which includes 4,563 bank-year observations on 666 publicly traded BHCs between 1992 and 2006. Section VII presents and interprets our empirical results. We find strong evidence that large BHC capital targets were higher than their actual capital ratios during our sample period; that these targets increase with BHC risk but decrease with BHC size; and that BHCs adjust toward their targets quite rapidly. Poorly capitalized BHCs adjust toward their targets more quickly than already well capitalized BHCs, and BHCs under the most severe regulatory pressure adjust toward their targets more slowly. Importantly, our results suggest that incorporating firm-specific adjustment speeds into a partial adjustment model has non-trivial effects on the estimated model coefficients. Section VIII concludes.

II. BHC Capital Requirements and Aggregate Capital Ratios

Supervisors require that banks and bank holding companies maintain minimal equity capital ratios as protection for depositors, other stakeholders, and the government safety net.[4] During our 1992-2006 sample period, these minimum ratios were specified by the U.S. implementation of the 1988 Basel Accord, an international agreement commonly referred to as "Basel I."[5] Basel I specifies which outstanding securities "count" as regulatory capital. In the main, "Tier 1" regulatory capital includes common and preferred equity shares. "Tier 2" capital includes subordinated debentures and a variety of limited-life (hybrid) securities. The allowance for loan and lease losses also counts as Tier 2 capital, up to 1.25% of the bank's risk-weighted assets.[6] Basel I also specifies a set of risk weights applicable to bank assets, including contingent and off-balance sheet obligations. The international Basel Accord specifies two minimally acceptable capital ratios: Tier 1 capital must be at least 4% of risk-weighted assets, while total capital (Tier 1 plus Tier 2) must be at least 8% of risk-weighted assets.

Basel I capital standards consider only credit risk and distinguish only coarsely among different types of bank assets. In recognition of difficult-to-measure interest rate, operational, and market risk exposures, U.S. supervisors placed a floor under bank capital by imposing a third minimum equity ratio known as the "leverage requirement," which requires banks to maintain a minimum ratio of Tier 1 capital to unweighted assets. BHCs with the highest supervisory rating (i.e., a BOPEC rating of 1, discussed below), as well as those that have implemented the Federal Reserve Board's risk-based capital measure for market risk, may hold a leverage ratio of 3%. All other BHCs are expected to maintain a minimum leverage ratio of at least 4%.

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[4] At a multibank holding company these supervisory capital standards are applied at two organizational levels: individually at each of the affiliate banks by applying risk weights to their assets and activities, and collectively at the bank holding company by applying risk weights to the combined or "consolidated" assets and activities of the organization, including the assets and activities of its affiliates.

[5] Basel II was finalized and published by the Basel Committee in 2006. European and Japanese banks began transitioning to Basel II rules in January 2007, while U.S. banks have not yet begun their transition. Recent rules announced by the U.S. regulatory agencies set 2008 as the earliest year for a large U.S. banking organization to begin its transition to Basel II's advanced internal ratings-based (AIRB) method for computing adequate capital.

[6] The complete rules for determining a BHC's capital adequacy are provided in Appendix A to CFR Part 225 (Regulation Y).

While these formal capital regulations specify minimums for all institutions, supervisors may require some additional capital for individual institutions that are perceived to pose significant risks. The largest institutions and those with special roles in the payments system may also be required to hold additional capital as protection against systemic defaults. Strictly speaking, therefore, an outside observer cannot determine whether an individual large BHC's capital exceeds regulatory and supervisory requirements. However, U.S. bank holding companies as a whole do hold capital in amounts that substantially exceed the Basel I minimums. Figures 1a and 1b plot, respectively, the annual time-series of (equally-weighted) mean capital ratios for all of the large BHCs in our 1992-2006 sample period, and for the largest 25 BHCs in our sample during that time period.[7] While the figures display some systematic ups and downs over time, the annual averages exceed minimum capital standards by material amounts in every year of the data. For example, Figure 1a shows that in 2006 the average Tier 1 risk-based capital ratio exceeded the "well-capitalized" standard by 5.27% (= 11.27% - 6%), while the Total risk-based capital ratio exceeded the well-capitalized standard by 2.83% (= 12.83% - 10%). Calculated relative to the "adequately capitalized" standards, these capital cushions would be 200 basis points larger. Similar conclusions follow for the very largest BHCs, as shown in Figure 1b.

The time trends in Figures 1a and 1b reflect two separate phenomena: recovery from a weak banking environment and risk-shifting behavior by banks. The banking system re-capitalized itself in the early 1990s, following the effects of the 1990-91 recession and the so-called "credit-crunch." Basel I, the leverage requirement, and renewed regulatory vigilance about capital ratios are often credited with these increases in bank capital. Note that the leverage ratio is more than 100 basis points higher in 2006 than it was at year-end 1992, continuing a trend that goes back at least to 1986 (not shown in the figures). The two risk-based measures, however, peaked in the mid-90s and then declined. The broader impact of these time trends are reflected in Figures 2, 3, and 4, which show how the distribution of the leverage, Tier 1, and total capital ratios shifted between 1992 and 2006 for the individual bank holding companies in our

[7] We evaluate book-valued capital ratios because supervisory minima apply to book values. It remains an open question whether a firm, left to its own devices, would evaluate its leverage in terms of book or market values.

sample.[8] The rightward shift in Figure 2's distribution of leverage capital ratios reflects the general increase in industry-wide capital during our sample period. Over the same interval, the cross-sectional standard deviation of leverage ratios fell slightly, from 1.8% to 1.6%. Figure 3 indicates a relatively stable distribution of Tier 1 risk-weighted capital ratios which became more tightly distributed over time around a center of 11% to 12% – well above regulatory minimums. The reduced dispersion occurs on both sides of the mean: poorly capitalized banks increased their capital ratios, while the most heavily capitalized banks reduced their capital ratios. Similarly, the total risk-based capital ratio shown in Figure 4 also became more tightly distributed over time, around a center of about 13% – again, well above regulatory minimums. The increasing leverage ratio together with the flat (or declining) risk-weighted capital ratios suggest that banks have substituted into assets with higher risk weights over time.

III. Hypotheses: Why do Banks Hold Excess Capital?

Some authors have asserted that explicit and implicit government guarantees lead banking institutions to operate with as little capital as the supervisor will permit. Clearly, though, the evidence displayed above shows that this assertion is not always true. We investigate three alternative hypotheses, some or all of which may help explain the high observed capital ratios:

1. Earnings Retention. High capital may simply reflect BHCs' retention of historically high earnings during the period following 1992. Myers (1984) suggests that firms may face difficulties raising equity capital on short notice, and hence prefer to retain earnings as a precaution against unknown future needs (see also Myers and Majluf 1984). This "pecking order" theory of capital structure implies that leverage at any point in time primarily reflects the history of retained earnings, not a forward-looking leverage goal. Capital payouts may also send unfavorable signals to the market about the bank's ability to invest the funds profitably (i.e., its growth opportunities). Supervisory pressure to maintain high capital may further reinforce the "pecking order" considerations.

[8] The figures exclude BHCs with high outlying capital ratios in the top 1% of the distributions.

2. Economic Capital. Banking organizations may match their capital ratios to perceived risk exposures and to the benefits of maintaining a specific standing in credit markets. Under this view, minimum supervisory standards are largely irrelevant, at least under normal industry conditions.[9] Instead, a BHC's optimal capital ratio responds to (at least) four forces. First, banks with *more volatile* earnings should choose higher equity capital ratios.[10] Second, banks whose customers are *more sensitive to default risks* should hold added capital, reflecting pressure from uninsured market counterparties such as large liability-holders, customers with lines of credit, and OTC trading partners. Third, firms with *more valuable charters* may tend to hold more equity to protect their future profit streams (e.g., Marcus 1984, Keeley 1990, Demsetz, Saidenberg, and Strahan 1996, Hellmann, Murdock, and Stiglitz 2000). A valuable charter may be reflected in a higher market-to-book ratio (MB), so a high MB would be associated with a higher capital ratio. (Alternatively, a high MB may indicate that it would be easier to raise new equity in the future, which reduces the demand for "precautionary" capital today. The sign of the market-to-book ratio should reflect the net effect of these opposing hypotheses. Peura and Keppo (2006) model the bank capital decision as a dynamic tradeoff between the opportunity cost of equity and the loss of franchise value.) Finally, bank capital ratios tend to be inversely related to asset size. This might reflect greater diversification, scale economies in risk management, and/or lower expected cost of raising new equity on short notice. For the very largest banks, another contributor to low capital may be the presence of conjectural government guarantees ("too big to fail").

3. Acquisition Plans. Acquisition-minded banking organizations may maintain additional capital in order have some "dry powder" available should attractive investment opportunities arise. Since the

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[9] Gropp and Heider (2007) find no evidence of a strong supervisory influence on capital ratios at large U.S. and European banking firms. Rather, they conclude that their sample banks select leverage in much the same way that nonfinancial firms do. Although we evaluate a very similar question, our analysis differs in several important regards. First, Gropp and Heider investigate the determinants of book-valued and market-valued *equity* ratios, while we explicitly study the *regulatory capital* ratios. Second, their static regression imposes the assumption that capital is chosen each period without regard to the prior year's capital. This assumption is not consistent with significant leverage adjustment costs. Finally, our explanatory variables reflect banking institutional arrangements more closely than Gropp and Heider's, which include the same balance ratios typically related to nonfinancial firms' leverage ratios.

[10] Related to this motive for holding capital is the risk aversion of bank decision makers. See, for example, Gale and Ozgur (2005).

Financial Accounting Standards Board (FASB) eliminated pooling-of-assets accounting treatment for mergers in mid-2001, acquiring a firm at above its book value requires more capital than the target and the acquirer had previously been holding.[11] Even without this accounting reform, supervisors may be reluctant to permit large acquisitions on safety and soundness grounds unless the resulting *pro forma* firm would be sufficiently capitalized. We therefore expect that banks planning more mergers and acquisitions would maintain higher capital ratios.

Clearly, these three hypotheses are not mutually exclusive and we include variables related to all three in our regressions. Still, it may be difficult to disentangle their independent effects, for two reasons. First, the observed capital ratios may not be equilibria. Actual bank capital can differ from desired or "target" bank capital, and these hypotheses concern desired capital. Second, during our sample period relatively few banks were undercapitalized and bank earnings often reached historic highs. It may be more difficult to reject some of the null hypotheses during our sample period than it would be in a period in which banks experienced more variation in capital and earnings.[12]

IV. Sources of Capital Growth at Large BHCs

Here, we trace the growth of equity capital (relative to total assets) from 1992 through 2006 for the BHCs in our sample with publicly traded shares. In particular, we concentrate on the contribution of retained earnings to the aggregate growth in capital ratios. The 1990s provided U.S. banks with an extended period of historically high earnings, as shown in Figure 5. Since 1992, aggregate return-on-assets (ROA) at U.S. commercial bank holding companies has averaged 1.05% per year, substantially higher than the 0.63% annual average between 1976 and 1991. It seems possible that the recent high

[11] Before June 2001, most bank mergers were treated as a pooling of interests, in which the acquired firm's assets remained valued at their book values. The combined (post-merger) entity therefore had no increase in the value of its unweighted assets, and hence required no more capital on account of the merger. We estimated several versions of our empirical analysis below that included an interaction term between our merger strategy variable and a post-June 2001 dummy; the coefficient on this interaction variable was never statistically significant and hence we dropped the variable from the specifications shown here.

[12] We do not extend our analysis back before 1992 because the detailed financial data needed to test our hypotheses were not all available in earlier years, and because the Basel I international capital regime was not fully implemented in the U.S. until 1992.

levels of earnings permitted the banks to build their capital ratios through simple inertia – keeping dividends constant and retaining the high earnings as a defense against unspecified risks or eventualities.

How does this "pecking order" explanation accord with the movements in capital ratios observed in Figures 1 through 4? If BHCs were simply retaining earnings as they occurred, there should be no correlation between earnings and new shares. According to the pecking order theory, we might even expect a negative correlation: BHCs sell new shares only when their earnings are insufficient to cover available investment opportunities. However, based on aggregate annual data for our full sample of BHCs between 1992 and 2006, we find a +0.16 correlation between retained earnings and (total) new equity issued each year.[13] This correlation increases to +0.41 for the set of 136 Surviving Banks as well as for the 25 largest Surviving Banks, which might be expected to manage their equity capital more carefully. Such positive correlations strongly suggest that banks were actively seeking higher capital ratios, even beyond their unusually high levels of retained earnings.

This impression becomes even stronger after we net out the impact of acquisitions on the banks' capital ratios. Our 1992-2006 sample period coincides with the consolidation of the U.S. banking industry, predominantly via mergers, following the deregulation of geographic banking markets. Virtually all of the larger transactions were financed with stock.[14] Hence, the shifts in book capital at large surviving BHCs illustrated in Figures 1-4 includes (a) the book equity capital of the acquired banks plus (b) any acquisition premium paid in excess of the target banks' book equity capital. Because acquisitions are likely driven by considerations other than capital ratios, we separate the impact of acquisitions from the impact of retained earnings on capital.

Each bank's year-over-year change in equity capital can be decomposed (approximately) into two parts: retained earnings (net income less dividends) and the net issuance of new common shares. We

[13] The annual dollar figures we used in these correlations correspond with the percentages in Table 1 below.

[14] Until the middle of 2001, bank acquisitions were generally accounted for as a pooling of interests, which required payment in shares. The FASB eliminated the pooling treatment on June 30, 2001, but large transactions continued to be financed with shares. Because the post-2001 "purchase" method of accounting recognizes capital gains in the target's assets, this accounting change tends to raise the amount of equity required for the post-transaction entity.

estimate how much new equity a bank issued each year in the following way:

1) Calculate the change in the bank's capital value between adjacent year-ends (ΔCAP).

2) Calculate the bank's retained earnings as "net income" less "dividends paid" (RE).

3) Identify any BHCs in our sample that were acquired by the bank.[15]. Assume that the acquirer issued new shares to the target's shareholders. This acquisition cost (AC) should equal the market value of the target's equity on its last trading day.

4) A BHC can adjust its capital independent of its acquisitions by issuing or redeeming additional shares beyond those involved in the merger. We can compute the value of these *other* new shares issued by the BHC as: value of other shares issued = ΔCAP – RE – AC.

The darker bars in Figures 6a and 6b indicate shares issued to acquire other BHCs (AC), while the lighter-colored bars illustrate the "value of other shares issued" in the same year. In the aggregate, BHCs were redeeming substantial amounts of existing shares at the same time they were issuing new shares to finance their acquisitions. This is equally true of the entire sample (Figure 6a) and of the 25 largest surviving BHCs (Figure 6b), and strongly suggests active capital management.

Table 1 decomposes each year's aggregate change in equity capital for the firms in our sample into retained earnings (RE), shares issued in connection with mergers (AC), and other shares issued (OTHER). We generate these numbers separately for three groups of BHCs: all 666 sample banks (4,563 bank-year observations), the 136 banks that survived our entire sample period (1,598 bank-year observations), and the 25 largest surviving banks based on their year-end 2006 book assets (348 bank-year observations).[16] Because one year's results (1999) distort the sample means, we focus primarily on the medians reported in the bottom row of Table 1.[17] Retained earnings accounted for roughly two-thirds

[15] This procedure ignores any acquisitions that were not previously included in our dataset of exchange-traded BHC. Such omissions are likely to be relatively small.

[16] Note that even BHC that "survived" – in the sense of reporting data in the first and last sample years -- have some missing values in the intervening years. As we discuss in Section VI, some of these missing values reflect extremely high capital ratios, which we omitted in order to avoid distorting our results by idiosyncratic factors outsdie of our model.

[17] This 1999 distortion may be related to the unusual amount of bank acquisition activity in 1998. Approximately $200 billion (market value of equity) worth of banks were acquired in the U.S. during 1998, including the NationsBank-Bank of America, Wells Fargo-Norwest, and Bank One-First Chicago NBD deals. Absorbing these

of new equity capital for all three groups, although the variation across time is large. New shares to finance acquisitions account for more than half of new equity capital in the entire sample, but more than 85% of new equity for the surviving banks, which are presumably more acquisitive than average. Perhaps the most surprising feature of Table 1 is that the "other issuance" of shares is negative on average for all three groups. For all three sub-samples, BHCs *retired* shares on net as part of their non-acquisition-related activities in twelve of the fifteen sample years. The median amount retired was about 51% of the change in equity capital for the entire sample, and 55% (65%) for the Surviving (Largest 25 Surviving) sub-samples. These share retirements are strongly related to merger-related share issuance: the simple linear correlations between the AC/ΔCAP and Other/ΔCAP columns are -0.77, -0.73, and -0.74 (left-to-right) for these three groups of BHCs.

The results in Table 1 strongly suggest that U.S. BHC actively manage their capital positions to compensate for the effect of acquisitions. Thus, the industry's high capital ratios reflect more than a simple accumulation of historically high retained earnings. We now proceed to model more completely how and why BHCs' regulatory capital ratios change over time.

V. Model Specification

We apply a "variable speed of partial-adjustment" model to the data underlying Figures 1 through 4. This model allows us to estimate whether banks' operating features determine specific target capital ratios. We model the target capital ratio $k_{i,t}*$ as a function of the firm's characteristics:[18]

$$k_{i,t}* = \frac{K^*_{i,t}}{A_{i,t}} = \beta X_{i,t-1} \qquad (1)$$

where:

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large acquisitions apparently sidelined large acquisitive banks for a year, resulting in only about $60 billion worth of bank merger deals in 1999. (Data from Thomson Financial.)

[18] In terms of this model, a supervisory capital standard is "binding" when it equals or exceeds the firm's preferred capital ratio ($\beta X_{i,t-1}$). Note that if BHCs operate without capital targets, or if we have not included relevant firm characteristics in X, we will find $\hat{\beta} = 0$.

$K^*_{i,t}$ is the target (desired) book value of either Tier 1 capital or Total capital,

$A_{i,t}$ is the book value of either simple assets or risk-weighted assets,

β is a vector of coefficients, and

$X_{i,t-1}$ is the set of firm characteristics that affect target financial leverage, including firm risk, firm size, business strategy, and market-to-book ratio. The determinants of target financial leverage also include a set of fixed firm effects, which have been shown to be important in previous research (Flannery and Rangan (2006), Lemmon, Roberts and Zender forthcoming).

Finding β coefficients that differ significantly from zero would be consistent with the relevance of a target capital ratio to BHC.

However, it seems unreasonable to impose the assumption that BHCs always remain at their target capital ratios. If banks choose to hold capital cushions, they likely do so because they feel that rapidly adjusting their capital ratios upwards entails substantial adjustment costs. We can thus combine (1) with a partial adjustment model specifying that the firm closes a constant proportion of the gap between its current capital ratio and its target capital ratio ($k_{i,t}$*) each period. We write this as:

$$k_{i,t} - DNK_{i,t} = \lambda \, (k_{i,t}^* - DNK_{i,t}) + \tilde{\delta}_{i,t} \qquad (2)$$

where:

$k_{i,t}$ = book value of BHC equity capital $K_{i,t}$ (measured alternatively as Tier 1 or the sum of Tier 1 and Tier 2 capital, depending on the capital ratio we are considering) divided by BHC assets $A_{i,t}$ (measured alternatively unweighted assets or risk-weighted assets),

$DNK_{i,t}$ = "do-nothing capital ratio" ≡ $\left(\frac{K_{i,t-1} + NI_{i,t} - DIV_{i,t-1}}{A_{i,t}} \right)$. This is BHC i's *pro forma* capital ratio at time t if it maintains the prior year's dividend payments and maintains outstanding a constant number of shares.

$NI_{i,t}$ = net income of the i^{th} BHC in the current period,

$DIV_{i,t-1}$ = dollar dividend payments by the i^{th} BHC in period t-1,

λ is a scalar adjustment speed, and

$\widetilde{\delta}_{i,t}$ is a random error.

The dependent variable in (2) can be viewed as the bank's voluntary, or actively managed, capital ratio change, undertaken through a combination of equity issues/repurchases, changes in dividend payments, or adjustments to asset size or risk-weighted assets. We specify the partial-adjustment process in terms of ($k_{i,t} - DNK_{i,t}$) rather than simply $k_{i,t}$ in order to separate a BHC's capital ratio into an active component and a passive component. Low estimated values for λ will indicate that BHCs are passive managers of their capital ratios, doing little to actively manage their capital ratios away from the "do-nothing" capital ratio $DNK_{i,t}$ and toward the desired capital ratio $k_{i,t}$*. In contrast, a high estimated λ will indicate that BHCs actively manage their capital ratios away from $DNK_{i,t}$ and toward $k_{i,t}$*. Hence, we can interpret λ as the speed of capital adjustment and its complement 1-λ as the portion of capital that is inertial. Substitute (1) into (2) to get an estimable regression model:

$$k_{i,t} - DNK_{i,t} = \lambda\ (\beta X_{i,t-1} - DNK_{i,t}) + \gamma D\_YEAR_t. + \widetilde{\delta}_{i,t} \qquad (3)$$

According to (3), each firm has its own capital target and its own starting place (*DNK*), but all firms adjust at the same rate (λ). We include a vector of year dummies D_YEAR_t to absorb the effects of unspecified macroeconomic and financial market conditions on observed capital.

Equation (3) constitutes a standard partial adjustment model for capital structure. We conjecture, however, that the speed with which a large BHC adjusts its capital ratio depends on its specific situation. A BHC that finds itself far away from its desired capital ratio (due to exogenous events) may feel the need to adjust quickly at first, but then slow its adjustment speed once it is closer to its target. The speed of capital adjustment may be slower for banks that find themselves above their target capital ratios, but faster for banks that find themselves below their targets. This may be especially true for capital-deficient banks if they are subject to extra pressure from bank supervisors or investors to increase capital. We therefore specify a firm-specific adjustment speed that varies with time and bank characteristics:

$$\lambda_{i,t} = \Lambda Z_{i,t-1} \quad (4)$$

and investigate a "nonlinear" model in which bank characteristics affect both the target capital ratio and the speed of adjustment:

$$k_{i,t} - DNK_{i,t} = (\Lambda Z_{i,t-1})(\beta X_{i,t-1} - DNK_{i,t}) + \gamma D\_YEAR_t + \tilde{\delta}_{i,t} \quad (5)$$

where:

Λ is a vector of coefficients for the adjustment speed function, and

$Z_{i,t-1}$ is the set of bank characteristics that affect adjustment speed, including the lagged capital ratio (expressed relative to static regulatory capital standards), the supervisory assessment (BOPEC), and the bond rating.

Econometric tests of our hypotheses about capital targets and adjustment speeds are complicated by several potential endogeneities. First, profits may vary with the firm's capital structure, and with relatively constant dividends increasing capital will also increase retained earnings, further adding to the capital cushion (Berger 1995). Second, asset risk and capital may be co-determined, as banks with more capital may choose to take on more portfolio risk and their supervisors may allow this behavior (Flannery and Rangan 2008). Finally, supervisory opinions and bond ratings may entail some endogeneity. If the BOPEC or bond rating is kept low until the BHC has raised its capital ratio, we might find a negative coefficient on low ratings as a result of the rating process itself.[19]

VI. Data and Variables

We estimate our models using annual data for all publicly traded U.S. bank holding companies

[19] On January 1, 2005, the U.S. supervisory rating system for bank holding companies changed from a "BOPEC" system to an "RFI(C)" system. The new rating system emphasizes risk management (R), financial condition including capital adequacy, asset quality, earnings, and liquidity (F), impact of the parent company and nondepository entities on the subsidiary depository institutions (I), and a composite rating (C). R is rated on a three-point scale of Strong, Adequate, or Weak, while F, I, and C are rated on a 1 to 5 numeric scale as in the past, with a 1 indicating the highest rating." For the final two years of our sample, the composite C rating from RFI(C) is used in place of the composite BOPEC rating to form the variable BADBOPEC (described below).

(BHCs) between 1992 and 2006 for which we could compile complete information.[20] Most of our information comes from the Federal Reserve's Y-9C Consolidated Financial Statements for Bank Holding Companies. Before 2006, all BHCs with at least $150 million in total assets filed these quarterly reports. Beginning with the March 2006 reports, the cutoff for mandatory filing was raised to $500 million. In addition, we collect information on stock prices from the Center for Research on Stock Prices (CRSP) database, information on bond ratings from Standard and Poor's Compustat, and information on BHC examination ratings from the Federal Reserve. Table 2 defines the variables and provides summary statistics.

Capital measures. We construct three capital ratio variables $k_{i,t}$, corresponding to the three measures of regulatory capital. CAPLEV is the Tier 1 leverage ratio and is equal to Tier 1 capital divided by total unweighted, on-book assets. CAPTIER1 is the Tier 1 risk-based capital ratio and is equal to Tier 1 capital divided by risk-weighted assets. CAPTOTAL is the total risked-based capital ratio and is equal to Tier 1 plus Tier 2 capital divided by risk-weighted assets. We delete observations for which one or more of these three regulatory capital ratios are in the top one percent of their sample distributions – respectively, above 17.7%, 30.5%, and 34.4%. Such high capital ratios might otherwise distort our findings because they are likely determined by idiosyncratic factors outside of our models. The resulting data set is an unbalanced panel containing 4,563 annual observations over 15 years, or about 304 BHCs per year on average.[21] Because the largest BHCs control the vast majority of banking assets, we also present estimates for a subset of such firms.

We also construct a pre-determined measure of "do-nothing capital" for each of the three regulatory capital ratios. DNK equals capital lagged one year plus current-year net income minus lagged dividends, all divided by current "assets," where "assets" is either total unweighted assets (DNK_LEV) or

[20] We focus on top-tier companies that are not owned by other BHCs. Lower-tier companies are owned by higher-tier BHCs are included as part of the larger entities.

[21] During the 1992-2006 sample period, BHCs entered our data set when they converted from privately held to publicly traded, and exited our data set because they either failed or (much more likely) were acquired by another BHC.

risk-weighted assets (DNK_TIER1 and DNK_TOTAL).[22] Thus, DNK corresponds to what the capital ratio would be if the bank "did nothing": kept dividend payments constant and let the remaining cash flow accrue to capital. In all three cases, the mean values of DNK are marginally below their corresponding "do something" capital ratios – on average 46 basis points below CAPLEV, 35 basis points below CAPTIER1, and 53 basis points below CAPTOTAL. This is our first indication that sample BHCs have actively sought to raise their capital ratios beyond the ratios implied by passive retention of earned income.

Determinants of capital targets. We include a number of exogenous variables to test for the determinants of target capital ratios (i.e., the elements of vector *X*), consistent with the hypotheses described above. First, we compute a risk variable (STDROA) measured as the standard deviation of accounting return on assets over the preceding twelve quarters. We hypothesize that riskier BHCs will hold larger stocks of buffer capital and/or have higher target capital ratios. We include the lagged market-to-book ratio MKTBOOK to measure two potentially offsetting BHC behaviors. A high MKTBOOK value might mean that the bank can raise capital more easily or cheaply in the future, implying less need for a protective capital cushion. Alternatively, a high MKTBOOK might reflect a valuable charter, which should be protected with a large capital ratio. The regression coefficients on this variable will reflect the net effect of these competing hypotheses.

Companies with external growth strategies may need to hold extra capital for unpredictable acquisition opportunities. We infer BHCs' acquisition strategies based on their actual pattern of acquisitions in the near future, and measure this by the number of acquisitions actually undertaken in the following calendar year, NMERGER. Larger banking organizations are likely to hold relatively less capital due to greater diversification, scale economies in risk management, greater ability to raise equity on short notice, and/or a "too-big-to-fail" expectation for the largest institutions. We attempt to capture this complex set of relationships with a two-part size measure: the continuous natural log of assets

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[22] We make small adjustments to DNK for various accounting corrections recorded in the Y-9C reports.

lnASSETS and a dummy variable for firms with more than $50 billion in assets (2001 dollars), which we also interact with each other. Only 5.4% of our observations had assets of more than $50 billion.

Organizations with more uninsured counterparties should choose higher capital ratios, all else equal. Although it is difficult to capture differences in counterparty risk concerns using financial statement data, we hope to capture several dimensions of this issue with the following proxy variables:

RETAILDEP: A one-year lag of retail deposits (non-demand transactions accounts plus small denomination, non-brokered certificates of deposit) divided by total liabilities. A greater reliance on insured retail deposits should reduce pressure from counterparties to hold capital. At the same time, a greater endowment of (core) retail depositors may increase the BHC's charter value and induce it to hold more equity as protection.

BUSINESSLOAN: A one-year lag of the ratio of commercial and industrial loans plus non-residential real estate loans to total assets. Allen, Carletti, and Marquez (2006) argue that corporate borrowers may prefer to deal with banks that put more capital at risk, which increases banks' incentives to monitor. We argue additionally that business borrowers prefer well-capitalized lenders because borrower-lender relationships are costly to replace in the event that the lender fails.

OFFBSHEET: A dummy equal to one for BHCs that hold (one-year lagged) derivatives with notional amounts that exceed ten times the value of BHC assets. Only 0.9 percent of the observations in our data have such large derivative concentrations. BHCs may desire to hold more capital against these exposures to counterparty risk. However, if BHCs are using these positions to hedge the risk of their other operations, then they may desire less capital.

Importantly, we exclude BUSINESSLOAN and OFFBSHEET from the CAPTIER1 and CAPTOTAL regressions because of endogeneity concerns, as the values of these business strategy variables partly determine these capital ratios' denominators.

Finally, we include firm fixed effects among the determinants of a BHC's target capital ratio. We also include year dummy variables in the regressions, but we do not specify these as determinants of the target capital ratios.

<u>Determinants of adjustment speed</u>. Troubled BHCs may raise capital more rapidly in response to extraordinary external pressures from bank supervisors and the bond markets. We measure supervisory pressure with the dummy variable BADBOPEC, equal to one if the BHC's BOPEC rating was a 3, 4, or 5. Only 7.8 percent of our observations had "bad" BOPEC ratings by this measure. We measure bond market pressure using Standard and Poor's bond ratings. The variables BBB and JUNK are dummy variables equal to one for BHCs with bond ratings of BBB (6.2 percent of our observations) or worse than BBB (Junk = 1 for 0.1 percent of our observations), respectively. We lack bond ratings for 83.3 percent of our observations and include the dummy variable MISSING to capture these firms.[23]

If regulatory capital standards influence where BHCs set their capital targets, then BHCs with especially high or low capital *relative to those regulatory standards* may adjust more quickly. We include a set of dummy variables indicating the BHC's beginning-of-period capital position relative to regulatory thresholds, specified as follows:

Wellcap_over800 = 1 if the BHC's capital ratio exceeds the regulatory standard for "well capitalized" by more than 800 bp, 0 otherwise;

Wellcap_600to800 = 1 if the BHC's capital ratio is 600 – 800 bps above the "well capitalized" threshold, 0 otherwise.

Wellcap_400to600 = 1 if the BHC's capital ratio is 400 – 600 bps above the "well capitalized" threshold, 0 otherwise.

Wellcap_200to400 = 1 if the BHC's capital ratio is 200 – 400 bps above the "well capitalized" threshold, 0 otherwise.

Wellcap_0to200 = 1 if the BHC's capital ratio is up to 200 bps above the "well capitalized" threshold, 0 otherwise;

Adeqcap = 1 if the BHC's capital ratio lies between the adequate and well-capitalized thresholds, = 0 otherwise;

Undercap = 1 if Adeqcap = 0 and the BHC's capital ratio lies less than 100 bps below the adequately capitalized level, = 0 otherwise.

Sig-Undercap = 1 if the BHC's capital ratio lies more than 100 bps below the adequately capitalized level, = 0 otherwise.

We construct separate versions of these dummy variables for each of the three capital measures. The "adequate capital" thresholds for Tier 1 and Total capital are 4% and 8% respectively. The "well capitalized" thresholds are 6% and 10%. There is no definition of "well capitalized" for the leverage

[23] Supervisory opinions and bond ratings may entail some endogeneity. If the BOPEC or bond rating is kept low until the BHC has raised its capital ratio, we might find a negative coefficient on low ratings as a result of the rating process itself. We return to this issue below.

ratio, but we define our capital dummies *as if* 4% corresponds to "adequate" and *as if* 5% corresponds to "well capitalized." Between 94 and 98 percent of the sample observations fall into the various well-capitalized categories. Between 0.3% and 1.2% of our bank-year observations fall into the "adequately" capitalized categories, and less than 1% are undercapitalized for any of the three capital measures.

VII. Estimation Results

A dynamic panel model like (3) requires special estimation techniques to control for the correlation between the lagged dependent variable and the firm fixed effects in target leverage (Baltagi (2001).[24] Our complete partial adjustment model (5) is even more difficult to estimate directly because $DNK_{i,t}$ interacts with several exogenous variables. We therefore estimate our model in a stepwise manner.

In the first step, we estimate a standard partial adjustment model (3) under the assumption that the adjustment speed λ is constant for all sample BHCs. To account for the biased adjustment speeds caused by the dynamic panel structure of the data, we estimate (3) using the Blundell-Bond (1998) GMM method. This provides an estimate of the average λ for all firms and an initial set of estimated $\hat{\beta}s$, which we use to calculate an initial estimated target capital ratio $\hat{k}^*_{i,t} = \hat{\beta} X_{i,t-1}$ for each BHC in each year. Of course, these estimated targets may be biased because in this step we are constraining the speed of adjustment λ to be constant.

In the second step, we relax the constant-speed-of-adjustment constraint. Using the results from the first step, we calculate each BHC's deviation from its (estimated) target capital ratio

$$D\hat{E}V_{i,t} = (\hat{\beta}X_{i,t-1} - DNK_{i,t}) \tag{6}$$

[24] Strictly speaking, (3) does not include a lagged dependent variable since $DNK_{i,t}$ is not identical to $k_{i,t-1}$. However, the lagged capital ratio is a prominent component of DNK. The correlations between $DNK_{i,t}$ and $k_{i,t-1}$ are 0.78, 0.86, and 0.81, respectively, for CAPLEV, CAPTEIR1, and CAPTOTAL.

and substitute it into equation (5) [25]

$$k_{i,t} - DNK_{i,t} = (\Lambda Z_{i,t-1})(D\hat{E}V_{i,t}) + \gamma D\_YEAR_t + \tilde{\delta}_{i,t} \tag{5a}$$

Note that this is simply a linear regression of the dependent variable on a set of variables defined as the product of $D\hat{E}V_{i,t}$ and the exogenous variables affecting adjustment speed. Estimating (5a) yields $\hat{\Lambda}$, from which we can calculate a speed of adjustment term $\lambda_{i,t}$ that varies for each BHC in each year. The vector of estimated coefficients $\hat{\Lambda}$ also allows us to test the determinants of adjustment speed hypotheses stated earlier.

In the third and final step, we re-estimate the target capital ratios in a variable-adjustment speed context. We substitute the estimated adjustment speeds $\hat{\Lambda}Z_{i,t-1}$ from the second step into equation (5), which we then rearrange as follows:

$$k_{i,t} - DNK_{i,t}(1 - \hat{\Lambda}Z_{i,t-1}) = \beta[(\hat{\Lambda}Z_{i,t-1})X_{i,t-1}] + \gamma D\_YEAR_t + \tilde{\delta}_{i,t} \tag{7}$$

Again, we use the Blundell-Bond estimation technique. The new estimated βs allow new tests to identify the significant determinants of target capital ratios, and also allow us to calculate unbiased estimates of the target capital ratio $\hat{k}^*_{i,t} = \hat{\beta} X_{i,t-1}$ for each BHC in each year.

The results from each step in this sequential estimation process are presented in Table 3, which has a separate panel for each definition of capital (CAPLEV, CAPTIER1, and CAPTOTAL). The leftmost columns report the estimates from Step 1; because these results serve primarily to obtain initial estimates, we will not discuss them in detail.

Determinants of Adjustment Speed (Step 2 estimations). An important contribution of this paper is the inferences we can draw by estimating the determinants of BHC capital adjustment speeds. We hypothesize that the speed with which a BHC adjusts its capital ratio depends on its initial capital adequacy (measured relative to regulatory standards), extraordinary supervisory pressure to improve

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[25] One could imagine permitting the adjustment speed to include firm fixed effects, but we do not pursue that possibility here.

overall BHC safety and soundness, and extraordinary market pressure to improve BHC credit quality. We omit the Wellcap_over800 category from the $Z_{i,t-1}$ vector in regression (5); thus, we measure the effect of initial capital adequacy on adjustment speed relative to the adjustment speed of the most highly capitalized BHCs. Extraordinary supervisory pressure is measured by the BADBOPEC dummy. Market pressure is reflected in the bond ratings BBB and JUNK. The majority of our sample's bank-years have no bond rating and these BHCs are identified by the dummy variable MISSING. Banks with poor capital market access (MISSING = 1) might be unable to adjust quickly to their target capital levels. Firms with a JUNK rating (below BBB) might adjust very quickly back upward if they can, but they also might be in such poor shape that recovering an investment grade rating may be effectively impossible. BHCs rated BBB, the lowest investment grade, might be particularly keen to reduce their leverage.[26]

Regression results for the speed-of-adjustment equations (the Step 2 estimation of equation (5a)) are reported in the center columns in each Panel of Table 3. For the CAPLEV model in Panel A, all but one of the capital-ratio dummy variables carry significantly positive coefficients; these firms adjust toward their targets roughly 20 to 45 percentage *points* faster than the most-highly-capitalized BHCs (the omitted category with capital cushions greater than 800 basis points). Firms below the ADEQUATE capital level adjust particularly fast, roughly 33 and 45 percentage points faster for the UNDERCAPITALIZED and SIG-UNDERCAP BHCs, respectively. Since adjustment speeds are theoretically bounded at 100%, these are large effects. Note that these adjustments would be predominantly in an upward direction, given that the mean CAPLEV target from Step 1 is roughly 330 basis points above our assumed 5% "well-capitalized" minimum. BHCs with BADBOPEC ratings adjust toward their capital targets more slowly than BHCs with better regulatory safety and soundness ratings, presumably because they are unable to raise new capital effectively.

The adjustment speeds for CAPTIER1 and CAPTOTAL reported in Panels B and C broadly resemble the CAPLEV results. BHCs with capital cushions less than 800 basis points above the well-

[26] This is one implication of Kisgen's (2006) analysis of nonfinancial firms' bond ratings.

capitalized minimums adjust toward their targets more quickly than BHCs with larger cushions, with those in the UNDERCAP and SIG-UNDERCAP categories tending to adjust upward at the fastest rates. Firms with BADBOPEC ratings continue to adjust toward their targets more slowly than more highly rated firms. The only substantive difference is in Panel B, where BBB-rated BHCs and BHCs without bonds ratings (MISSING) adjust toward their CAPTIER1 targets somewhat faster than BHCs with bond ratings above BBB (the omitted category).

The estimated bank- and year-specific adjustment speeds in Step 2 are quite dispersed, ranging between 1% and 97% across the three panels. On average, these variable adjustment speeds averaged between 28% and 41%, substantially slower than the constrained adjustment speeds of 50% to 61% (i.e., 1-(1-λ)) estimated in Step 1. Still, these low average values exceed the estimated adjustment speeds typically found for nonfinancial firms, although Marcus (1984) reports adjustment speeds near these for large U.S. banks in the 1970s.

Determinants of Target Leverage (Step 3 estimations). We hypothesize that BHCs with volatile earnings (STDEVROA), plans to make acquisitions in the future (NMERGER), exposure to significant counterparty risk (OFFBSHEET) and/or pressures from counterparties (BUSINESSLOAN), and high franchise value (MKTBOOK, RETAILDEP) will desire higher capital levels. We also hypothesize that large BHCs (LNASSETS, DB50) as well as BHCs with access to inexpensive debt or equity financing (RETAILDEP, MKTBOOK) and those that mitigate risk off-balance sheet (OFFBSHEET) will desire lower capital levels. We test these hypotheses in equation (7), in which the estimated speed of adjustment from Step 2 varies across BHCs and across years. The resulting equation (7) coefficients, as well as the bank- and year-specific capital targets constructed using those coefficients, should be free of the bias in the Step 1 estimates caused by imposing a constant speed of adjustment.

Regression estimates for the target capital equations (the Step 3 estimation of equation (7)) are reported in the rightmost columns in each Panel of Table 3. We find evidence that BHCs hold additional capital against earnings volatility: STDEVROA has the expected positive and significant effect on CAPTIER1 and CAPTOTAL targets, but not on the CAPLEV targets (perhaps because CAPLEV is not a risk-based measure). MKTBOOK carries a negative coefficient, but is statistically significant only in the CAPLEV regressions; we interpret this either as weak evidence that BHCs with access to inexpensive external capital can afford to hold less capital, <u>*or*</u> that this inexpensive external finance effect is partially offset by the capital target-increasing effect of high franchise values. BHCs with relatively large amounts of off-balance sheet derivatives hold lower leverage capital.[27]

As expected, larger BHCs hold significantly lower capital ratios. We illustrate this using the CAPTIER1 regression estimates in Panel B, in which all three asset size coefficients are statistically significant. On average, the CAPTIER1 target for BHCs with assets greater than \$50 billion is an estimated 146 basis points lower than the CAPTIER1 target for BHCs with assets less than \$50 billion.[28] Among the smaller BHCs—which comprise 94.6% of our observations—a \$10 billion increase in assets reduces the CAPTIER1 target substantially, by an estimated 129 basis points; in contrast, a \$10 billion increase in assets for the mean BHC above \$50 billion increases the CAPTIER1 target by an economically insignificant 3 basis points.[29]

The average estimated capital targets exceed both the well-capitalized regulatory minimums (consistent with Figures 2, 3, and 4) and the average observed capital ratios (Table 2). For the leverage capital ratio, the mean fitted value is 8.6% (ranging from 5.1% to 14.1%) compared to the sample average value of 8.5%; the fitted TIER 1 ratio averages 14.4% (ranging from 9.3% to 22.3%) compared to an observed 12.1%; and the fitted TOTAL capital ratio is 16.9% (ranging from 10.7% to 24.0%) compared to a sample mean of 13.8%. In other words, BHCs held less capital than they desired on average during our sample period – but based on the speed-of-adjustment results discussed above, these firms were making systematic annual upward progress toward their desired target capital levels. Importantly, the

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[27] Because the effects of BHC size are like to be incompletely captured by our explanatory variables, this finding could also indicate the existence of economies of scale at the very largest BHCs (for example, diversification effects or too-big-to-fail status).

[28] The calculation is $-0.1985 + 0.0109*16.87 = -0.0146$, where 16.87 is the natural log of the mean of ASSETS for BHCs with assets greater than \$50 billion.

[29] The first calculation is $-.0053*(1/\$4.1)*\$10 = -0.0129$, where the mean of ASSETS (note: not LNASSETS) is \$4.1 billion. The second calculation is $(-.0053 + .0109)*(1/\$213.2)*\$10 = 0.0003$, where the mean of ASSETS is \$213.2 billion.

average estimated target values for CAPLEV, CAPTIER1, and CAPTOTAL generated in Step 3 are respectively 34, 138, and 194 basis points higher than the estimated targets generated in Step 1, where adjustment speeds were not allowed to vary across banks or years.

VIII. Summary and Conclusions

We have documented in some detail that the largest U.S. banking firms hold capital far in excess of even the most stringent regulatory requirements. The question is "why?" This has important implications for the implementation of Basel II (or any other capital standard), because we cannot understand the effects of a regulatory standard without understanding why banks are holding so much capital relative to that standard. Some observers argue that equity reflects nothing more than a pecking order view of capital structure: because the banks have been very profitable, they retained a lot of earnings and capital ratios passively rose. Another possibility is that large banks actively target high capital ratios because market conditions make them optimal. To differentiate between these two (main) possibilities, we study an annual panel of BHCs with publicly traded equity over the period 1992-2006. We use a nonlinear regression framework to investigate a series of hypotheses about the capital ratios of these large institutions.

Our first main conclusion comes from simply decomposing the aggregate annual changes in these BHCs' equity capital ratios over time. Each year, equity capital can change because of retained earnings (or losses) or because of new shares sold to (or repurchased from) the public. Over the entire 1992 to 2006 sample period, retained earnings plus new equity issued to acquire other banks averaged 167% of the annual increase in equity capital; the balancing figure of -67% reflects the repurchase of existing equity shares. In twelve of the fifteen sample years banks either partially or fully offset new share issuance with existing share repurchases, and in six of those years banks repurchased enough existing equity to fully offset the new share issuance *plus* offset a portion of retained earnings. These patterns seem very clearly to indicate that our sample BHCs actively managed their capital ratios, freely using share repurchases to offset other additions to equity capital. Whether they would use share issues to *actively* offset losses remains an open question, and cannot be evaluated using data from our regularly profitable sample period.[30]

We then model the typical BHC's capital adjustment process, using a variable-rate of partial adjustment model that includes the possibility of a time-varying, firm-specific target capital ratio as well as a time-varying, firm-specific capital adjustment speed. We find strong evidence that target capital ratios decrease with BHC size and increase with the volatility of BHC earnings (risk). The relationships between capital targets and BHC market value, growth strategy, and business mix are less systematic and statistically weaker. Our estimations indicate that the capital ratios targeted by large BHCs during our sample period were higher than their actual capital ratios, and that BHCs adjusted toward those targets quite rapidly—on average, closing between 28% and 41% of the distance to their desired capital ratios in a year.

A more innovative contribution of our paper may be the process by which we estimate the determinants of individual BHCs' capital adjustment speeds. In general, we find the sensible result that poorly capitalized and merely adequately capitalized BHCs adjust toward their capital targets at a faster speed than do already well capitalized BHCs. In addition, we find that financially troubled BHCs under severe supervisory pressure adjust more slowly toward their capital targets; however, we find only limited evidence that pressure from the bond markets affects capital adjustment speeds. Importantly, our results show that incorporating firm-specific adjustment speeds into a partial adjustment model has non-trivial effects on the estimated model coefficients.

[30] The recent equity recapitalizations at CitiBank, UBS, and other large financial institutions in response to subprime loan losses suggest that active capital management may be asymmetric. While sustained periods of profitability allow managers to steer toward capital targets with gradual adjustments, large unexpected losses that plunge banks toward their regulatory capital minimums can require lumpy, one-time adjustments. Lessons learned during the former circumstances may not be especially transferrable to episodes like the latter.

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Table 1: Composition of Annual Change in Equity Capital, three different BHC Samples

	All Sample BHC				136 Surviving BHC				Largest 25 Surviving BHC			
	ΔCAP ($mill.)	**RE/ ΔCAP**	**AC / ΔCAP**	**Other/ ΔCAP**	**ΔCAP ($mill.)**	**RE/ ΔCAP**	**AC / ΔCAP**	**Other/ ΔCAP**	**ΔCAP ($mill.)**	**RE/ ΔCAP**	**AC / ΔCAP**	**Other/ ΔCAP**
1992	33,464,467	38%	35%	26%	10,765,075	49%	26%	25%	9,889,252	47%	27%	25%
1993	35,766,439	62%	18%	20%	10,387,281	63%	31%	6%	8,688,715	64%	36%	0%
1994	15,375,086	143%	37%	-80%	5,349,121	131%	14%	-45%	4,574,816	132%	14%	-46%
1995	37,323,971	64%	70%	-33%	12,152,642	63%	92%	-55%	10,322,956	64%	106%	-70%
1996	43,252,849	67%	101%	-68%	19,827,409	62%	99%	-61%	18,514,502	59%	105%	-65%
1997	28,110,388	104%	108%	-112%	19,771,332	73%	136%	-109%	17,074,483	75%	155%	-130%
1998	83,381,366	34%	189%	-124%	62,241,051	32%	202%	-134%	58,991,425	30%	209%	-140%
1999	11,760,269	302%	220%	-422%	2,370,769	1072%	271%	-1243%	1,600,351	1453%	302%	-1656%
2000	61,320,691	60%	61%	-21%	39,178,553	53%	89%	-42%	36,046,110	51%	94%	-46%
2001	54,497,943	57%	100%	-57%	31,087,795	49%	149%	-98%	28,937,925	45%	158%	-102%
2002	37,074,888	120%	5%	-26%	22,188,525	107%	6%	-13%	19,354,866	109%	6%	-15%
2003	42,317,033	140%	11%	-51%	21,768,404	150%	21%	-71%	18,877,339	158%	20%	-77%
2004	178,400,000	30%	78%	-8%	152,100,000	24%	86%	-10%	146,800,000	23%	89%	-11%
2005	25,138,571	184%	5%	-89%	15,593,931	154%	8%	-62%	12,668,214	167%	5%	-72%
2006	96,504,957	66%	2%	32%	84,873,057	57%	1%	42%	81,080,573	57%	1%	42%
	Mean:	98%	69%	-67%		143%	82%	-125%		169%	88%	-157%
	Median:	66%	61%	-51%		63%	86%	-55%		64%	89%	-65%

Table 2: Summary Statistics
Unbalanced panel of 4,563 annual observations for publicly traded bank holding companies, 1992 - 2006.

	Mean	Std Dev	Minimum	Maximum	Definition
Continuous variables					
CAPLEV	0.0846	0.02	0.01	0.18	Ratio of Tier 1 capital to total (unweighted) assets.
CAPTIER1	0.1208	0.03	0.01	0.30	Ratio of Tier 1 capital to risk-weighted assets.
CAPTOTAL	0.1381	0.03	0.01	0.33	Ratio of (Tier 1 plus Tier 2) capital to risk-weighted assets.
DNK_LEV	0.08	0.02	-0.11	0.18	Do-nothing leverage ratio
DNK_TIER1	0.1173	0.03	-0.13	0.34	Do-nothing Tier1 capital ratio
DNK_TOTAL	0.1328	0.03	-0.11	0.37	Do-nothing Total capital ratio
STDROA	0.0034	0.0052	0.0002	0.122	Standard deviation of (Net current operating earnings/TA) past 12 quarters.
MKTBOOK	1.857	0.82	0.22	17.76	
NMERGER	0.066	0.31	0.00	7.00	Number of acquisitions in the following year.
RETAILDEP	0.605	0.14	0.01	0.93	(Non-business transactions deposits + small certificates of deposit) / total liabilities
BUSINESSLOAN	0.281	0.14	0.00	0.94	(C&I plus Commercial Real Estate plus Construction and land development loans) / total loans
lnASSET	14.415	1.685	11.93	21.36	Natural log of asset
Dummy variables					
BADBOPEC	0.078	0.27	0	1	=1 if BOPEC rating = 3, 4, or 5.
BBB	0.062	0.24	0	1	BHC has bonds outstanding, rated lower than BBB-
JUNK	0.001	0.04	0	1	BHC had bonds outstanding one year earlier, rated BBB
MISSING	0.833	0.37	0	1	BHC did not have a bond rating one year earlier.
OBS10	0.009	0.092	0	1	= 1 if (total gross notional amount of all derivative contracts)/(total assets) > 10
D50B	0.054	0.23	0	1	= 1 if BHCs assets greater than $50 billion
dy1992	0.057	=1 for observations in 1992, otherwise = 0			
dy1993	0.070	=1 for observations in 1993 , otherwise = 0			
dy1994	0.064	=1 for observations in 1994 , otherwise = 0			
dy1995	0.067	=1 for observations in 1995 , otherwise = 0			
dy1996	0.072	=1 for observations in 1996 , otherwise = 0			
dy1997	0.072	=1 for observations in 1997 , otherwise = 0			
dy1998	0.072	=1 for observations in 1998 , otherwise = 0			
dy1999	0.074	=1 for observations in 1999 , otherwise = 0			
dy2000	0.076	=1 for observations in 2000 , otherwise = 0			
dy2001	0.078	=1 for observations in 2001 , otherwise = 0			
dy2002	0.080	=1 for observations in 2002 , otherwise = 0			
dy2003	0.081	=1 for observations in 2003 , otherwise = 0			
dy2004	0.075	=1 for observations in 2004 , otherwise = 0			
dy2005	0.030	=1 for observations in 2005 , otherwise = 0			
dy2006	0.030	=1 for observations in 2006 , otherwise = 0			

	LEV / Total Assets	TIER1 / RWA	TOTAL / RWA
Well-capitalized requirement	> 5%	≥ 6%	≥ 10%
WELLCAP_OVER800	0.024	0.232	0.11
WELLCAP_600TO800	0.061	0.209	0.092
WELLCAP_400TO600	0.240	0.284	0.193
WELLCAP_200TO400	0.467	0.196	0.316
WELLCAP_0TO200	0.192	0.06	0.252
Adequately-capitalized requirement	4% - 5%	4% - 6%	8% - 10%
ADEQCAP	0.012	0.005	0.03
Under-capitalized cutoff	< 4%	< 4%	< 8%
UNDERCAP	0.003	0.001	0.005
SIG-UNDERCAP	0.001	0.0004	0.001

Table 3, Panel A: Partial Adjustment Model for Dependent Variable = CAPLEV.

	Step 1			Step 2			Step 3		
	Estimate	**t-Stat**		**Estimate**	**t-Stat**		**Estimate**	**t-Stat**	
INTERCEPT	.1155	11.18	***				.0007	0.70	
STDEVROA	-.2835	2.286	**				0.1160	0.739	
MKTBOOK	-.0012	1.587					-0.002	1.907	*
NMERGER	-.0002	0.325					0.0001	0.134	
LNASSETS	-.0030	7.013	***				-0.0030	2.394	**
D50B	-.0254	0.943					-0.0687	1.591	
D50B*LNASSETS	.0014	0.944					0.0038	1.595	
RETAILDEP	.0162	3.533	***				0.0122	1.595	
BUSINESSLOAN	.0167	4.073	***				-0.0015	1.781	
OFFBSHEET	-.0121	2.946	***				-0.0089	1.704	*
Λ	.6024	9.725	***				0.1256	6.731	***
INTERCEPT				0.1768	4.22	***			
WELLCAP_600TO800				0.0483	1.57				
WELLCAP_400TO600				0.2717	9.04	***			
WELLCAP_200TO400				0.3239	11.01	***			
WELLCAP_0TO200				0.2152	7.27	***			
ADEQCAP				0.2203	4.61	***			
UNDERCAP				0.3165	5.54	***			
SIG-UNDERCAP				0.4493	5.41	***			
BADBOPEC				-0.1383	-5.33	***			
JUNK				0.4454	0.82				
BBB				0.0168	0.35				
MISSING				-0.0255	-0.72				
Adj R-squared							0.35		
Nobs	4,563			4,563			4,563		
Mean fitted target	.0830						.0864		
Mean fitted adjustment speed				.4113					
Maximum				.9461					
Median				.4231					
Minimum				.0131					

Table 3, Panel B: Partial Adjustment Model for Dependent Variable = CAPTIER1.

	Step 1			Step 2			Step 3		
	Estimate	**t-Stat**		**Estimate**	**t-Stat**		**Estimate**	**t-Stat**	
Intercept	.2268	10.60	***				-0.0007	0.498	
STDEVROA	-.3107	1.464					0.5911	1.948	*
MKTBOOK	-.0025	1.721	*				-0.003	1.358	
NMERGER	-.0027	2.251	**				-0.0016	0.729	
LNASSETS	-.0071	7.796	***				-0.0053	1.930	*
D50B	-.1146	2.391	**				-0.1985	2.335	**
D50B*LNASSETS	.0061	2.354	**				0.0109	2.321	**
RETAILDEP	.0195	2.324	**				0.0104	0.661	
Λ	. 4864	11.92	***				0.2183	5.230	***
Intercept				0.1303	4.37	***			
WELLCAP_600TO800				0.1447	5.48	***			
WELLCAP_400TO600				0.1197	5.76	***			
WELLCAP_200TO400				0.1219	6.21	***			
WELLCAP_0TO200				0.1305	5.32	***			
ADEQCAP				0.1715	4.02	***			
UNDERCAP				0.4846	5.60	***			
SIG-UNDERCAP				0.0986	1.09				
BADBOPEC				-0.0981	-4.67	***			
JUNK				0.1468	0.18				
BBB				0.117	2.81	***			
MISSING				0.0612	2.13	**			
Adj R-squared							0.21		
Nobs	4,563			4,563			4,563		
Mean fitted target	.1302						.1440		
Mean fitted adjustment speed				.2785					
Maximum				.6338					
Median				.3112					
Minimum				.0322					

Table 3, Panel C: Partial Adjustment Model for Dependent Variable = CAPTOTAL.

	Step 1			Step 2			Step 3		
	Estimate	**t-Stat**		**Estimate**	**t-Stat**		**Estimate**	**t-Stat**	
Intercept	.2000	11.83	***				-0.0020	1.307	
STDEVROA	-.3501	1.855	*				0.5931	2.290	**
MKTBOOK	-.0029	2.309	**				-0.0024	1.317	
NMERGER	-.0029	2.366	**				-0.0021	1.161	
LNASSETS	-.0035	4.642	***				-0.0003	0.137	
D50B	-.0328	0.740					-0.1273	1.783	*
D50B*LNASSETS	.0020	0.832					0.0074	1.860	*
RETAILDEP	.0111	1.494					0.0121	0.893	
Λ	.5632	11.08	***				0.1685	4.799	***
INTERCEPT				0.2791	8.83	***			
WELLCAP_600TO800				0.1449	3.85	***			
WELLCAP_400TO600				0.2376	7.91	***			
WELLCAP_200TO400				0.1122	4.73	***			
WELLCAP_0TO200				0.1096	5.16	***			
ADEQCAP				0.1533	5.39	***			
UNDERCAP				0.2384	5.04	***			
SIG-UNDERCAP				0.3231	4.73	***			
BADBOPEC				-0.1524	-6.55	***			
JUNK				0.4542	0.98				
BBB				-0.0084	-0.2				
MISSING				-0.0424	-1.47				
Adj R-squared							0.34		
Nobs	4,563			4,563			4,563		
Mean fitted target	.1500						.1694		
Mean fitted adjustment speed				.3604					
Maximum				.9708					
Median				.3489					
Minimum				.0843					

Figure 1a

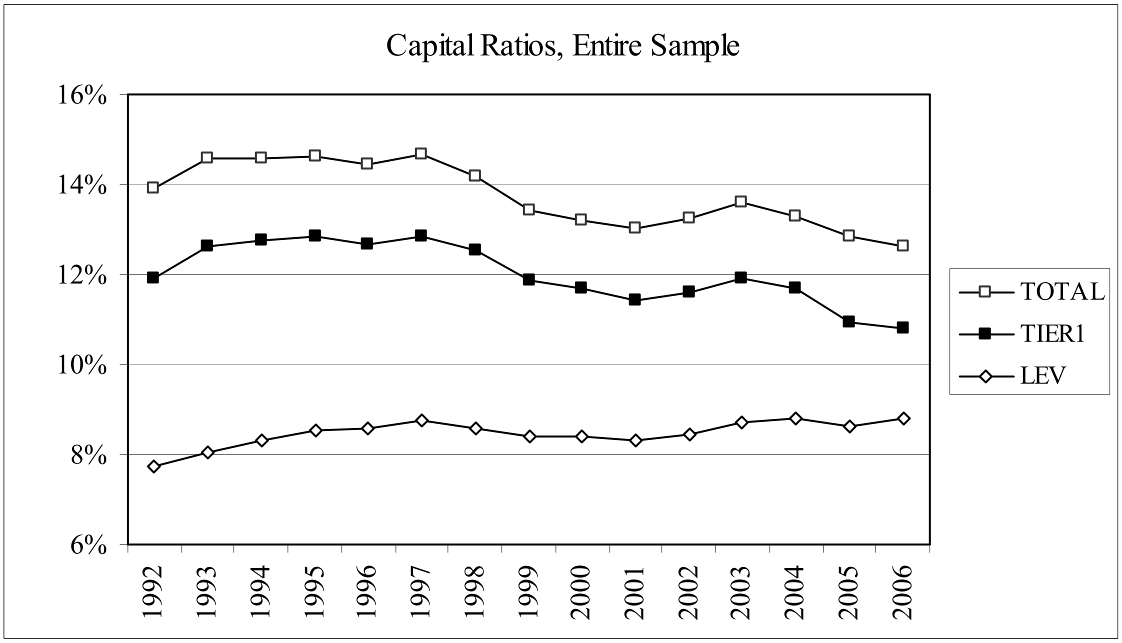


Figure 1b

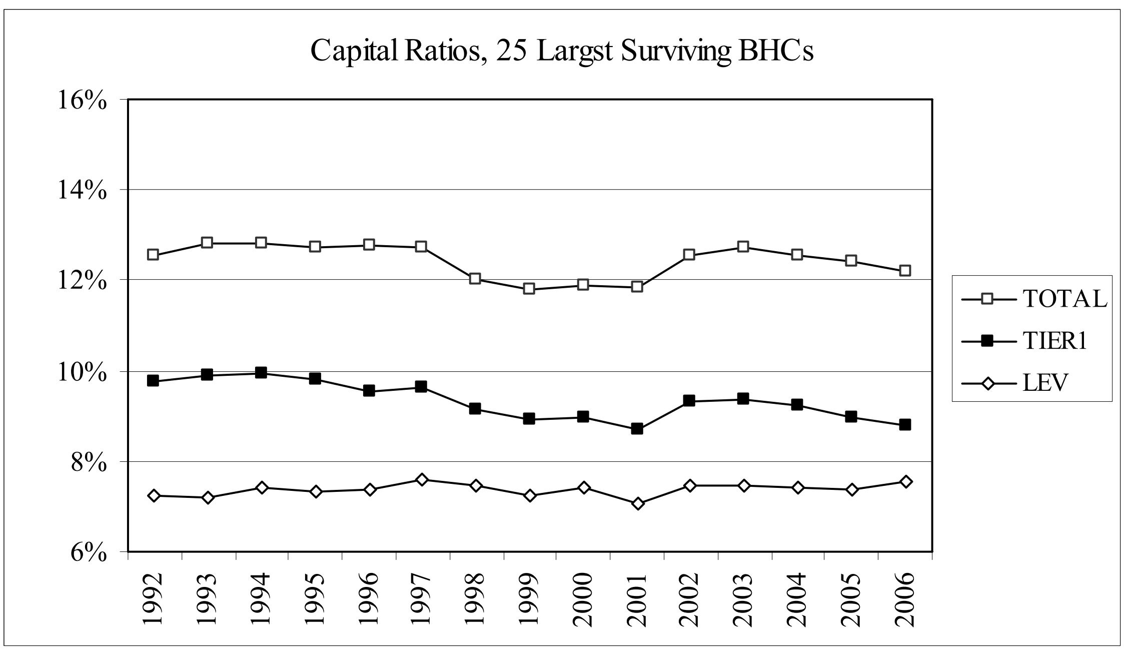
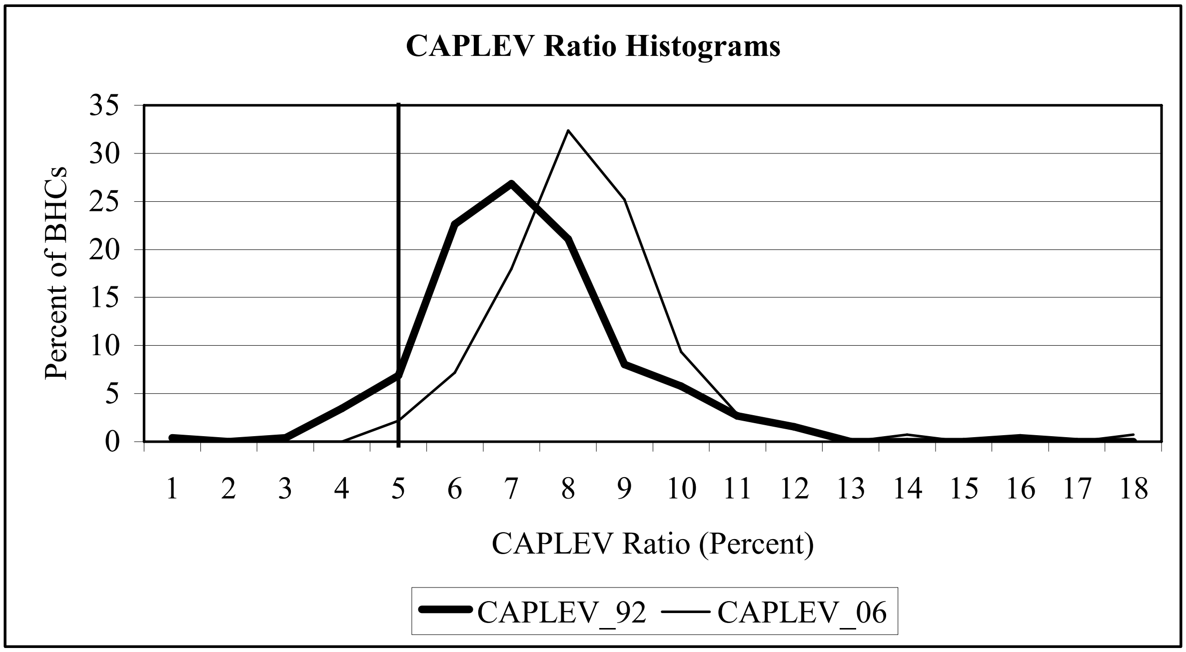
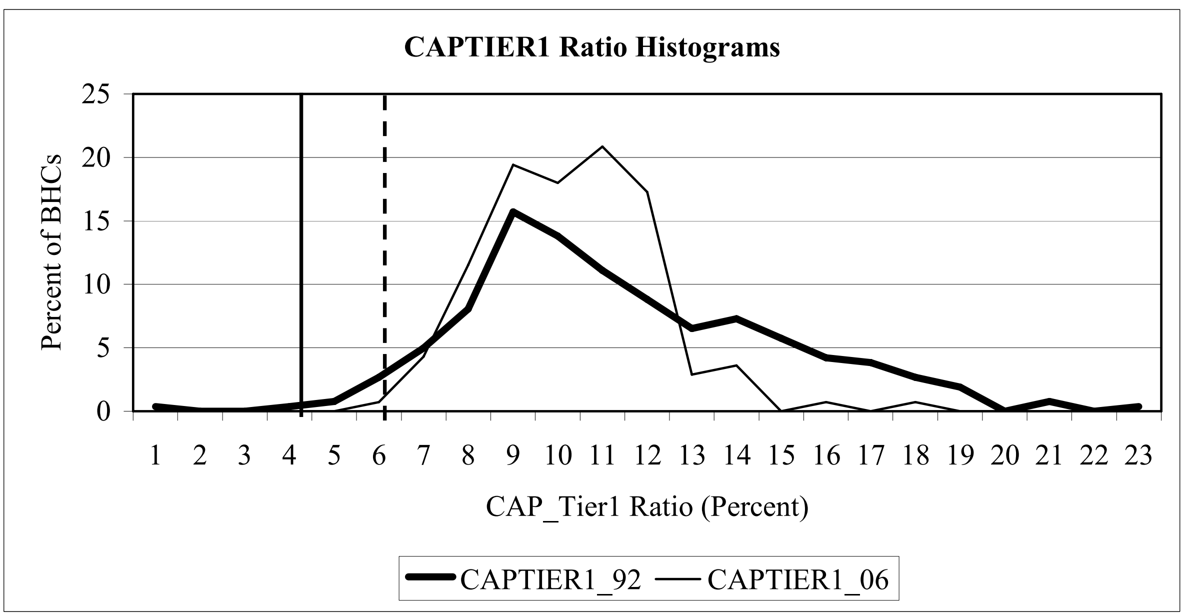


Figure 2



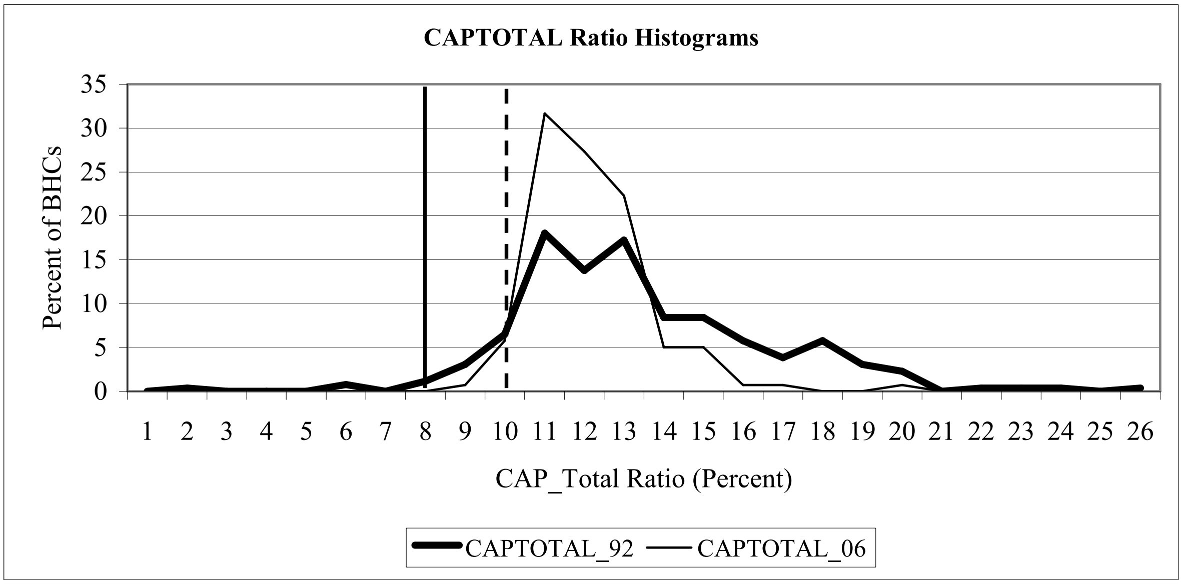
Note: The solid vertical line represents the most commonly-applied regulatory minimum.

Figure 3



Note: The solid and dashed vertical lines represent, respectively, the adequately capitalized and well-capitalized regulatory minimums.

Figure 4



Note: The solid and dashed vertical lines represent, respectively, the adequately capitalized and well-capitalized regulatory minimums.

Figure 5

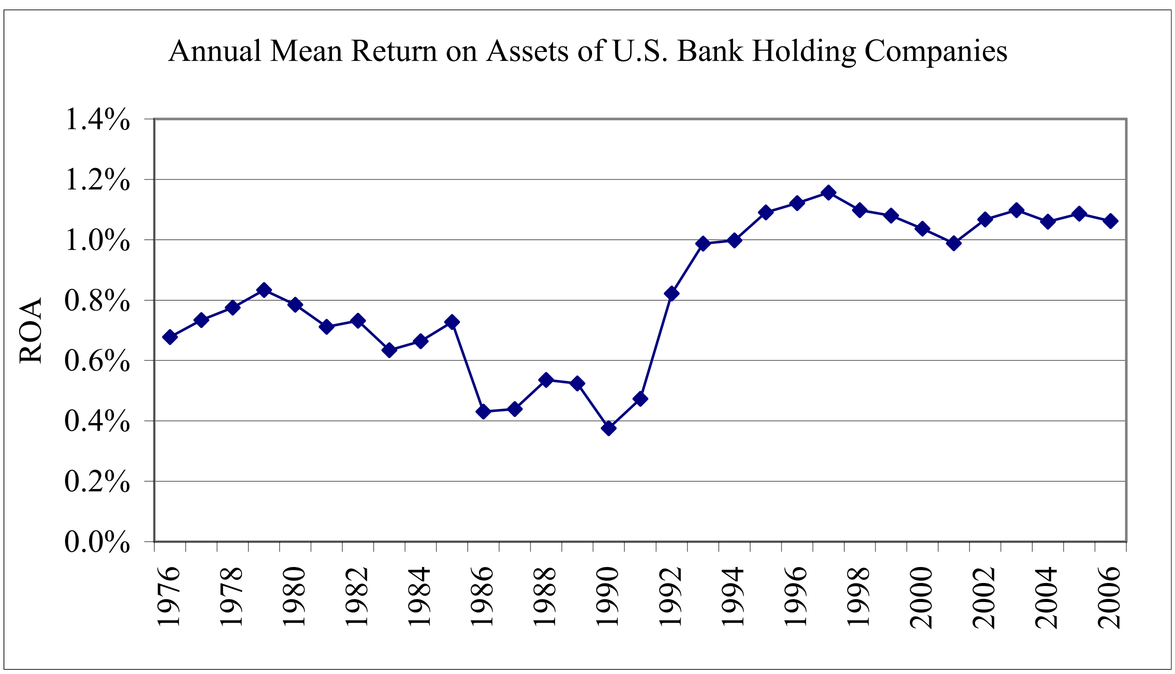


Figure 6a

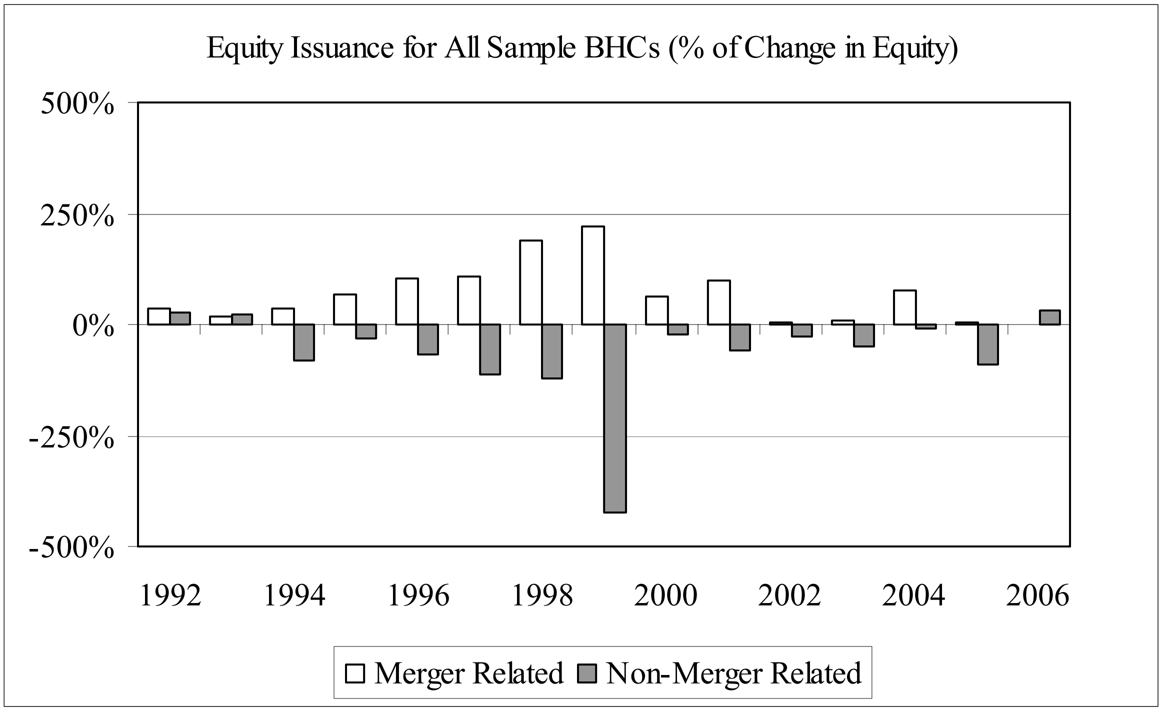


Figure 6b