What Caused the Bank Capital Build-up of the 1990s?

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ABSTRACT

Large U.S. banks dramatically increased their capitalization during the 1990s, to the highest levels in more than 50 years. We document this buildup of capital and evaluate several potential motivations. Our results support the hypothesis that regulatory innovations in the early 1990s weakened conjectural government guarantees and enhanced the bank counterparties' incentive to monitor and price default risk. We find no evidence that a bank holding company's market capitalization increases with its asset volatility prior to 1994. Thereafter, the data display a strong cross-sectional relation between capitalization and asset risk. Our estimates indicate that most of the bank capital buildup over the sample period can be explained by greater bank risk exposures and the market's increased demand that large banks' default risk be priced.

Key words: bank capital, bank risk, market discipline

JEL Classification: G18, G14

CFR research programs: bank regulatory policy, risk measurement

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The data on large U.S. banks' equity ratios in Figure 1 indicate wide variations in the mean capital ratio during the course of the 20th century. Figure 1 also indicates that the U.S. banking Industry has undertaken a dramatic capital buildup over the last decade and a half. Large bank holding companies (BHC) have more than doubled their equity ratios (measured using equity market values) between 1986 and 2001. Starting from the end of the 1990-91 recession, the expansion has been even more dramatic: the mean market equity ratio in our sample of large BHC nearly tripled from 5.8% in 1990 to 17.5% in 2001. These equity ratios currently stand at their highest levels in 70 years. Book-valued capital ratios also rose quite sharply during the 1990s, to the point that virtually no large BHCs were operating below or close to the minimum capital levels required by regulators. Indeed, our mean sample BHC holds 75% more book capital than the regulatory minimum by the end of our sample period.

In this study we document this buildup of bank capital and investigate its genesis. Several factors might explain the capital buildup and for expositional ease we classify them into three sets of explanations. First, the observed increase in capitalization might simply reflect an unusual period of bank profitability and share price appreciation during the 1990s. BHC capital ratios might thus have risen "passively", simply because bank managers failed to raise dividends or repurchase shares. Second, regulators may have raised *de jure* or *de facto* capital requirements. A new set of risk-based (Basel) capital standards were introduced between yearends 1990 and 1992, and the FDIC Improvement Act (1991) sought to impose greater credit risk on uninsured bank liability holders. FDICIA also introduced a mandatory set of prompt corrective actions that increased the cost of violating the capital standard. Hence, direct supervisory pressure may have contributed to the capital buildup. Finally, the observed capital buildup might have been a rational response by market participants to changes in the banking environment, particularly to the withdrawal of implicit government guarantees. Through the late 1980s, creditors often escaped a large bank's failure without serious losses. Regulatory and legislative changes in the early 1990s may have reduced the market's perceived probability that a failed bank's counterparties would enjoy a government bail out. Banks therefore came under greater

pressure to control their default probabilities. Rather than paying large default risk premia on uninsured obligations, banks chose to align their capital ratios more closely with their portfolio risk exposures.

Although each of these three explanations contributed to the capital buildup, our results strongly indicate that the majority of the capital buildup can be attributed to market forces. During the first half of our 1986-2001 sample period we find little correlation between portfolio risk and a bank's capitalization. After about 1993, however, bank capital ratios are reliably positively related to portfolio risk exposures, consistent with the hypothesis that counterparties began to price default risk when their conjectural guarantees were weakened by FDICIA and nationwide depositor preference. Bank risk exposures also increased during the 1990s, as banks were permitted to enter new, riskier lines of business (Stiroh [forthcoming]). We estimate that the combination of increased risk aversion and increased risk exposure explain the majority of the observed buildup. The passive effects of earning growth accounted for less than 3% of the buildup and the stock market boom affected bank capital ratios only temporarily.

Our findings have several important implications. First, many supervisors and academics have assumed that a federal safety net distorts bank incentives to limit leverage, implying that supervisory capital standards will always constrain bank leverage. While this may have been true in the 1980s, our results clearly show that it is no longer accurate. Large U.S. BHCs hold capital beyond their regulatory requirements and future theoretical models should recognize this possibility. Second, we demonstrate that market investors can *influence* bank behavior, in the sense of Bliss and Flannery [2002]. Prior studies have documented the impact of bank condition on the pricing of its (debt) obligations, but have been unable to demonstrate that the banks respond to this price sensitivity. We establish here a connection between investor preferences and bank default risk. Our results indicate that markets can recognize *and* influence bank default risk. Market discipline can thus play an important role in bank supervision, as envisioned by the Third Pillar of Basel II. Third, it has been widely conjectured that the anticipated treatment of failed institutions importantly affects market participants' incentives to discipline bank risk-taking. We show that the market's influence on bank

leverage became more prominent only after regulatory innovations (FDICIA and national depositor preference) had placed bank counterparties more explicitly at risk.

The remainder of this paper is organized as follows. Section I discusses the determinants of bank leverage and the relationship between a banking firm's book value of equity (the object of supervisory concern) and its market value of equity (the presumed object of market concern). Section II documents that bank capital ratios and risks both increased *and* became more dispersed during the 1986-2001 period, and identifies several hypotheses to explain these developments. Section III describes our empirical model and section IV reports the main results. In section V we test the hypothesis that higher bank capital ratios reflect increased supervisory pressure Section VI provides robustness results, and the final section discusses implications for banking theory and regulation.

I. *Determining a Bank's Optimal Leverage*

In an unregulated market, a firm's fixed claimants ("bondholders") are repaid only if the firm's asset market value exceeds the present value of promised payments (Merton [1974]). Bondholders therefore demand a promised interest rate that reflects the amount by which a firm's assets exceed its liabilities – that is, the firm's equity capital ratio. Although capital structure is irrelevant under extreme financial market conditions (Modigliani and Miller [1958]), theory implies an optimal leverage due to corporate taxation, bankruptcy costs, and various agency problems. Firms seek to maximize their market value by jointly selecting operating risk and financial (leverage) risk. If conditions change (e.g., through a change in perceived bank risk or a change in creditors' aversion to bank risk), firms should change their preferred level of equity capital.

Banking firms' unique access to a (formal and informal) federal safety net may prominently affect their capital decisions. For example, Merton [1977] concludes that bank shareholders wish to maximize both leverage and portfolio risk when all bank liabilities are guaranteed by federal insurance at a fixed premium. Marcus [1984] shows that this single-period result does not generalize to multi-period models when the bank expects to earn economic quasi-rents. In a multi-period model with valuable banking charters, Merton [1978]

shows that the value-maximizing choice for equity holders balances two effects: maximizing risk to take advantage of the immediate deposit-insurance subsidy vs. constraining risk to increase the expected duration of the anticipated quasi-rents.[1] Keeley [1990], Berger [1995], and Demsetz, Saidenberg, and Strahan [1996] demonstrate empirically that these rents do affect capital decisions.

Investors have sometimes viewed U.S. regulators as *de facto* insuring all liabilities, especially at the largest banks (O'Hara and Shaw [1990]). However, supervisory and political reactions to the 1980s' thrift debacle almost surely weakened bank creditors' *de facto* protection during the 1990s.[2] In 1991, FDICIA limited the insurer's ability to engineer "purchase and assumption" transactions that protected uninsured bank claimants from default losses. The Omnibus Budget Reconciliation Act of 1993 subordinated all non-deposit financial claims to a failed bank's deposits. In states without prior depositor preference laws, unsecured non-deposit investors thereby became much more exposed to default losses. Market disciplinary forces became more prominent as conjectured government guarantees abated. In reaction to their increased risk exposure, large liability-holders would demand higher returns on their claims, reducing bank equity values. In an effort to mitigate this increase in funding costs, bank owners would likely raise their equity and/or lower risk. Such a response might be particularly important for the largest banks, whose creditworthiness affects their ability to trade in OTC derivatives markets and to provide credit enhancements for commercial paper issuers.

While most non-financial firms choose their optimal capital ratios primarily in response to market constraints, regulated financial institutions must also heed their supervisors' capital adequacy requirements. Banking firms must therefore satisfy two equity constraints: uninsured market counterparties price their

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[1] These rents or quasi-rents could derive from several sources. First, banks may have monopoly protection (Keeley [1990]). Second, durable bank-borrower relationships may reduce the cost of loan origination and hence make repeat lending more profitable (Berger and Udell [1995], Petersen and Rajan [1995]). Third, productive efficiency tends to bestow quasi-rents in a competitive market. Stiroh [1999] provides evidence that bank holding companies in the 1990's have had higher productivity and better scale economies, which has translated into improved performance.

[2] Evidence of this change in perceived policy can be seen in banks' subordinated debenture spreads. Avery *et al*. [1988] and Gorton and Santomero [1990] find no evidence that subordinated debenture rates reflect bank risks in 1983-4. Flannery and Sorescu [1996] show that this situation had changed by about 1989, after a regulatory transition toward letting market participants share the losses when a banking firm fails. See also Jagtiani *et al*. [2002] or Morgan and Stiroh [1999].

claims on the basis of equity's *market* value, while supervisors impose *book* value restrictions.[3] Although these two capital ratios reflect similar features of the firm, they are not perfectly correlated.[4] GAAP accounting conventions provide managerial options to raise book capital ratios independent of the market's valuation. For example, many BHCs sold their headquarters building in the late 1980s, booked a capital gain, and then leased it back from the purchaser. A bank can also "cherry-pick" its securities portfolio, realizing the gains on appreciated securities while postponing the sale of assets with unrealized losses. Loan provisioning provides another (notorious) avenue for troubled banking firms to boost their book capital. This reserving system is designed to approximately mark the loan book to market (Flannery [1989]), but managers have substantial latitude about how much inside information to reflect in their reported loan loss allowance.[5]

Finance theory indicates that the creditors of any large corporation should assess their default risk exposure on the basis of equity market valuations instead of book valuations. Book values are inherently backward looking, while default probabilities depend on future developments, which investors strive to impound into the firm's stock prices. Equity's *market* value determines the probability of credit loss because it measures the amount that existing shareholders will pay to avoid default. For the case of depository institutions in particular, Saunders [2000] comments that:

> The concept of [a financial institution's] economic net worth is really a *market value accounting* concept. … Because it can actually distort the true solvency position of an FI, the book value of capital concept can be misleading to managers, owners, liability holders, and regulators alike. (pp. 444-445)

The ready availability of book value measures from bank Call Reports and bank holding company Y-9C reports has lead some researchers to rely on book values when studying bank leverage (e.g., Berger [1995], Osterberg and Thomson [1996]). However, Marcus [1983] and Keeley [1990] have previously used market

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[3] Despite the known faults with book value measures of bank equity, supervisors have chosen to use book values for two main reasons. First, many U.S. banks have no publicly traded equity. An initial effort to treat all regulated banks similarly therefore mandated use of book values. Second, supervisors in the U.S. and (especially) abroad suspect that market values are excessively volatile and potentially inaccurate. Kane and Ünal [1990] model the deviations of market from book values, and show that these differences vary systematically with market conditions.

[4] For our sample BHCs, the simple correlation between book and market capital ratios is 0.68 across the full time period. Cross-sectional correlations within a year range from 0.49 to 0.71, with a mean of 0.59.

[5] Note that each of these three strategies for raising book capital simultaneously increases the present value of the firm's tax obligations.

equity values to measure large banks' capitalization, and KMV successfully markets company default estimates ("EDF™ Credit Measure") derived from the firm's market share price. We use market equity ratios as our primary variable of analysis.

Despite our theoretical and empirical preference for market equity values as the relevant determinant of BHC default risk, we cannot ignore book capital regulations, which may limit a bank's ability to return unwanted capital to shareholders. For example, dividends and share repurchases reduce book and market capital by (roughly) the same dollar amount. Unless a bank can freely exercise GAAP options to increase stated book equity, its ability to reduce market capital ratios may be limited by supervisory constraints on book capital. Since we are interested in the impact of supervisors and market forces on bank equity ratios, our empirical specification must control for possible book equity constraints on market value equity ratios.

II. *Rising U.S. Bank Capitalization, 1986-2001*

We begin by establishing that BHC equity ratios rose in terms of both book and market values during our sample period for the 100 largest BHC, then discuss the possible causes for this capital increase.[6]

A. The Supervisors' Focus: Book Capital Ratios

Supervisors' minimum capital requirements are multi-facetted. Before the Basel Accord came into effect at the end of 1990, U.S. regulators employed a simple leverage ratio to assess capital adequacy: "primary" capital (the sum of equity plus loan loss reserves) had to exceed 5.5% of assets, while the total amount of primary plus "secondary" (primarily qualifying subordinated debentures) capital had to exceed 6% of assets. The Basel Accord sought to relate equity capital more closely to portfolio credit risks by introducing the concept of risk-weighted assets (RWA), which weights on-book assets and off-balance sheet commitments in proportion to their presumed credit risks. The Basel Accord also established two components of regulatory "capital" (Saunders [2000], page 457):

[6] We find very similar patterns in the equity ratios of smaller BHC (asset ranks 101-1000), but we focus our attention on the largest 100 BHC, which held more than 71% of all (FDIC insured) banking assets during our sample period.

Tier 1 includes common equity, non-cumulative preferred stock, and minority interests in consolidated subsidiaries.

Tier 2 includes the loan loss allowance (up to a maximum of 1.25% of RWA), cumulative and limited-life preferred stock, subordinated debentures and certain hybrid securities (such as mandatory convertible debt).

Under the Basel Accord, U.S. regulators set the minimum acceptable level of Tier 1 capital at 4% of RWA, while the sum of Tier 1 plus Tier 2 capital must exceed 8% of RWA.[7] Well-managed banks' capital levels were intended to exceed these minima, and in 1991 FDICIA specified that an institution with at least 5% Tier 1 and 10% Tier 2 ratios would be considered "well-capitalized" and therefore freed from selected regulatory constraints.

The solid line in Figure 2 illustrates that the 100 largest banks' median ratio of book equity to total assets rose from 5.98% in 1986 to 8.19% in 2001. U.S. book capital ratios are currently higher than they have been in more than half a century.[8] Figure 3 plots the mean Tier 1 and total (Tier 1 plus Tier 2) capital ratios relative to their required minimum values of 4% and 8% respectively.[9] The average bank has exceeded the minimum required capital ratio by a comfortable margin throughout our sample period, and this margin expanded considerably early in the 1990s. The sample BHCs' mean Tier 1 (total) capital stood at 7.26% (9.44%) of RWA in 1986 but reached 11.1% (13.8%) by 1994 and remained relatively stable thereafter.[10]

As average capital ratios have risen, the number of individual banks constrained by capital adequacy regulations has fallen sharply. Figure 4 plots the proportion of the 100 largest BHC constrained by *de jure* capital standards, where we define a firm as "constrained" if its book capital ratio exceeds the regulatory minimum by less than 1.5%. The percentage of constrained BHC trended down from the start of the sample

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[7] U.S. supervisors implemented the Basle capital standards in two steps. At yearend 1990, banks and BHCs were required to hold Tier 1 capital of at least 3.625 percent of RWA and total capital (Tier 1 plus Tier 2) of at least 7.25 percent. At yearend 1992, the minimum acceptable ratios became 4 and 8 percent of RWA. In the U.S., a "leverage" requirement further mandated that Tier 1 capital exceed 3 percent of total (unweighted) assets. This constraint has not been a major factor for our sample banks, so we omit it from our analysis.

[8] Using means in place of medians reveals very similar patterns in the equity ratios (see Figure 1).

[9] The Appendix explains how we compute these ratios from data reported in the Y-9C forms.

[10] Starting in about 1998, the Tier 2 capital ratio rises and the Tier 1 ratio falls. As we discuss in connection with Figure 8 below, BHC were substituting subordinated (Tier 2) debt for equity capital over this period.

period and dropped sharply after the Basel standards were implemented at year-end 1990. Overall, it appears that supervisory capital restrictions have been effectively irrelevant to the 100 largest U.S. BHC since about 1992. Most of the BHC with "excess" market-valued capital ratios could have paid out at least some of that excess capital without violating regulatory constraints.

To summarize, the evidence indicates that book capital ratios at the largest U.S. BHC have risen well above statutory minima. Section V evaluates whether this means that supervisory capital standards no longer affect the banks' capital decisions.

B. Investors' Focus: Market Capital Ratios

The dotted line in Figure 2 plots the median ratio of common equity's market value to the market value of total assets (defined as the sum of equity's market value plus liabilities' book value).[11] This equity ratio stood at 7.9% in 1986, declined until about 1990, and then began a rapid increase. The median market capital ratio peaked in 1998 at 20.1%, before ending the sample period at 16.7%. At the end of our sample period, bank equity ratios were almost three times their 1990 value (5.8%) and more than double their 1986 value. Figure 5 plots histograms showing the distribution of capital ratios during 1986-88 and 1998-2001. The sample's central tendency clearly shifts rightward. Equally striking is the near doubling of the capital ratios' cross-sectional standard deviation, from 3.53% to 6.71%.[12]

C. BHC Portfolio Volatility and Default Risks

A firm's equity capital protects fixed claimants from default losses in the event of moderate declines in the firm's total market value. Because equity is the junior claim on firm cash flows, its return reflects asset value changes, liability value changes, and other developments. We estimate each BHC's total risk exposure by de-levering its equity volatility:

$$\sigma_A = \left(\frac{E}{A}\right)\sigma_E \tag{1}$$

[11] For each calendar year, we plot the median quarter-end value.

[12] A similar, although less dramatic, pattern occurred for book equity ratios, which rose from a mean 6.12% in 1986-88 to 8.19% in 1998-2000, while the cross-sectional standard deviation of this ratio rose from 1.32% to 1.81%.

where σ_E is the standard deviation of the BHC's daily equity returns over a calendar quarter;

E is the market value of the BHC's equity at the end of the quarter; and

A is the quasi-market value of assets (E plus the book value of debt) at the end of the quarter.

We annualize the resulting measure of σ_A by multiplying the quarter's daily standard deviation by the square root of 250 (the approximate number of trading days in a year). The variable σ_A incorporates all BHC risks, including asset returns, liability returns, changes in the off-balance-sheet book, and operating efficiencies.

Figure 2 indicates that large BHCs' median asset volatilities rose slowly from 1986-1996, then jumped to what appears to be a new, higher level in 1997. Recall that these were not placid times for large BHC. The Asia crisis of 1997 raised the spectre of large default losses for banks with overseas loan portfolios, while the Russian-LTCM disorders in August-September 1998 cast doubt on the stability of the international financial system. A general measure of equity market volatility (the CBOE's VXO) was much higher after 1995. The late 1990s also witnessed the implementation of previous deregulatory decisions, which allowed banks to expand their offerings across geographical and product markets. Recent evidence suggests that these changes actually provided few diversification benefits but, rather, increased bank revenue variances (Stiroh [forthcoming], DeYoung and Ronald [2001] and Schuermann [2004]).

How can we reconcile Figure 2's sharp increase in portfolio risk with a general view that the U.S. banking sector had low default risk in the 1998-2001 period (including the recession of March - November 2001)? One must simply note that equity ratios rose along with estimated asset volatilities. Figure 6 shows the median BHC's approximate "distance to default", as measured by the ratio of equity capitalization to asset volatility. Assuming that BHC value is distributed normally, the mean 1998-2001 distance to default of 3.08 implies a BHC default probability of roughly 0.2%. Had BHC portfolio risk increased with no corresponding change in capitalization, the sector would surely have had numerous BHC failures. However, capitalization did rise over time, and our empirical tests will demonstrate that the *association* between a bank's risk and its capital ratio became closer and more significant later in the sample period.

Figure 7 plots histograms showing the distribution of σ_A during 1986-99 and 1998-2001. The sample BHCs' mean risk rose from 1.76% during 1986-89 to 6.09% in 1998-2001. At the same time, the cross-sectional standard deviation of asset volatilities more than tripled, from 0.93% to 3.49%. The concurrent increases in mean capitalization and mean risk illustrated in Figures 5 and 7 suggest that the changes may be related to one another. The fact that both capital ratios and asset volatilities became more dispersed over the period should permit strong statistical tests of the hypothesis that riskier banks have added more to their capital ratios, presumably in response to external pressures.

At very high leverage levels, equity's market value may include the value of safety net subsidies. With nontrivial safety net subsidies, (E/A) in (1) would be biased upwards, and so too would our measure of σ_A. The resulting positive correlation between leverage and asset risk would bias our regression results toward finding a significant relation between leverage and risk. To address this potential problem, we construct an instrumental variable for σ_A. We also used the method of Ronn and Verma [1986] to adjust measured equity value for safety net subsidies. Although most of our reported results utilize the asset risk measured defined in (1), Table 6 shows that our main conclusions are unaffected if Ronn-Verma estimates of leverage and asset risk are used instead.

D. Possible Causes of the Increased Capitalization

Why have large BHC increased their capital ratios, and what is responsible for the greater cross-sectional variation in capital? One clear possibility is that the observed increases were not a result of deliberate actions on the part of banks, but were an artifact of the sample period under study. The 1990s were exceptionally profitable for the banking industry, and Berger (1995) reports that commercial bank "dividends do not fully respond to changes in earnings, so part of earnings changes accumulate into future changes in the level of capital." (page 454). Our BHCs clearly exhibit this type of behavior: their mean earnings rose from 8.1% of book equity during 1986-91 to 14.6% during 1992-2001 while dividends rose only from 3.4% of book equity to 4.1%. Hence part of the observed increase in capital could be attributed to the "passive"

retention of earnings, although an active decision to build capital through retained earnings would look the same.

Share prices also rose very sharply during the 1990s. Perhaps banks simply rode this boom, accepting whatever level of market capitalization was associated with its share prices. Indeed, if banks felt that the market overvalued their shares, they may have *issued* new shares to take advantage of investors' optimism. Either the stock price effect alone or endogenous share issues would tend to raise bank capital ratios temporarily, even if bankers were not trying to provide capital protection consistent with their risk exposures. However, the large banks' securities issuance suggests that they were trying to limit the impact of share price increases on their market capital ratios. The line graph in Figure 8 plots the mean market equity ratio of the top 100 BHC. The bars in Figure 8 plot the net issuance of three security types by the top 100 BHC, for each year of our sample period. While the dominant security issued before 1992 was common or preferred equity, this situation changed sharply after 1992. In the years 1994 through 2001, the 100 largest U.S. BHC retired $331 million of equity while issuing $1,731 million of net new subordinated debentures. Put another way, each year between 1994 and 2001, the sample BHC retired shares equal to 1.23% of their prior yearend's equity value (common plus preferred), while issuing net new debentures equal to 5.76% of prior yearend equity. *Ceteris paribus*, these transactions increased book leverage while share price gains were reducing market leverage, consistent with the hypothesis that managers were trying to "undo" the leverage effects of share price appreciation.[13] Figure 3 shows that beginning in 1998, the mean Tier 1 capital ratio was actually falling in book value terms.

Why might the large banks have chosen to raise their equity ratios? Perhaps tougher capital regulation forced them to do so. This possibility seems particularly relevant for the early 1990s, when U.S. supervisors were implementing Basel capital rules: Figure 3 shows that book equity ratios rose quite sharply

[13] At least some of this substitution was probably elicited by an important regulatory change. On October 21, 1996, the Federal Reserve Board decided that deeply subordinated debentures issued to a trust financed by preferred stock ("trust preferred shares") would count as up to 25% of Tier 1 regulatory capital (Benston *et al*. [2000]). BHC thereby acquired an incentive to replace some of their Tier 1 capital (e.g. common and preferred shares) with the new debentures. Even with this caveat, the evidence in Figure 8 suggests managerial decisions actively increased leverage in 1993-5 and perhaps 1996.

between 1991 and 1994. Perhaps the "excess" capital in Figure 3 reflects a rational margin of safety, protecting the banks from heavy supervisory penalties if they violate the *de jure* capital standard. Another plausible hypothesis is that higher capitalization was a rational response to regulatory innovations that reduced the extent of the federal safety net. Evidence from the bank debenture market shows that conjectural government guarantees weakened around 1990 (Flannery and Sorescu [1996], Morgan and Stiroh [1999]). FIRREA (1989) and FDICIA (1991) legislated less generous government "bailouts," and nationwide depositor preference in 1993 reduced the seniority of many banks' non-deposit claims. As a result of these supervisory changes, bank counterparties should have become more sensitive to default risk. BHCs' asset volatilities were also rising over this period.[14] (See Figure 7 and the right-hand scale in Figure 2.) In response to both of these developments, banks would rationally increase capital ratios to reduce their default risk and hence their funding costs.

We test these alternative explanations via panel regressions for bank capital ratios. The model differentiates between short run and long run adjustments, and explicitly identifies the impact of unanticipated share price changes on BHC capital ratios. We focus on the determinants of equity's market value while recognizing that supervisory restrictions on book capital may prevent a bank's complete adjustment to its desired market ratio.

III. *Regression Model*

A bank's supervisors and counterparties care primarily about its risk of default, which is jointly determined by its leverage and risk exposures. We are therefore interested in estimating a model of the general form:

$$\boldsymbol{MKTRAT}_{it} = \alpha + \beta\, \sigma_{Ait} + \gamma\, Z + \tilde{\varepsilon}_{it} \tag{2a}$$

[14] Identifying the source of this increased bank risk lies beyond the scope of this paper. It could reflect changes in the economy's basic uncertainties, or an endogenous decision to hold riskier assets.

$$\sigma_{Ait} = \eta + \kappa \boldsymbol{MKTRAT_{it}} + \lambda Y + \nu_{it} \tag{2b}$$

where $\boldsymbol{MKTRAT_{it}}$ is the ith bank's target capital ratio, defined as the market value of common equity at time t, divided by the market value of its total assets.

σ_{Ait} is the bank's risk.

Z, Y, are sets of predetermined variables (specified below).

α, β, η, κ and the vectors γ and λ are coefficients to be estimated.

Identifying both equations in a simultaneous equation system for the equity ratio and risk is very difficult, and a mis-specification in one of the equations can bias the coefficient estimates in both. As we are primarily interested in the determinants of ***MKTRAT***, we use two-stage least squares (2SLS) to estimate (2a) alone (details in section III B).

The estimated β in (2a) measures the response of the typical bank's capital ratio to a unit increase in bank risk. Corporate finance theory predicts $\beta > 0$ for a firm subject to normal market forces: counterparties (e.g. uninsured liability holders) demand more equity protection from firms with greater risk. Our main interest lies in determining whether supervisory changes in the early 1990s induced banks to hold more equity per unit of risk. If BHC became more subject to market forces during our sample period, β should have a larger value later in the period. If we knew exactly when market assessments changed, we could add a single "shift" variable to the specification (2a) and estimate:

$$\boldsymbol{MKTRAT_{it}} = \alpha + (\beta_0 + \beta_1 \boldsymbol{D})\hat{\sigma}_{\boldsymbol{Ait}} + \gamma\, \boldsymbol{Z} + \tilde{\varepsilon}_{\boldsymbol{it}} \tag{3}$$

where D equals zero early in the 1986-2001 time period and unity later in the period. A positive coefficient β_1 is consistent with banks reducing their default probabilities by increasing capital per unit of risk. (See the discussion of Table 6 in Hovakimian and Kane [2000].)

Because it is unclear when the risk parameter actually shifted – or, how many shifts there may have been -- we divided the sample period into four 4-year segments and let the data indicate when the sensitivity of ***MKTRAT*** to risk changed. That is, we specify that a bank's target capital ratio takes the form:

$$\boldsymbol{MKTRAT}_{\boldsymbol{it}}^{*} = \alpha_{0i} + (\beta_0 + \sum_{k=1}^{3} \beta_k \boldsymbol{D}_k)\hat{\sigma}_{Ait} + \lambda \boldsymbol{Z}_{i,t-1} + \tilde{\varepsilon}_{it} \tag{4}$$

where $\boldsymbol{MKTRAT}_{\boldsymbol{it}}^{*}$ is bank i's target capital ratio in period t,

$\hat{\sigma}_{Ait}$ = the fitted value for observed asset volatility (σ_{Ait}) from an instrumental variables regression,

D_1 = 1 during 1990-93 and zero otherwise,

D_2 = 1 during 1994-97 and zero otherwise, and

D_3 = 1 during 1998-2001 and zero otherwise.

The omitted time period is 1986-89, for which the risk-sensitivity of $\boldsymbol{MKTRAT}^{*}$ is included in β_0. If BHC provided greater equity protection to their counterparties after 1989, (4) should include one or more significantly positive β_k coefficients. [15]

The sub-periods defined in (4) correspond to several logical "break points" in institutional conditions. Flannery and Sorescu [1996] detect increased risk-sensitivity in subordinated debt pricing by year-end 1989, so the 1986-89 period can be characterized as substantially pre-reform. The 1990-93 period includes important changes to capital regulation and the safety net. The last two periods exhibit different stock market trends: predominantly upward during 1994-7, followed by a peak and reversal in 1998-01.

In addition to σ_A the other determinants ($\boldsymbol{Z}_{i,t-1}$) of the target capital ratio are charter value, regulatory restrictions, firm size, and earnings.

HMB(-1). Banks will protect a valuable charter by lowering their risk and/or leverage (Marcus [1984], Keeley [1990], Demsetz, Saidenberg, and Strahan [1996]). Researchers frequently proxy for a bank's charter value with Tobin's q, but the dependent variable in (4) ($MKTRAT^{*}$) is likely to be correlated with q by construction because both variables include the market value of equity in their numerator. We mitigate this

[15] Researchers frequently observe that high risk could enhance a bank's equity value simply because the value of the safety-net subsidy increases with risk. Because equity and asset market values enter the computation for σ, our risk measures may also be biased. When we applied the method of Ronn and Verma [1986] to estimate adjusted market values and bank risks, the results are similar to those for the un-adjusted measures. See Table 6.

induced correlation by constructing a dummy variable ***HMB*** ("high market-to-book"), which takes the value of 1 if a BHC's market-to-book ratio is in the top 25 percent of sample BHCs in that year. The coefficient on ***HMB*** should be positive in (4).

REGP(-1). Banks with relatively low book equity ratios may be subject to ***REG***ulatory ***P***ressure, which limits their ability to reduce ***MKTRAT***. The dummy variable ***REGP*** identifies constrained banks: ***REGP*** = 1 if a bank's capital ratio does *not* exceed the regulatory capital minimum by at least 1.5%. Otherwise ***REGP*** = 0. The sign of ***REGP***'s coefficient is theoretically ambiguous: regulatory pressure might raise ***MKTRAT*** by forcing a BHC to hold more capital than is justified by its risk, or it might lower ***MKTRAT*** if the constraint depresses the bank's equity value.

LNTA(-1). Larger banks may be more widely followed by market investors, and may therefore have better access to wholesale liabilities, loan sale markets, and so forth. With better access to these liquidity sources, larger banks may therefore require less capital. Alternatively, larger banks have more complex balance sheets, which are optimally financed with a larger proportion of equity capital. We include the natural logarithm of total assets (***LNTA***) in the ***MKTRAT*** equation to control for size-related effects.

ROA(-1). Market capital ratios may be higher for BHC with higher returns on assets if sticky dividends cause managers to retain more equity.[16]

Finally, we include firm fixed effects to control for omitted factors that vary across institutions but are relatively constant over time.

A. Lags in Adjusting Toward Target Capitalization

In a frictionless world, firms would always maintain their target leverage. However, transaction costs may prevent immediate adjustment to a firm's target, as the firm trades off adjustment costs against the costs of operating with a sub-optimal debt ratio. We therefore revise the model (4) to permit incomplete (partial)

[16] Banks with high earnings may also hold equity to protect their charter value. However, if ***HMB*** adequately controls for this effect, we are left with Berger's [1995] hypothesis about the effect of earnings on capitalization. Section VI demonstrates that our results are not affected by excluding ***HMB*** from the specification.

adjustment of the firm's initial capital ratio toward its target within each time period. The data can then indicate a typical adjustment speed.

Begin by re-writing a BHC's long-run, desired capital ratio (4) as

$$\boldsymbol{MKTRAT}_{it}^{*} = \boldsymbol{\delta X_{it}} \tag{5}$$

where X_{it} is a vector of risk and other capital determinants discussed above and δ is a vector of coefficients. A standard partial adjustment model is written:

$$\boldsymbol{MKTRAT}_{i,t} - \boldsymbol{MKTRAT}_{i,t-1} = \lambda_1 (\boldsymbol{MKTRAT}_{i,t}^{*} - \boldsymbol{MKTRAT}_{i,t,-1}) + \mu_{i,t} \tag{6}$$

Substitute (5) into (6) to give an estimable model

$$\boldsymbol{MKTRAT}_{i,t} - \boldsymbol{MKTRAT}_{i,t-1} = \lambda_1 \beta \boldsymbol{X_{i,t}} - \boldsymbol{\lambda_1 MKTRAT}_{i,t-1} + \mu_{i,t} \tag{7}$$

Equation (7) says that managers take actions to close the gap between where they are ($\boldsymbol{MKTRAT}_{i,t-1}$) and where they wish to be ($\delta \boldsymbol{X_{i,t}}$). The typical firm closes a proportion λ_1 of the gap each year.[17] The assumed smooth adjustment path may only approximate an individual firm's actual adjustments, particularly if there are fixed costs of changing a firm's capital structure (Fischer, Heinkel, and Zechner [1989], Mauer and Triantis [1994]). However, unreported simulation results indicate that this smooth adjustment specification readily incorporates discrete capital adjustments caused by fixed adjustment costs. The coefficient λ_1 thus reflects the average adjustment speed for a typical firm in the sample.

Share price movements will also affect ***MKTRAT***: an increase (decrease) in a firm's stock price mechanically tends to decrease (increase) its leverage. Hence, our model should allow for the possibility that managers may take actions to offset some share price effects. We augment our basic partial adjustment model in (7) to recognize the potential effects of share price changes on leverage.:

$$\boldsymbol{MKTRAT}_{i,t} - \boldsymbol{MKTRAT}_{i,t-1} = \boldsymbol{\lambda_1 (\beta X_{i,tt} - MKTRAT}_{i,t-1}) + \boldsymbol{(1-\lambda_2)(Share\ price\ effect)}_{t-1,t} + \boldsymbol{\mu}_{i,t} \tag{8}$$

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[17] The specification (7) assumes that the firm acts to close any deviation from the desired target ratio, no matter how small. An alternative model would permit small deviations from the target to persist because adjustment costs outweigh the gains from removing small deviations between actual and target leverage. (See Leary and Roberts' [2003] hazard model.) Unreported simulation results indicate that this smooth adjustment specification readily incorporates discrete capital adjustments caused by fixed adjustment costs.

where λ_2 is the adjustment speed to share price effects. Equation (8) says that the observed change in equity ratio is the sum of the partial movement to the target leverage [$\lambda_1 (\beta X_{i,tt} - MKTRAT_{t-1})$] and the residual portion of the share price effect that has not been offset [$(1-\lambda_2)(\text{Share price effect})_{t-1,t}$]. Because managers cannot anticipate stock price shocks at the beginning of the period, we expect $\lambda_2 < \lambda_1$.

We estimate the "share price effect" as the impact of the ith firm's stock return on its capital ratio:

$$\boldsymbol{SPE}_{i,t} = \left(\frac{E_{t-1}(1+\widetilde{R}_{t-1,t})}{D_{t-1} + E_{t-1}(1+\widetilde{R}_{t-1,t})} \right) - \boldsymbol{MKTRAT}_{t-1} \tag{9}$$

where $\widetilde{R}_{t-1,t}$ = the realized return the ith bank's stock between t-1 and t.

E_{t-1} = market value of common equity at the end of period t-1

D_{t-1} = book value of BHC outstanding debt at the end of period t-1

SPE measures the change in ***MKTRAT*** that will occur if managers leave E and D unchanged during the period. Substituting (9) into (8) gives:

$$\boldsymbol{MKTRAT}_{i,t} = \lambda_1 \beta X_{i,tt} + (1-\lambda_1)\, \boldsymbol{MKTRAT}_{i,t-1} + (1-\lambda_2)\, \boldsymbol{SPE}_{i,t} + \mu_{i,t} \tag{10}$$

In the long run, (10) implies that

1) The firm's actual debt ratio converges to its target debt ratio, $\beta X_{i,,t}$
2) The long-run impact of $X_{i,t}$ on the capital ratio is given by its estimated coefficient, divided by λ_1.

Inserting the two partial adjustments into equation (4) gives our main regression specification:

$$\begin{aligned} \boldsymbol{MKTRAT}_{it} = {} & \alpha_0 + (1-\lambda_0 - \sum_{k=1}^{3} \lambda_k \boldsymbol{D}_k)\, \boldsymbol{MKTRAT}_{i,t-1} + (\delta_0 + \sum_{k=1}^{3} \delta_k \boldsymbol{D}_k)\, \boldsymbol{SPE}_{i,t} + (\beta_0 + \sum_{k=1}^{3} \beta_k \boldsymbol{D}_k)\, \hat{\sigma}_{it} + \\ & \alpha_1 \boldsymbol{HMB}_{it-1} + \alpha_2 \boldsymbol{REGP}_{it-1} + \alpha_3 \boldsymbol{ROA}_{it-1} + \alpha_4 \boldsymbol{LNTA}_{i,t-1} + \textbf{Firm Fixed Effects} + \widetilde{\mu}_{it} \end{aligned} \tag{11}$$

B. Econometric Issues

We estimate (11) as a fixed-effects panel regression, in which three of the explanatory variables are likely to be correlated with the residual: σ_A, $\boldsymbol{SPE}_{it}$, and the lagged dependent variable ($MKTRAT_{i,t-1}$). OLS

coefficient estimates would therefore be biased, and we employ the method of 2SLS to estimate (11). This procedure requires additional exogenous variables that are correlated with the endogenous regressors, but not with the error term in (2a).

First, we require an instrument for σ_A. Theory suggests that a BHC jointly selects its portfolio risk and its ***MKTRAT***, as in (2a) and (2b). In addition, our volatility measure is derived from ***MKTRAT*** in (1), so positive (negative) random errors in ***MKTRAT*** will generate over-(under-) estimates of σ_A. We use three exogenous variables to help predict the expected value of σ_A:

VOL_SP$_t$ = the next 30 days' expected stock market volatility, measured by the VXO index published by the CBOE. (See description of VXO at http://www.cboe.com/micro/vix/index.asp).)

VOL_I$_t$ = the standard deviation of the daily yield to maturity on a 1-year, constant-maturity Treasury bond, computed over the preceding quarter.

CRED_SPR$_t$ = the average daily spread between Moody's index of BAA corporate bonds and AAA corporate bonds during the last month of the quarter.

These exogenous variables should capture the external components of financial uncertainty confronted by a BHC in choosing its σ_A and ***MKTRAT***.

Second, ***SPE***$_{it}$ will be correlated with the error term because both ***SPE***$_{it}$ and the dependent variable contain the BHC's realized stock return ($\tilde{R}_{t-1,t}$). We therefore replace ***SPE*** with its fitted value from an instrumental variables regression that includes the exogenous variable

$$\boldsymbol{SPE}^{O}{}_{it} = \left(\frac{\boldsymbol{E}_{t-1}(1+\tilde{\boldsymbol{R}}^{\boldsymbol{O}}{}_{t-1,t})}{\boldsymbol{D}_{t-1} + \boldsymbol{E}_{t-1}(1+\tilde{\boldsymbol{R}}^{\boldsymbol{O}}{}_{t-1,t})} \right) - MKTRAT_{t-1} \qquad (10a)$$

where $\tilde{\boldsymbol{R}}^{\boldsymbol{O}}{}_{t-1,t}$ = the mean realized return on all the *other* sample BHC's stocks during the period ending at t. $SPE^{O}{}_{it}$ will be correlated with the ith firm's share price effect, but does not include the realized value of i's stock return.[18]

[18] Table 6 demonstrates that substituting the S&P 500 return for $\tilde{\boldsymbol{R}}^{\boldsymbol{O}}{}_{t-1,t}$ leaves our main conclusions unchanged.

Third, dynamic panel regressions generally produce biased estimated coefficients because of the correlation between a panel's lagged dependent variable and the error term (Greene [2002]). In addition, serially correlated residuals in (11) can bias the estimated coefficient on the lagged dependent variable. Both of these problems are addressed by constructing an instrumental variable for $\boldsymbol{MKTRAT_{t-1}}$, with the fitted values from a first-stage regression that includes the firm's lagged *book* value equity ratio (called $\boldsymbol{BOOKRAT_{i,t-1}}$) as the identifying exogenous variable. To prevent biases caused by serially correlated residuals, we allow for an AR(1) error structure in (11).

C. Data

Each BHC's stock price series was obtained from CRSP. We gathered daily interest rates from the Federal Reserve's H.15 report, and daily VXO (equity volatility) values from the CBOE web site. Balance sheet and income statement data were taken from the quarterly Consolidated Financial Statements for Bank Holding Companies (FR Y-9C). The sample period begins on June 30, 1986, when the Y-9C reports were substantially revised. We estimate annual regressions using the September Y-9 data. The sample firms comprise the 100 largest U.S. bank holding companies, as measured by book value of total assets. We re-select the 100 largest BHC at the end of each year's third quarter. We estimate our regression model for the subset of these 100 BHC with end-of-quarter stock prices available on CRSP and at least thirty days of reported stock returns within the quarter.

The final data set included 1,231 BHC-year observations with which to estimate an annual version of the pooled regression (11). The total number of banks represented in the sample was 153, and the mean (median) number of banks in each cross-section was 77 (80). Although the sample includes a relatively small *number* of BHC, those firms held a majority of all U.S. banking assets (between 61% and 88%) during the sample period. In order to limit the influence of extreme outliers, we average σ_A measures over the preceding four quarters and winsorize the resulting variable at the 5% and 95% levels each year. Table 1 provides summary statistics for the variables used in estimating regression (11).

IV. *Estimation Results*

Table 2 reports the first stage regressions used to construct our three instrumental variables. Weak instruments generally result in large standard errors for the coefficients of interest, and can also yield 2SLS estimates that are strongly biased toward their (inconsistent) OLS values (e.g. Nelson and Startz [1990]). Our first-state regressions indicate that weak instruments are not a problem in the present context: the exogenous variables' coefficients are highly significant and the regressions' overall explanatory power is high -- "within" R^2 statistics between 0.34 and 0.86. We therefore proceed with confidence that our instruments will perform well in 2SLS estimation.

Table 3 reports the results from estimating three versions of the regression (11) for our sample of large BHC. Panel (A) of Table 3 reports the full model, which permits partial adjustment toward the target capital ratio and recognizes the contemporaneous effect of stock price changes on ***MKTRAT***. The impact of risk on capitalization during our four sub-periods is shown in the first four rows. During the two periods before 1994, the estimated effect of risk on ***MKTRAT*** was insignificantly different from zero. (These two coefficients even have the wrong sign.) For the last two sub-periods, however, we find significant positive coefficients on risk, consistent with the hypothesis that bank counterparties demanded greater protection against default following the institutional reforms discussed above. During the last sub-period, the target ***MKTRAT*** was 2.52% higher for each 1% increase in risk. In other words, increasing risk by 1 standard deviation raised MKTRAT by 1.3 standard deviations. Another way to assess the economic importance of this effect is to observe that large BHC were operating with a marginal default probability of approximately 0.6% (the cumulative standardized density of -2.52, assuming normally distributed asset returns).

The non-risk determinants of ***MKTRAT**** generally carry appropriately-signed, significant coefficients in Table 3A. A relatively high charter value (HMB(-1)) or profitability (ROA(-1)) significantly raises the target capital ratio, while larger banks (LNTA(-1)) tend to hold less equity. The effect of a binding regulatory constraint on book equity (REGP(-1)) is positive, but differs insignificantly from zero.

The coefficients on the lagged dependent variable indicate that bankers adjust toward their target capital ratios rather quickly. The estimated adjustment speeds vary across the sub-periods between 49% and 71% per year, although these speeds do not differ significantly from one another across time. The average adjustment speed is about 53% per year, which is faster than similar estimates for non-financial firms (Flannery and Rangan [2004]).

None of the estimated coefficients on ***SPE*** differs significantly from unity, implying that managers do not offset stock price effects on ***MKTRAT*** in the year they occur. However, a small (zero) value for λ_2 does not mean that managers never adjust ***MKTRAT*** to share price changes. The residual effect of a price change during the period [t-1, t) is impounded in the next period's lagged ***MKTRAT*** and hence gets offset at an annual rate of about 53% in the years following the initial price shock.

Although we believe that (11) is the most appropriate specification for large BHCs' capital adjustment process, the stock price effect and the lag structures on the dependent variable are somewhat new to the literature. We therefore provide two further estimates based on constrained specifications, for the sake of comparison. Panel B of Table 3 removes the effect of contemporaneous stock price changes on a BHC's observed capital ratio. The resulting coefficients for risk display roughly the same pattern as in Panel A: negative early in the period and positive later, although the effect no longer rises monotonically. The estimated adjustment speeds vary more widely over time than in Model (I), and average about 31% per year.

Panel C of Table 3 reports a severely constrained version of regression (11), which specifies that BHC attain their target ***MKTRAT*** at all times, at least on average across the sample. The same qualitative result holds: the estimated coefficients on asset risk remain consistent with the hypothesis that BHC provided more capital protection later in the sample period. (Note that omitting the lagged dependent variable means that the model's "short run" and "long run" coefficient estimates are identical.)

C. De-composing the Change in BHC Capitalization

The mean BHC market capital ratio increased between 1986 and 2001, and we can use the results in Table 3 to de-compose this increase into several component parts. Figure 9 illustrates that an intertemporal

change in leverage can be attributed to two broad factors, "market" effects and "passive bank" effects. Begin by considering the lowest dotted line, which represents the banks' initial (1986-89) tradeoff between risk and capitalization. Market discipline should make this line slope up to the right (as shown), but recall that the actual slope in Panel A of Table 3 is insignificantly negative. The estimated regression model has a slope of 2.52 for the 1998-2001 time period, corresponding to a leftward rotation of the equilibrium line in Figure 9. *Ceteris paribus*, this effect would make bank shareholders want to hold higher capital, in the amount **E1**. Bank portfolios also became riskier during our sample period, meaning that the initial σ_{A0} shifted right to σ_{A3}. The resulting increase in optimal equity can be divided into two parts. **E2** in Figure 9 is the extra capital associated with the change in risk alone (i.e., holding the slope constant its initial value β_0). **E3** measures the impact of combined changes in bank risk and market sensitivity. Finally, the solid line in Figure 9 will shift up in a roughly *parallel* fashion (**E4**) if managers enhance capital passively and if earnings or stock price increases are independent of σ_A.

Our estimated regression coefficients from Panel A in Table 3 can be used to estimate the contribution of Effects **E1 – E4** to the observed change in mean (median) ***MKTRAT*** values between 1986-89 and 1998-01. Table 4 reports the long-run change in ***MKTRAT*** associated with each of these effects:

E1. The long-run impact of a change in market risk aversion: $\left[\frac{\beta_0+\beta_3}{1-\lambda_0-\lambda_3}-\frac{\beta_0}{1-\lambda_0}\right]\sigma_{A0}$

E2. The long-run impact of a change in the asset portfolio risk, independent of the market's changed risk aversion: $\left[\frac{\beta_0}{1-\lambda_0}(\Delta\sigma_A)\right]$.

E3. The interaction between E1 and E2: $\left[\frac{\beta_0+\beta_3}{1-\lambda_0-\lambda_3}-\frac{\beta_0}{1-\lambda_0}\right]\left[\Delta\sigma_A\right]$.

E4. The "passive bank" effect of retained earnings on bank capital, given by $\left[\frac{\alpha_3}{1-\lambda_0-\lambda_3}(\Delta \boldsymbol{ROA_{t-1}})\right]$.

Our empirical model includes three additional adjustments, which we identify as "other (technical) effects" in Table 4. First, we adjust the predicted ***MKTRAT*** values in 1998-2001 for the transitory impact of changes in regulatory pressure (***REGP***). Second, we incorporate the negative impact of asset growth on target capitalization. Third, we recognize that the BHC sample changes between 1986-89 and 1998-01, so we must recognize differences in the included firms' fixed effect values.

Table 4 reports each calculated Effect as a proportion of the observed change in the typical bank's ***MKTRAT*** between 1986-89 and 1998-01. If sample BHC were close to their long-run equilibria in each period, these Effects should sum to approximately 100%. The sample BHCs' mean market capital ratio rose by 9.70% between 1986-89 and 1998-01, from 8.02% to 17.72%. About 53% of the observed change reflects increased market risk aversion (effect **E1**), and this proportion differs from zero at the 1% confidence level. The measured increase in risk (**E2**) has a surprising effect of *reducing* desired ***MKTRAT*** by 27.42% of the observed change. This effect is statistically indistinguishable from zero, and results from the negative, but insignificant, coefficient on σ_A in (11) for the 1986-89 time period. The combined effect of greater risk aversion and riskier assets (**E3**) raises ***MKTRAT*** by 143.5% of the ratio's actual change. Taken together, the three "active" effects (**E1 + E2 + E3**) account for 168.6% of the mean change in sample BHCs' capitalization. By contrast, the "passive bank" effect from retained earnings (**E4**) is statistically significant, but accounts for less than 3% of the observed change. Finally, "other (technical) effects reduce predicted the equity ratio by 66.24%, leaving our model's predicted change in MKTRAT equal to 105% of the mean observed change between 1986-89 and 1998-2001. The second column of Table 4 shows the same decomposition in terms of sample medians, with similar results.

The results in Table 4 indicate that most of the large BHCs' ***MKTRAT*** increase resulted from active managerial decisions to increase ***MKTRAT*** in conjunction with higher risks. An important remaining question is whether this increased risk sensitivity derived from supervisory pressure or market forces.

V. *Do Higher Market Ratios Reflect Stricter Regulatory Constraints?*

Perhaps the results in Table 3 reflect, at least in part, supervisory efforts to raise book capital ratios.[19] Supervisors had been explicitly seeking higher minimum capital standards during our sample period, and they were empowered to deal quickly with capital standard violations. FDICIA specifies a series of "prompt corrective actions" that supervisors must take if a bank's book capital falls below 8% of risk-weighted assets (Jones and King [1995], page 492), and bank mergers were likely to gain regulatory approval only if the surviving entity would be "well capitalized" (i.e. more than 10% of RWA). Higher capital standards might contribute to the results in Table 3 in either of two ways.

First, we know that the book capital ratios (***BOOKRAT***) are correlated (ρ = 0.68) with the dependent variable in regression (11), ***MKTRAT***. Perhaps the "true" linkage is between ***BOOKRAT*** and asset risk and the impact of risk on ***MKTRAT*** in Table 3 is at least partly spurious. We test whether market risk measures affect book capital ratios by estimating:

$$\begin{aligned} BOOKRAT_{it} = \alpha_0 + (1-\lambda_0 - \sum_{k=1}^{3} \lambda_k D_k)\, BOOKRAT_{i,t-1} + (\beta_0 + \sum_{k=1}^{3} \beta_k D_k)\, \hat{\sigma}_{Ait} + \alpha_1 HMB_{it-1} + \alpha_3 ROA_{it-1} \\ + \alpha_4 LNTA_{i,t-1} + Firm\,Fixed\,Effects \;\; + \;\; \tilde{\varepsilon}_{it} \end{aligned} \tag{12}$$

Compared to regression (11), this specification replaces ***MKTRAT*** with ***BOOKRAT*** as the dependent variable and removes ***SPE*** (because share price does not directly affect ***BOOKRAT***).

Panel A of Table 5 reports the results of this regression. Portfolio risk significantly *negatively* affects ***BOOKRAT*** in the first two subperiods, as it did in Table 3. However, unlike the results for ***MKTRAT***, the risk coefficient in Table 5 remains negative (t = -1.76) during the 1994-97 subperiod and becomes insignificantly positive (t = 1.56) during 1998-01. The estimated risk coefficients for ***BOOKRAT*** rise over time, but their pattern is quite different from the corresponding results in Table 3.. Even if supervisory pressure on ***BOOKRAT*** might partially explain our results, it cannot fully account for them.

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[19] Wall and Peterson [1995] discuss this possibility for their 1989-92 sample period.

Supervisory capital requirements may affect observed ***MKTRAT*** because bankers hold "excess" capital to protect themselves against violating book capital restrictions. Under this view, the "excess" book capital in Figure 3 cannot actually be distributed back to shareholders because it serves to protect against potential supervisory interventions.[20] Lindquist [2004] observes that a protective equity cushion would likely vary directly with the firm's risk exposure. For a protective equity cushion to cause the results in Table 3, the cushion would have to increase over time *and* vary across BHC in proportion to their σ_A. We test for this relationship by regressing "excess" book capital on BHC risk. Recognizing the potential for costly adjustment suggests the specification:

$$\boldsymbol{CUSHION_{it}} = \delta_0 + (1 - \lambda_0 - \sum_{k=1}^{3} \lambda_k \boldsymbol{D_k})\, \boldsymbol{CUSHION_{i,t-1}} + (\beta_0 + \sum_{k=1}^{3} \beta_k \boldsymbol{D_k})\ \hat{\sigma}_{\boldsymbol{Ait}} + \boldsymbol{Firm\ Fixed\ Effects} + \tilde{\varpi}_{\boldsymbol{it}} \tag{13}$$

where $\boldsymbol{CUSHION_{it}}$ = the difference between observed *book* capital (equity plus qualifying debt) and the operative minimum requirement:[21]

- 6% of total assets during the period 1986-1990-III
- 7.25% of risk-weighted assets during the period 1990-IV through 1992-III
- 8% of risk-weighted assets starting in 1992-IV.

σ_A = the instrument for observed asset volatility.[22]

If capital standards became more strictly applied between 1987 and 2001, the coefficients on σ_A should rise later in the period.

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[20] Osterberg and Thomson [1996] study publicly-traded BHCs' leverage decisions in 1986-87, and conclude that "even if a bank meets or exceeds the capital guidelines, the guidelines influence movements of bank leverage." (page 327)

[21] Note that the *de facto* capital standard could be above these minima – e.g 10% of RWA under Basel. Any uniform change in measuring ***CUSHION*** would induce an offsetting change in the regression's constant term, without affecting the slope coefficients.

[22] The relevant risk is that some losses will make book equity inadequate. A measure of credit risk alone (e.g. the ratio of risk-weighted assets to total on-book assets) is incomplete because it ignores other reasons for changes in book capital ratios. Although σ_A includes some risks that do not affect book equity (e.g. unrealized losses on loans or bonds), we feel that this risk measure most closely approximates the type of risk that should affect an equity cushion.

Panel B of Table 5 reports the estimation results for (13).[23] Throughout the sample period, a BHC's risk exposure has no significant effect on ***CUSHION***. Perhaps the cost of violating *de jure* capital standards did not really rise over time, or perhaps σ_A imperfectly measures the relevant uncertainty for a capital cushion. Regardless, the increasing effect of σ_A on MKTRAT in Table 3 does not seem to result from bankers' desire to hold a protective cushion of equity above the required minimum level.

VI. *Robustness*

To summarize our results thus far, we find that the largest 100 U.S. BHC held more equity capital per unit of risk exposure by the latter half of the 1990s. We assess the robustness of these results by modifying several features of regression (11). In order to save space, we report only the estimated (short-run and long-run) impact of $\boldsymbol{\sigma_A}$ on ***MKTRAT*** for each specification in Table 6. The revised results always correspond closely to the results in the first column of Table 3. BHC risk became a significant influence on capitalization after 1993, following several years of supervisory reform.

(1) Adjust for Possible Safety-net Subsidies in ***MKTRAT***. The positive coefficients on risk in Table 3 may reflect the tendency of the safety net subsidy to increase with risk. If ***MKTRAT*** includes this type of subsidy, a positive coefficient on risk could reflect either market discipline or a risk-sensitive government subsidy. Ronn and Verma [1986] employ a method for estimating asset values and return volatilities that take this phenomenon into account. We used their method to compute alternative values for each bank's capital ratio and risk. The first column of Table 6 reports the results of estimating (11) with these adjusted (and winsorized) ***MKTRAT*** and σ_A values.[24] We again find that risk had a significantly perverse effect on MKTRAT through 1993, after which its effect became positive and statistically significant.

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[23] Including the other variables from (12) – HMB(-1), ROA(-1), and LNTA(-1) -- on the right-hand side of (13) results in an identical pattern among the β_k.

[24] We also estimated (10) for a dependent variable that entirely removes the insurance value from equity's market value. (Ronn and Verma [1986] point out that an extreme assumption underlies this adjustment: that competition forces none of the insurance value to be passed through to bank customers.)

(2) Alternative Instrument for BHC's Realized Stock Return. Thus far, we have used an equal-weighted index of our sample BHCs to instrument for the impact of exogenous price changes on a bank's capital ratio. If all BHC were simultaneously moving to align their ***MKTRAT*** with their risk, this variable may be correlated with each bank's ***MKTRAT***. We therefore re-estimated our main regression model using the S&P 500 index return to instrument for a firm's ***SPE***. The estimated risk coefficients' magnitudes increased somewhat, but their time pattern remains the same as in Table 3.

(3) Estimates for the Twenty Largest Banks. The top 100 BHC are not homogeneous in terms of their activities, or in terms of their claim on possible safety net guarantees. We therefore wished to compare the "Mega" banks against those that are merely "Large". In order to preserve a reasonable number of data points for the mega sub-sample, we assigned the twenty largest banks (by asset book value) to the Mega group each year. The third panel in Table 6 shows a familiar pattern, with risk becoming a more important influence on ***MKTRAT*** later in the sample period. Unlike the general case in Table 3, Mega banks exhibit significantly positive risk sensitivity only in the last (1998-01) sub-period, perhaps because market participants were slower to accept that the Mega banks' conjectural guarantees had been reduced.

(4) Estimate for Eighty "Next Largest" Banks. Banks that did not qualify as "mega" institutions were assigned to the "large" category, and estimation results for these firms are presented in the fourth panel of Table 6. The results are very similar to those in Table 3: large banks' capital ratios show no sensitivity to risk before 1994, but the short-run and long-run coefficients on risk become significantly positive (and larger) in the subsequent two periods.

(5) Excluding the Charter Value Proxy. We used the proxy ***HMB*** ("high market-to-book") for charter value to reduce the possible effect of charter value's endogeneity on estimated coefficients. However, ***HMB*** could still be correlated with the residual in equation (11). To check whether this effect materially influences our coefficients of interest, we excluded ***HMB*** from the regression specification and obtained very similar estimates.

VII. *Summary and Implications*

This paper has evaluated the capitalization decisions of large bank holding companies over the period 1986-2001, when financial supervisors were trying to reverse the market's conjecture that large banks' default risks were borne mostly by the government. Toward this end, bank supervisors and the U.S. Congress revised their methods for resolving failed institutions (late 1980's), mandated prompt corrective actions vis-à-vis poorly capitalized institutions (1991), and introduced nationwide depositor preference (1993). The large banks' counterparties (depositors, guarantee beneficiaries, FX and derivatives traders) thus became more exposed to banks' true default risks. At the same time, supervisors became more resolved to raise book capital ratios. During the 1990s, U.S. bank equity ratios attained their highest levels in more than 50 years, with virtually all large BHCs' equity ratios comfortably exceeding supervisory standards.

Over the same period, restrictions on permissible bank activities were removed, allowing BHC to select from a broader array of potential risk exposures. The typical BHC's risk exposure increased over our sample period, as the diversification effects of new business activities were (apparently) outweighed by the higher risks associated with those new lines of business. The cross-sectional variation in risk exposures also increased dramatically, as did the cross-sectional variation in capital ratios. Our regression model estimates that the cross-sectional correlation between risk and capitalization also rose, consistent with the hypothesis that uninsured bank counterparties demanded greater protection as government conjectural guarantees receded. Although capitalization did not reflect a bank's portfolio risk before about 1994, U.S. BHC with greater risks were holding significantly more equity capital during the second half of our sample period. It appears that supervisory changes made uninsured bank counterparties feel more exposed to default risks, and the counterparties pressured bankers to provide equity protection to replace the waning government (implicit) guarantees. U.S. supervisors and legislators deserve plaudits for initiating the process that made market discipline more relevant to large banks and their customers.

Regulatory influence may also have continued via pressure to raise *de jure* (book) capital ratios. We cannot rule this out. However, we conclude that supervisory pressure on book capital ratios alone cannot

completely account for our empirical results. Market-related bank responses to counterparty risk exposures contributed substantially to our sample banks' increased capital ratios between 1986-89 and 1998-2001. Since the late 1990s, it appears that large U.S. banking firms have chosen their own (market-valued) capital ratios in response to market pressures.

Two implications follow from our analysis. First, academic and industry models of banking firms should not assume that supervisory capital standards always constrain a bank. Such an assumption is simply inconsistent with the existing facts, at least for the largest (and hence most important) U.S. banking firms. During the 1990s, sharply higher capital levels accompanied increased risk-taking within the banking sector, and banks with the riskiest portfolios ended up holding the most equity. Second, the market's ability to induce higher capitalization at riskier banks provides further support for the role of market forces in supervising large financial firms. Supervisory capital standards might again become binding if banks suffer large losses that drive their capital ratios closer to statutory minima, but now market disciplinary forces appear to have a larger impact on BHC capital ratios than regulatory standards do.

APPENDIX: Estimating BHC Risk Weighted Assets (RWA) in the 1986-91 Period

The Basel Accord established risk weights of 0, 20, 50 or 100% for each asset category on and off a BHC's balance sheet. The risk-weighted sum of the asset categories was termed "risk-weighted assets" (RWA), and capital standards (Tier 1 and Tier 2) were set as proportions of RWA. BHC were required to report their RWA explicitly on the Y-9C forms from 1996, and there is sufficient information reported from 1992 – 96 that we can construct RWA accurately. However, prior to 1992 the Y-9C does not provide enough detail to construct RWA or (therefore) the Tier 1 and Tier 2 capital ratios. For the data reported in Figures 3 and 4, we estimate these capital ratios using a methodology developed by Rangan [2001].

The basic idea is that we can use empirical regularities from the 1992-2001 period to estimate a BHC's RWA in an earlier year. First, we run a pooled regression of the following specification:

$$RWA_{jt} = a_0 + \sum_i b_i A_{ijt} + cO_{ijt} + \varepsilon_{jt} \qquad \text{(A-1)}$$

A_{ijt} is the dollar value of asset category i in BHC j's balance sheet at time t

O_{jt} is the notional value of all off-balance sheet assets of BHC j at time t.

The balance sheet asset categories (A_{ijt}) correspond to those reported on the Y-9C form: securities, federal funds sold, trading account securities, premises and fixed assets, acceptances outstanding, loans secured by real estate, commercial and industrial loans, agricultural loans, "other" loans, intangible assets, bad loans (past due and non-accruing), other real estate owned, and miscellaneous other assets. Because asset composition varies greatly among BHCs of different sizes, we partition our sample into three size categories (asset ranks 1-20, 21-50 and 51-100), and estimate (A-1) separately for each size category. The regression R^2 stastistics range from 0.92 to 0.98.

The estimated coefficients in (A-1) measure the risk-weight contribution of each balance sheet category to RWA over the estimation time period. If the risk-weight contributions (coefficients) estimated from (A-1) are the same in the pre-Basel period, we can estimate each BHC's RWA in the pre-Basel period

(1986Q3-1991Q4) by applying the estimated coefficients to the observed asset categories and off-balance sheet assets.

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Table 1: Summary Statistics

	Mean	Median	Min	Max.	Std. Dev.
MKTRAT	12.14%	11.05%	0.10%	52.00%	6.58%
σ_A	3.20%	2.54%	0.70%	15.24%	2.12%
HMB	0.25	0	0	1	0.43
REGP	0.12	0	0	1	0.32
TA ($ bill)	37.30	13.10	3.64	1070.00	75.20
ROA	0.95%	-1.06%	-10.74%	3.62%	0.78%
SPE	0.43%	-0.84%	-14.86%	16.73%	3.44%

MKTRAT = the ratio of the common stock's market value to the quasi-market value of assets (book value of liabilities + market value of equity).

σ_A = unlevered standard deviation of asset returns, annualized and computed from the preceding quarter's daily equity returns. We limit the influence of outliers by averaging σ_A measures over the preceding four quarters and winsorizing the resulting variable at the 5% and 95% levels each year.

HMB = dummy variable equal to one if the BHC's ratio of market to book asset values is in the highest quartile that period, and zero otherwise.

TA = book value of total assets, in billion dollars.

REGP = a dummy variable measuring of regulatory pressure to keep capitalization high. ***REGP*** equals one if a BHC's book equity capital lies within 1.5% of mandated minimum value, and zero otherwise.

ROA = ratio of net operating income to book value of total assets (TA).

$$SPE_{i,t} = \left(\frac{E_{t-1}(1+\widetilde{R}_{t-1,t})}{D_{t-1} + E_{t-1}(1+\widetilde{R}_{t-1,t})} \right) - MKTRAT_{t-1} \qquad (9)$$

where $\widetilde{R}_{t-1,t}$ = the realized return the ith bank's stock between t-1 and t.

E_{t-1} = market value of common equity at the end of period t-1

D_{t-1} = book value of BHC outstanding debt at the end of period t-1

Table 2: First-stage Regressions for 2SLS Procedure, 1986-2001

We use the following first-stage regressions to construct instruments for three endogenous variables in (11). ***MKTRAT*** is the ratio of common equity's market value to the market value of total assets. $\hat{\sigma}$ is annualized asset volatility, computed from equation (1) for the preceding four quarters. ***HMB*** is a dummy variable equal to one when the BHC's market-to-book ratio is in the sample's highest quartile. ***REGP*** is a dummy variable equal to one when the BHC's capital ratio is less than 1.5% above the required minimum. ***LNTA*** is the log of total book assets. ***ROA*** is net current operating income divided by total book assets. ***SPE*** measures the impact of stock price movements on the BHC's start-of-year ***MKTRAT***. ***VOL_SP*** is the implied volatility of the S&P 100 index and VOL_I_t is the volatility of the 1 yr treasury bond. $CRED_SPR_t$ is the basis point spread between Moody's BAA and AAA corporate bond indices. ***BOOKRAT*** is the BHC's ratio of equity's book value to book total assets. $\widetilde{R}^{O}_{t-1,t}$ is the mean realized stock return to all the other banks in our sample for the period ending at t. We also include dummy variables identifying all sample BHC, although these estimated coefficients are not reported. T-statistics are reported in parentheses below the coefficient estimates.

	$\hat{\sigma}$	*MKTRAT(-1)*	*SPE*
VOL_SP_t	0.001	0.002	-0.001
	(14.70)	(15.92)	(-5.36)
VOL_I_t	-0.012	-0.015	0.018
	(-2.87)	(-1.71)	(1.73)
$CRED_SPR_t$	-0.008	-0.046	0.032
	(-2.58)	(-7.18)	(4.26)
BOOKRAT(-1)	0.225	1.501	-0.091
	(5.26)	(17.24)	(-0.88)
$\widetilde{R}^{O}_{t-1,t}$	0.082	-0.186	0.780
	(4.50)	(-5.05)	(17.94)
HMB(-1)	0.009	0.019	0.004
	(7.75)	(8.02)	(1.29)
REGP(-1)	-0.002	0.010	-0.004
	(-1.61)	(3.14)	(-1.05)
ROA(-1)	0.227	1.064	0.361
	(3.32)	(7.63)	(2.20)
LNTA(-1)	0.011	0.025	0.001
	(10.21)	(11.73)	(0.49)
Firm Fixed Effects?	Yes	Yes	Yes
N	1,231	1,231	1,231
R^2 (within)	0.698	0.862	0.344

Table 3: Estimation Results, Equity Market Value Capitalization

$$\boldsymbol{MKTRAT_{it}} = \alpha_0 + (1 - \lambda_0 - \sum_{k=1}^{3} \lambda_k \boldsymbol{D_k})\ \boldsymbol{MKTRAT_{i,t-1}} + (\delta_0 + \sum_{k=1}^{3} \delta_k \boldsymbol{D_k})\ \boldsymbol{SPE_{i,t}} + (\beta_0 + \sum_{k=1}^{3} \beta_k \boldsymbol{D_k})\ \hat{\sigma}_{it} +$$
$$\alpha_1 \boldsymbol{HMB_{it-1}} + \alpha_2 \boldsymbol{REGP_{it-1}} + \alpha_3 \boldsymbol{ROA_{it-1}} + \alpha_4 \boldsymbol{LNTA_{i,t-1}} + \textbf{\textit{Firm Fixed Effects}} \quad + \quad [\tilde{\varepsilon}_{it} - \rho_i \tilde{\varepsilon}_{i,t-1}] \tag{11}$$

Estimated as a 2SLS regression with AR(1) correction using annual data from 1986-2001. ***MKTRAT*** is the ratio of common equity's market value to the market value of total assets. $\hat{\sigma}_{it}$ is the annualized asset volatility, computed by de-levering the standard deviation of daily equity returns over a quarter and averaged over the preceding 4 quarters. D_k are dummies marking three successive four-year periods, identified by the subscripts on the "D" variables in the table below. ***HMB*** is a dummy variable equal to one when the BHC's market-to-book ratio is in the sample's highest quartile. ***REGP*** is a dummy variable equal to one when the BHC's capital ratio is less than 1.5% above the required minimum. ***LNTA*** is the log of total book assets. ***ROA*** is net current operating income divided by total book assets. ***SPE*** is a proxy for the unanticipated effect that stock price movements have on the BHC's equity ratio**.** Coefficients for $\hat{\sigma}_{Ait}$, ***SPE*** and $\boldsymbol{MKTRAT}_{i,t-1}$ are estimated using fitted values from the first-stage regressions reported in Table 2. For the explanatory variables in (11) associated with shift dummies, we report both the coefficients themselves (λ_0, λ_1,… δ_0, δ_1, …β_0, β_1, ..) and the "Implied absolute coefficients" ($\lambda_0 + \lambda_1$, $\lambda_0 + \lambda_2$…). We also include dummy variables identifying all sample BHC, although these estimated coefficients are not reported. T-statistics are reported in parentheses below the coefficient estimates.

(continued)

Table 3, continued

	Panel A			Panel B			Panel C	
	Coeff. (t-stat)	***Implied Absolute Coeff. (t-stat)***	***Long-run Coeff. (t-stat)***	***Coeff. (t-stat)***	***Implied Absolute Coeff. (t-stat)***	***Long-run Coeff. (t-stat)***	***Coeff. (t-stat)***	***Implied Absolute Coeff. (t-stat)***
$\hat{\sigma}$	-0.380		-0.595	-2.285		-18.578	0.345	
	(-0.74)		(-0.66)	(-3.64)		(-0.61)	(1.15)	
$\hat{\sigma}$ * $D_{1990\text{-}1993}$	-0.215	-0.595	-1.213	-0.937	-3.222	26.472	-0.262	0.083
	(-0.49)	(-1.34)	(-1.04)	(-1.69)	(-6.29)	(0.91)	(-1.56)	(0.40)
$\hat{\sigma}$ * $D_{1994\text{-}1997}$	1.604	1.224	1.724	3.564	1.279	1.710	1.159	1.504
	(3.38)	(3.08)	(4.64)	(6.05)	(2.43)	(4.47)	(5.86)	(8.15)
$\hat{\sigma}$ * $D_{1998\text{-}2001}$	1.820	1.441	2.519	2.637	0.352	0.697	1.004	1.348
	(3.92)	(3.92)	(7.86)	(4.48)	(0.70)	(0.87)	(4.58)	(8.60)
HMB(-1)	0.009			0.018			0.015	
	(3.03)			(5.16)			(4.30)	
REGP(-1)	0.001			-0.018			-0.012	
	(0.36)			(-4.25)			(-3.07)	
ROA(-1)	0.390			0.744			0.929	
	(2.44)			(4.23)			(5.40)	
LNTA(-1)	-0.023			0.000			0.009	
	(-6.01)			(0.04)			(2.20)	
MKTRAT(-1)	0.362			0.877				
	(2.84)			(5.09)				
MKTRAT(-1) $^{*}D_{1990\text{-}93}$	0.148	0.510		0.245	1.122			
	(1.35)	(4.40)		(1.73)	(7.38)			
MKTRAT(-1) $^{*}D_{1994\text{-}97}$	-0.072	0.290		-0.625	0.252			
	(-0.62)	(2.78)		(-4.14)	(1.61)			
MKTRAT(-1) $^{*}D_{1998\text{-}01}$	0.066	0.428		-0.383	0.494			
	(0.56)	(3.97)		(-2.46)	(3.18)			
SPE	1.040							
	(5.23)							
SPE $^{*}D_{1990\text{-}1993}$	0.003	1.043						
	(0.01)	(17.18)						
SPE $^{*}D_{1994\text{-}1997}$	0.400	1.440						
	(1.61)	(8.12)						
SPE $^{*}D_{1998\text{-}2001}$	-0.352	0.688						
	(-1.42)	(4.55)						
Num. Obs.	1079			1079			1079	
$\overline{R}^2$ **(within)**	0.77			0.62			0.47	
ρ	-0.01			0.08**			0.28***	

Table 4: Percentage contributions to the observed mean change in market equity ratios, between 1986-89 and 1998-2001

Coefficient names refer to equation (11)). Reported numbers represent the proportion of observed change in the mean market value of equity ratio (***MKTRAT***) from the 1986-89 period to the 1998-2001 period. The four "Effects" are illustrated in Figure 9.

Contributions	**Computed at the means, as a percentage of the observed change in mean MKTRAT = 9.70%**	**Computed at the medians, as a percentage of the observed change in median MKTRAT = 9.46%**
E1: Impact of a change in market risk aversion (β_4)	52.51% ***	48.06% ***
E2: The impact of higher asset portfolio risk, $\beta_0(\Delta\sigma)$.	-27.42%	-25.54%
E3: The interaction between E1 and E2: $\beta_4(\Delta\sigma)$	143.52% ***	133.68% ***
The "market discipline" effect (E1 + E2 +E3):	168.61%***	156.20%***
E4: Change in Earnings: α_4(***ΔROA***) **(The "passive bank" effect)**	2.94% ***	1.49% ***
Other (technical) effects:	-66.24%***	-49.68%***
Mean Predicted change in ***MKTRAT*** implied by regression model (11), as a proportion of the actual change in ***MKTRAT***	105.30%	108.00%

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

Table 5: Estimation Results for Book Value Capitalization and Excess Regulatory Capital

$$BOOKRAT_{it} = \alpha_0 + (1 - \lambda_0 - \sum_{k=1}^{3} \lambda_k D_k)\, BOOKRAT_{i,t-1} + (\beta_0 + \sum_{k=1}^{3} \beta_k D_k)\ \hat{\sigma}_{it} + \alpha_1 HMB_{it-1} + \alpha_3 ROA_{it-1} + \alpha_4 LNTA_{i,t-1} + Firm\,Fixed\,Effects \ + \ [\tilde{\varepsilon}_{it} - \rho_i \tilde{\varepsilon}_{i,t-1}] \tag{12}$$

$$CUSHION_{it} = \ \delta_0 + (1 - \lambda_0 - \sum_{k=1}^{3} \lambda_k D_k)\, CUSHION_{i,t-1} \ + \ (\beta_0 + \sum_{k=1}^{3} \beta_k D_k)\ \hat{\sigma}_{it} + Firm\ \ Fixed\ \ Effects\ + [\tilde{\omega}_{it} - \rho_i \tilde{\omega}_{iit-1}] \tag{13}$$

Estimated as a 2SLS regression with AR(1) correction using annual data from 1986-2001. ***BOOKRAT*** is the ratio of common equity's book value to the book value of total assets. ***CUSHION$_{it}$*** is excess regulatory capital: total regulatory capital (equity plus qualifying debt) less the required supervisory minimum, as a proportion of total assets (before 1991) or Risk-Weighted Assets (after 1990). $\hat{\sigma}_{Ait}$ is the annualized asset volatility, computed by de-levering the standard deviation of daily equity returns over a quarter and averaged over the preceding 4 quarters. D_k are dummies marking three successive four-year periods, identified by the subscripts on the "D" variables in the table below. ***HMB*** is a dummy variable equal to one when the BHC's market-to-book ratio is in the sample's highest quartile. ***REGP*** is a dummy variable equal to one when the BHC's capital ratio is less than 1.5% above the required minimum. ***LNTA*** is the log of total book assets. ***ROA*** is net current operating income divided by total book assets. Coefficients for $\hat{\sigma}_{Ait}$, ***CUSHION$_{i,,t-1}$*** and ***BOOKRAT***$_{i,t-1}$ are estimated using fitted values from first stage regressions. For the explanatory variables in (12) and (13) associated with shift dummies, we report both the coefficients themselves (λ_0, λ_1,… δ_0, δ_1, …β_0, β_1, ..) and the "Implied absolute coefficients" ($\lambda_0 + \lambda_1$, $\lambda_0 + \lambda_2$…). We also include dummy variables identifying all sample BHC, although these estimated coefficients are not reported. T-statistics are reported in parentheses below the coefficient estimates.

(continued)

Table 5, continued

	Panel A: Book Capital Ratio			*Panel B: Book Capital Cushion*		
	Coeff. (t-stat)	*Implied Absolute Coeff. (t-stat)*	*Long-run Coeff. (t-stat)*	*Coeff. (t-stat)*	*Implied Absolute Coeff. (t-stat)*	*Long-run Coeff. (t-stat)*
$\hat{\sigma}$	-0.388		-0.714	-0.204		-0.142
	(-3.35)		(-2.79)	(-1.43)		(-1.36)
$\hat{\sigma}$ * $D_{1990\text{-}1993}$	0.208	-0.180	-0.345	0.133	-0.071	-0.133
	(1.87)	(-2.22)	(-2.04)	(1.43)	(-0.72)	(-0.69)
$\hat{\sigma}$ * $D_{1994\text{-}1997}$	0.265	-0.123	-0.252	0.214	0.010	0.038
	(2.42)	(-1.95)	(-1.76)	(1.88)	(0.12)	(0.14)
$\hat{\sigma}$ * $D_{1998\text{-}2001}$	0.491	0.103	0.166	0.158	-0.046	-0.100
	(4.28)	(1.47)	(-1.56)	(1.21)	(-0.53)	(-0.47)
HMB(-1)	0.000					
	(0.33)					
ROA(-1)	0.546					
	(9.07)					
LNTA(-1)	0.001					
	(0.55)					
Book_RAT(-1)	0.457					
	(5.71)					
Book_RAT(-1) * $D_{1990\text{-}1993}$	0.022	0.479				
	(0.57)	(6.32)				
Book_RAT(-1) * $D_{1994\text{-}1997}$	0.057	0.514				
	(1.48)	(7.06)				
Book_RAT(-1) * $D_{1998\text{-}2001}$	-0.077	0.380				
	(-1.54)	(5.05)				
CUSHION(-1)				-0.433		
				(-2.56)		
CUSHION(-1) * $D_{1990\text{-}93}$				0.901	0.467	
				(6.80)	(3.31)	
CUSHION(-1) * $D_{1994\text{-}97}$				1.164	0.731	
				(8.33)	(4.90)	
CUSHION(-1) * $D_{1998\text{-}01}$				0.973	0.540	
				(6.55)	(3.64)	
Num. Obs.	1079			1018		
$\overline{R}^2$ **(within)**	0.41			0.22		
ρ	0.05			0.12**		

Table 6: Robustness Results

Variations on the regression specification:

$$\boldsymbol{MKTRAT}_{i,t} = \alpha_0 + (1 - \lambda_0 - \sum_{k=1}^{3} \lambda_k \boldsymbol{D_k})\, \boldsymbol{MKTRAT}_{i,t-1} + (\delta_0 + \sum_{k=1}^{3} \delta_k \boldsymbol{D_k})\, \boldsymbol{SPE}_{i,t-1} + (\beta_0 + \sum_{k=1}^{3} \beta_k \boldsymbol{D_k})\, \hat{\sigma}_{Ait} + \tag{11}$$
$$\alpha_1 \boldsymbol{HMB}_{it-1} + \alpha_2 \boldsymbol{REGP}_{it-1} + \alpha_3 \boldsymbol{ROA}_{it-1} + \alpha_4 \boldsymbol{LNTA}_{i,t-1} + \textbf{\textit{Firm Fixed Effects}} \quad + \quad [\tilde{\varepsilon}_{it} - \rho_i \tilde{\varepsilon}_{i,t-1}]$$

Estimated as a 2SLS regression with AR(1) correction using annual data from 1986-2001. ***MKTRAT*** is the ratio of common equity's market value to the market value of total assets. $\hat{\sigma}_{Ait}$ is the annualized asset volatility, computed by de-levering the standard deviation of daily equity returns over a quarter and averaged over the preceding 4 quarters. D_k are dummies marking three successive four-year periods, identified by the subscripts on the "D" variables in the table below. ***HMB*** is a dummy variable equal to one when the BHC's market-to-book ratio is in the sample's highest quartile. ***REGP*** is a dummy variable equal to one when the BHC's capital ratio is less than 1.5% above the required minimum. ***LNTA*** is the log of total book assets. ***ROA*** is net current operating income divided by total book assets. ***MTKRAT*** is a proxy for the unanticipated effect that stock price movements have on the BHC's equity ratio**.** Coefficients for $\hat{\sigma}_{Ait}$, ***SPE*** and $\boldsymbol{MKTRAT}_{i,t-1}$ are estimated using fitted values from first stage regressions. The first column of coefficients reports the individual δ_k for k = 0, 3. The second column of coefficients is he sum of $\delta_0 + \delta_k$ for k = 1, 3 and the third column presents the long run coefficients. T-statistics are reported in parentheses below the coefficient estimates.

	(1) Asset values and return volatilities adjusted for safety net subsidies.			**(2) SP500 return as alternative instrument for BHC's realized stock return**			**(3) "Mega" BHC: asset ranks 1 - 20**			**(4) "Large" BHC: asset ranks 21 - 100**			**(5) Exclude HMB**		
	Coeff.	**SR**	**LR**	**Coeff.**	**SR**	**LR**	**Coeff.**	**SR**	**LR**	**Coeff.**	**SR**	**LR**	**Coeff.**	**SR**	**LR**
δ_0 (1986-89)	-0.917		-1.473	-0.438		-1.018	-3.386		10.486	-0.093		-0.133	-1.154		-2.191
	(-2.24)		(-1.74)	(-0.86)		(0.70)	(-1.91)		(1.01)	(-0.15)		(0.14)	(-2.07)		(1.39)
δ_1 (1990-93)	-0.949	-1.865	-6.538	-0.483	-0.921	-3.338	-0.015	-3.371	9.803	0.424	-0.517	-0.984	-0.264	-1.417	-4.255
	(-2.25)	(-5.69)	(-2.23)	(-1.00)	(-2.10)	(1.15)	(-0.01)	(-2.53)	(1.24)	(0.78)	(-1.06)	(0.87)	(-0.56)	(-3.03)	(1.48)
δ_2 (1994-97)	1.883	0.966	1.298	3.349	2.911	3.026	3.108	0.278	-0.887	1.397	-1.304	1.697	2.476	1.323	1.663
	(4.15)	(4.13)	(5.52)	(6.50)	(9.25)	(19.08)	(1.87)	(0.25)	(0.20)	(2.32)	(-3.16)	(4.51)	(4.66)	(3.13)	(4.72)
δ (1998-01)	1.316	0.399	1.001	2.003	1.565	2.522	4.511	1.125	2.984	1.586	1.494	2.172	2.464	1.311	2.209
	(3.06)	(2.35)	(3.20)	(3.88)	(4.65)	(10.71)	(2.69)	(0.93)	(3.59)	(2.68)	(3.84)	(6.62)	(4.72)	(3.32)	(6.42)
N		1,079			1,079			266			791			1,079	
R^2 (within)		0.74			0.70			0.76			0.73			0.73	

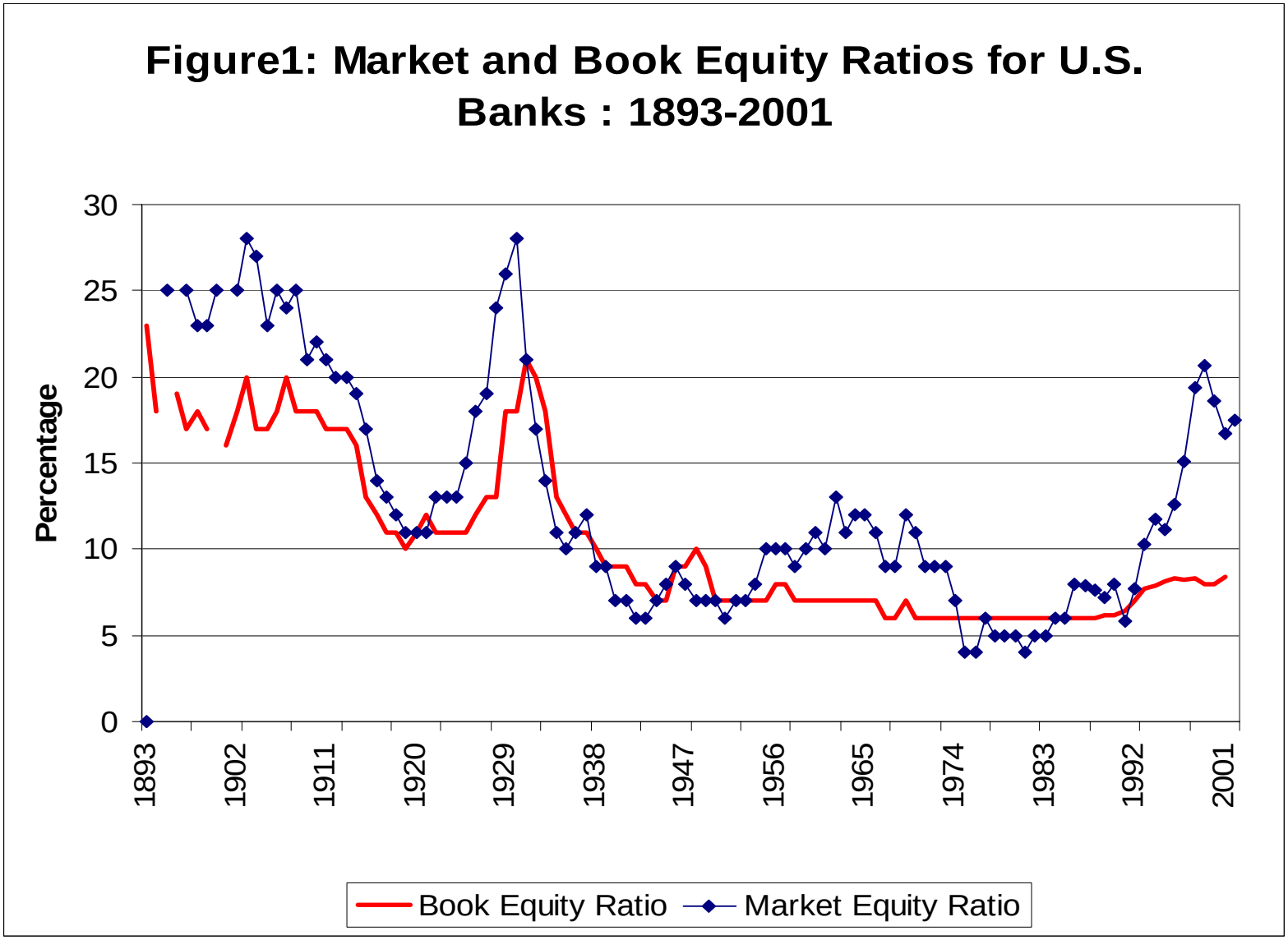
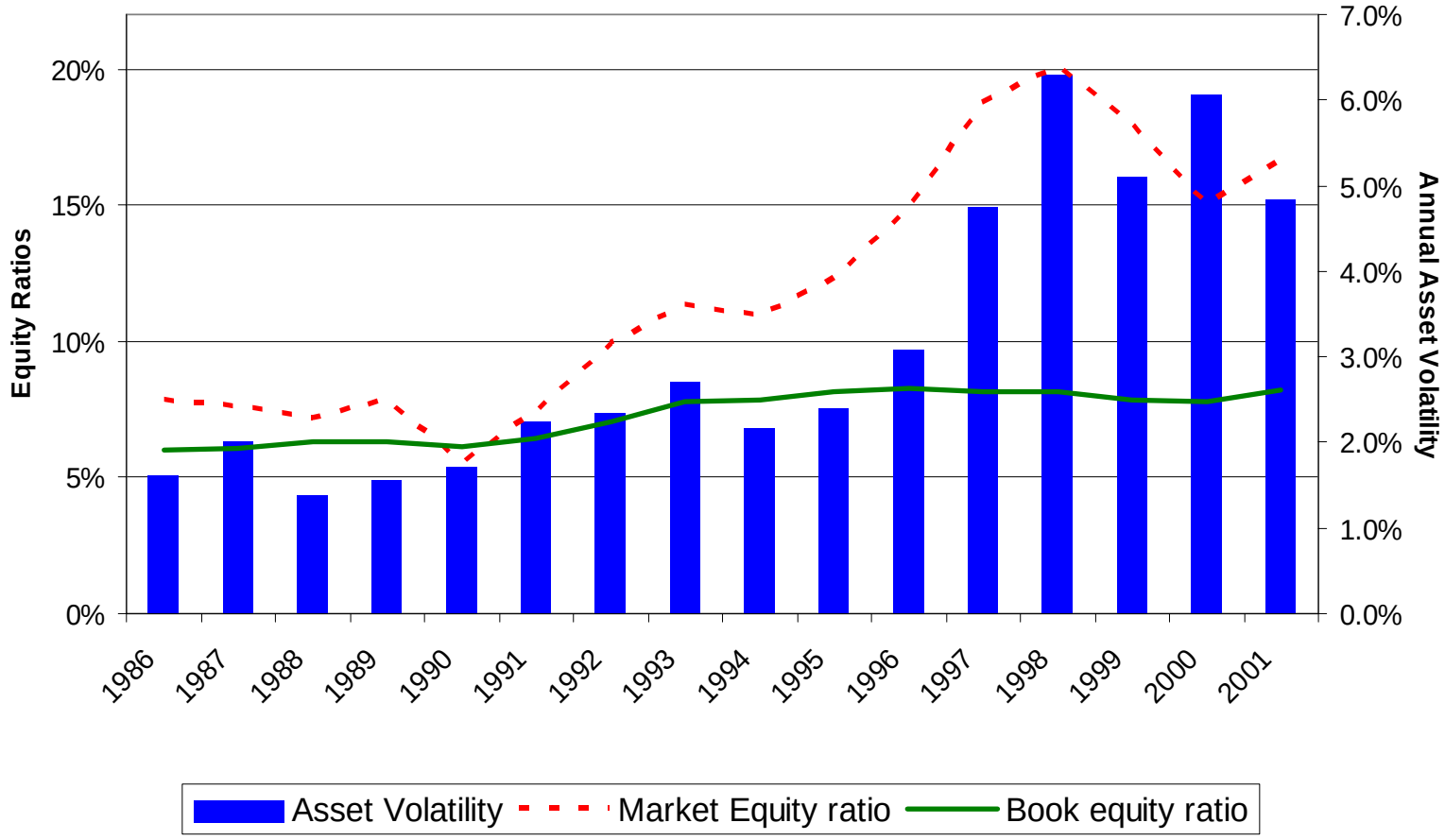


Figure1: Market and Book Equity Ratios for U.S. Banks : 1893-2001
Percentage
30
25
20
15
10
5
0
1893
1902
1911
1920
1929
1938
1947
1956
1965
1974
1983
1992
2001
Book Equity Ratio
Market Equity Ratio

Figure 2: Median Market and Book Equity Ratios, and Asset Volatility for the 100 Largest U.S. BHCs



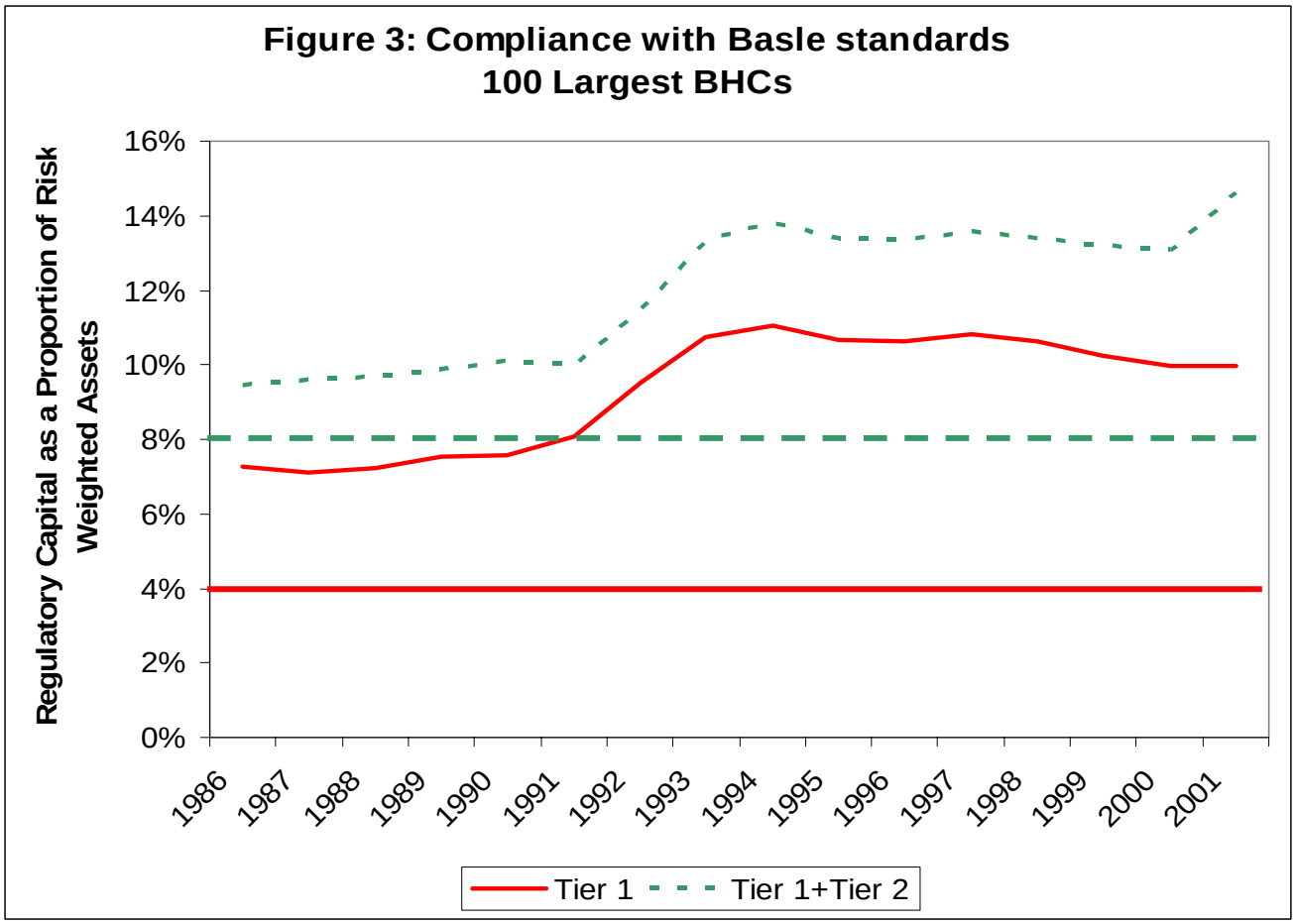


Figure 3: Compliance with Basle standards
100 Largest BHCs
Regulatory Capital as a Proportion of Risk Weighted Assets
16%
14%
12%
10%
8%
6%
4%
2%
0%
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Tier 1
Tier 1+Tier 2

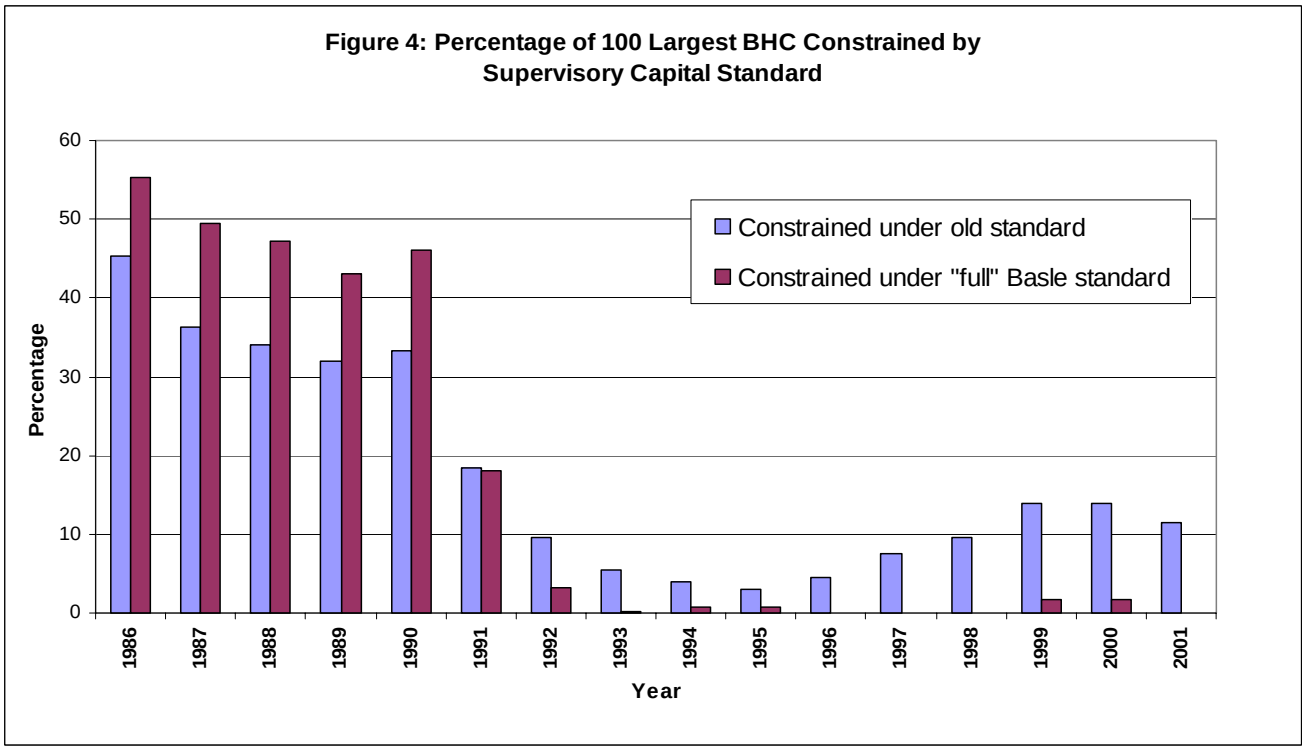


Figure 4: Percentage of 100 Largest BHC Constrained by Supervisory Capital Standard
Percentage
60
50
40
30
20
10
0
Constrained under old standard
Constrained under "full" Basle standard
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year

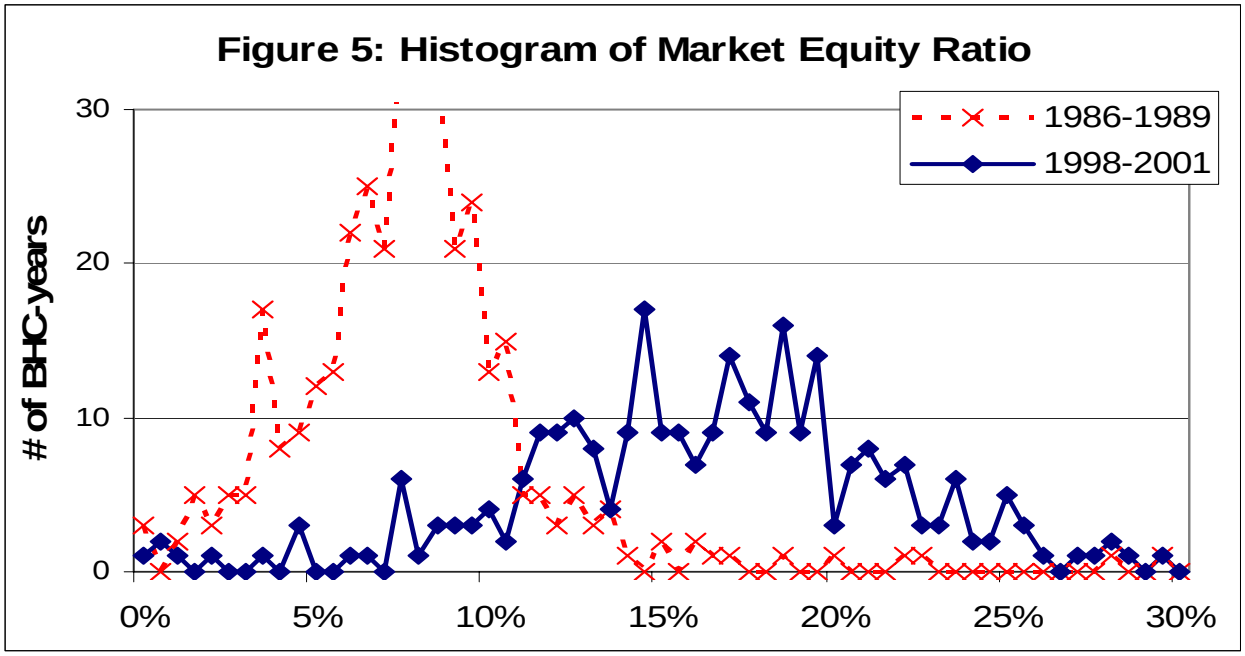


Figure 5: Histogram of Market Equity Ratio
# of BHC-years
30
20
10
0
0%
5%
10%
15%
20%
25%
30%
1986-1989
1998-2001

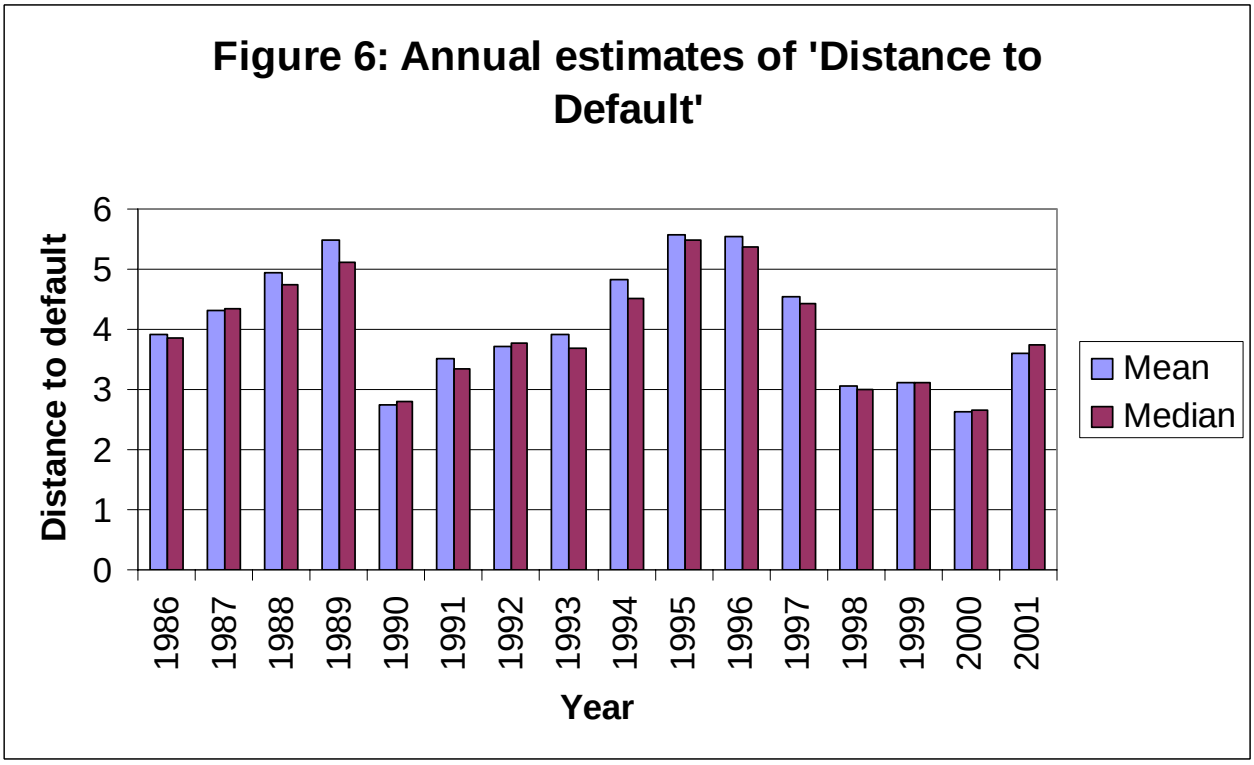


Figure 6: Annual estimates of 'Distance to Default'
Distance to default
6
5
4
3
2
1
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year
Mean
Median

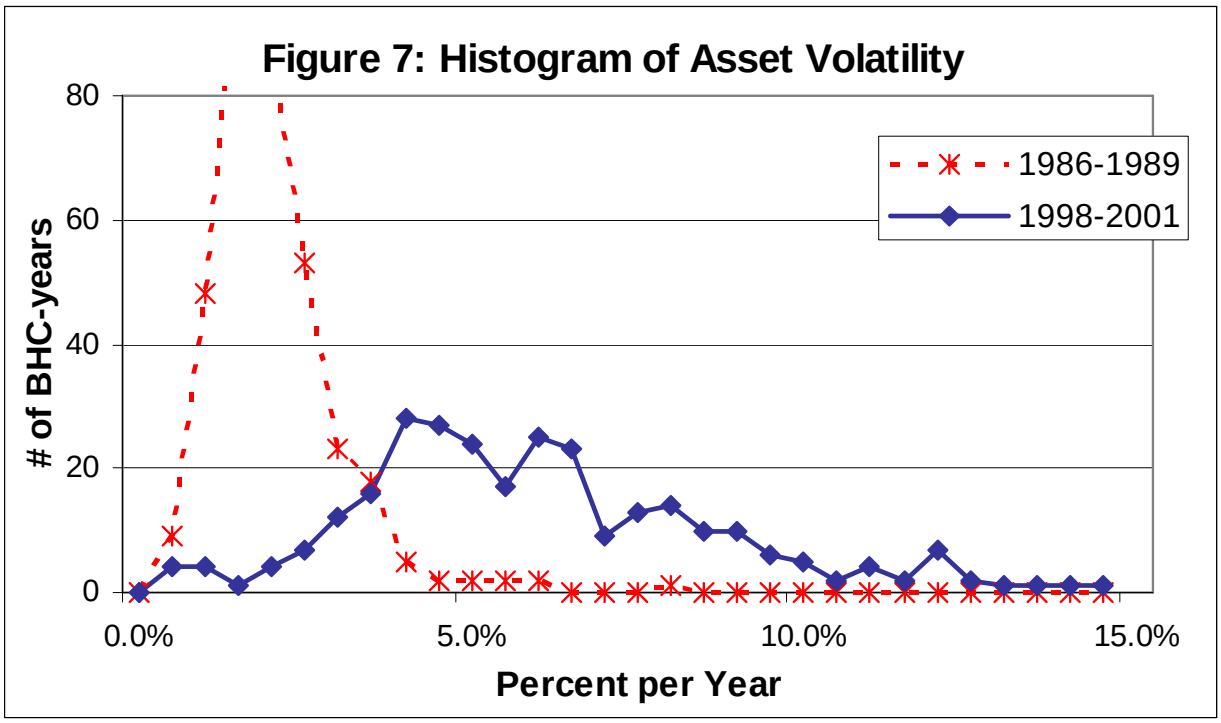


Figure 7: Histogram of Asset Volatility
80
60
40
20
0
# of BHC-years
0.0%
5.0%
10.0%
15.0%
Percent per Year
1986-1989
1998-2001

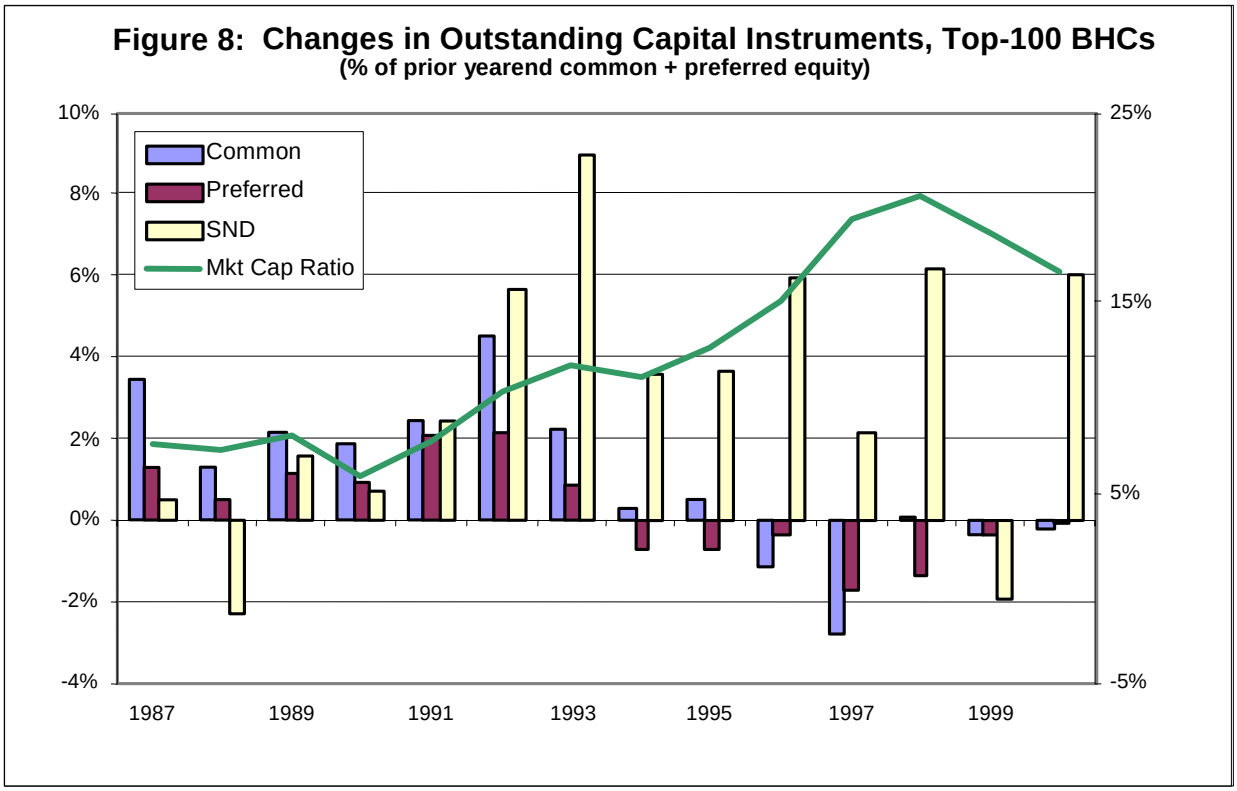
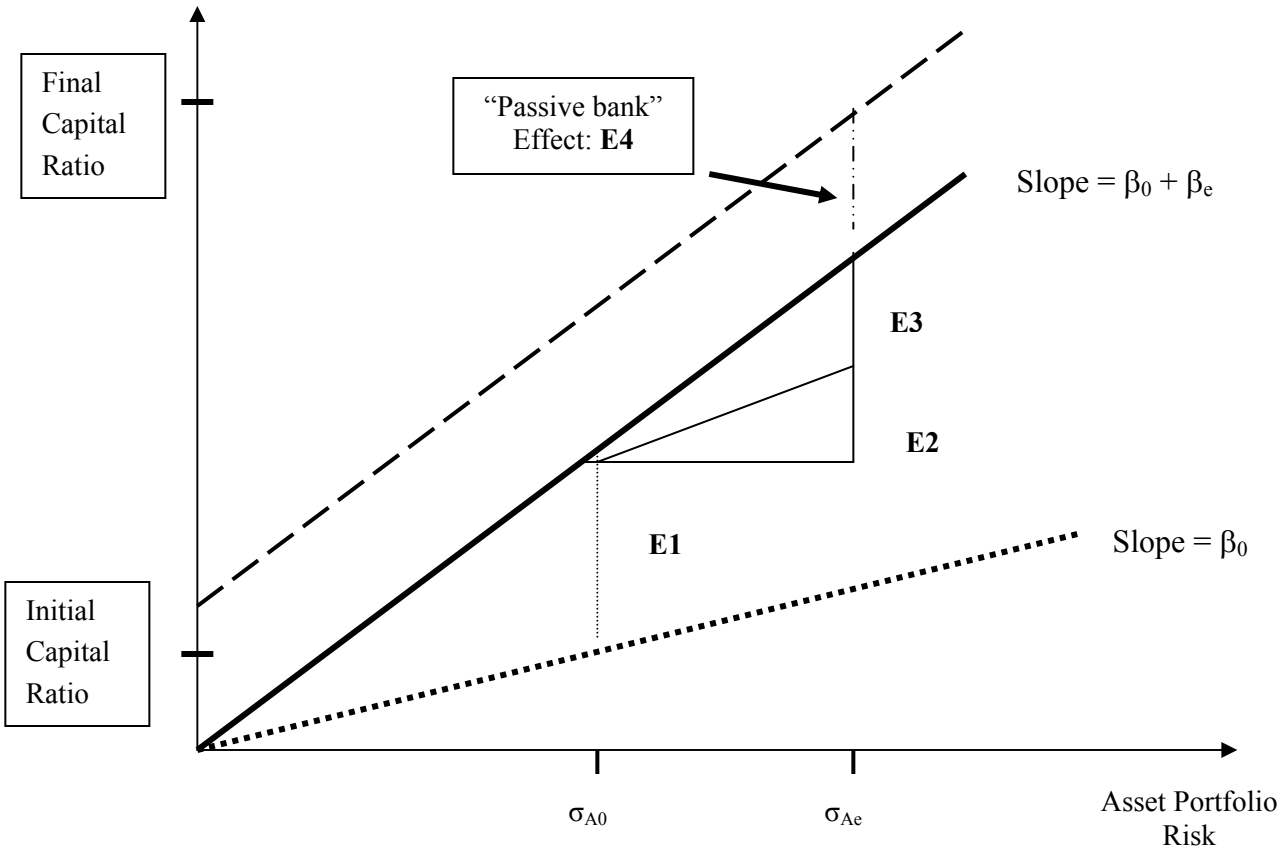


Figure 8: Changes in Outstanding Capital Instruments, Top-100 BHCs
(% of prior yearend common + preferred equity)
10%
8%
6%
4%
2%
0%
-2%
-4%
25%
15%
5%
-5%
1987
1989
1991
1993
1995
1997
1999
Common
Preferred
SND
Mkt Cap Ratio



"Market" Effect = E1 + E2 + E3.

"Passive Bank" effects occur as a shift in the original schedule, independent of risk exposure.

Figure 9