Capital Adjustment Speeds at U.S. BHC

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1. Introduction

The capital structure decision of a bank is interesting to study because of the interaction of regulatory and market forces. Banks facilitate capital flow and risk intermediation, and governments wish to ensure their safety and soundness. To this end a variety of regulatory instruments are used. While deposit insurance ensures that depositors channel their funds through a bank, capital regulation is often designed to minimize the moral hazard risk created by deposit insurance. Capital regulation requires banks to hold a minimum amount of capital in proportion to their risk. Adherence to these regulatory minimums is enforced by supervisors and the cushion – equity in excess of the regulatory minimum - is keenly monitored to assess the safety and soundness of the banking system. In addition to factoring capital regulation in their capital structure decisions, banks face the usual tradeoffs in a Modigliani and Miller sense. While the prevalent academic paradigm has been that capital regulation is a binding constraint (and hence the market tradeoffs are of second order importance), recent evidence (Billett et al. (1998) and Flannery and Rangan (2004)) suggests that markets also monitor the capital and risk positions of the banking firm, and hence influence the capital structure decision.

Modern capital adequacy regulation reflects the assessment that banking firms with greater risk exposures should hold more equity capital. In a Value-at-Risk context, we can interpret capital regulation as an effort to impose an upper bound on the firm's default probability. Yet both risk and capital ratios change frequently, for a variety of (endogenous and exogenous) reasons. If firms find it costly to adjust their capital positions, they may rationally remain over- or under-capitalized for quite some time. Pennacchi [1987] demonstrates that the speed with which a banking firm replaces lost capital (or dissipates surplus capital) has a first-order effect on its probability of failure (expected losses).[1] The speed with which large U.S. bank holding companies (BHC) adjust their capital positions should therefore affect the safety of large firms in our financial system. It should thus be of interest to both supervisors and the uninsured countererparties of large BHCs.

Recent work by Flannery and Rangan [2004] (FR) indicates that large U.S. banking firms operate with specific target capital ratios, which substantially exceed the regulatory minimum. Based on aggregate regressions, FR further conclude that large BHC act to close deviations between their actual and their target capital ratios. However, their regressions estimate a single, annual adjustment speed for all sample banks. Yet an individual firm's situation could easily affect its optimal adjustment speed, as could general financial market conditions.

The paper we write for this NBER project will refine FR's existing specification of capital adjustment speed to reflect firm conditions, market conditions, and the impact of supervisory pressure, and undertake regression estimates using quarterly data. Understanding the process by which large U.S. BHC adjust their equity positions will help supervisors and counterparties to evaluate (and react to) changes in a banking firm's situation. If certain types of shocks, or certain types of market conditions, elicit slower voluntary responses to capital insufficiency, outsiders can react more aggressively than if they expect the bank to correct the situation itself in short order.

2. A Partial-Adjustment Model of Bank Capital

Define the "market capital ratio" of the i^{th} bank holding company (BHC) at time t as

[1] Replacing or dissipating capital means adjusting toward the firm's target leverage by either changing capital, assets, or both.

$$MCR_{it} = \frac{E_{it}}{D_{it} + E_{it}} = \frac{S_{it}P_{it}}{D_{it} + S_{it}P_{it}} \quad (1)$$

where D_{it} = book value of all debt (measured in dollars) at time t

E_{it} = market value of firm i's equity at time t. E_{it} is the product of the number of shares outstanding (S_{it}) and the price per share (P_{it}).

FR estimate a partial adjustment model for the largest 100 U.S. bank holding companies' (market-valued) capital ratios during the period 1986-2001. Their model postulates that each firm has a long-run (target) capital ratio, which balances its perceived costs and benefits of operating with more or less leverage:

$$\boldsymbol{MCR}_{it}^* = \beta X_{it} + \tilde{\mu}_{it} \quad (2)$$

where $\boldsymbol{X}_{it}$ is a vector of firm characteristics related to the costs and benefits of operating with various leverage ratios.

The general literature on capital structure has identified a relatively small set of firm characteristics that seem to determine its target capital ratio. FR find a similar situation for banking firms, and include the following variables in the vector X in (2):

σ_A = unlevered standard deviation of asset returns, annualized and computed from the preceding quarter's daily equity returns.

Ln(TA) = the log of total assets' book value, in billion dollars.

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

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.

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.

A full set of firm fixed effects.

For banks and nonbanks alike, the fixed effects substantially sharpen each firm's estimated capital target (in (3), below), permitting us to estimate adjustment speeds that are not biased due to omitted variables.

A regression like (2) has often been used to identify the determinants of a firm's optimal capital structure. However, it implies that firms are always at their optima (at least on average), and this restriction should be tested. How quickly a firm actually restores capital to its target level will depend on the perceived costs and benefits of remaining away from that desired level. Security issuance costs and the costs of changing balance sheet size or riskiness will tend to slow adjustments. The extent of market (counterparty) pressure and supervisory pressure will tend to hasten adjustments, at least if the bank has become too thinly capitalized. (Thus, the observed adjustment speeds may be asymmetric: capital ratio adjustments might rise more promptly than they fall.) Our model therefore specifies a (potentially) gradual adjustment process to deviations between the firm's actual and desired (optimal) capital ratio. The specification also permits managers to reverse the effect of share price changes on their market capital ratios.

The Appendix derives the following regression specification:

$$\Delta MCR\_P_{i,t+1} = (\lambda_1 \beta) X_{i,t} - \lambda_1 MCR_t + \lambda_2 Surp_{i,t+1} - \tilde{\delta}_{i,t+1} \quad (3)$$

where $\Delta MCR\_P_{i,\ t+1}$ measures the managers' explicit actions during period t+1 designed to change the firm's capital ratio.

MCR is the firm's "market capital ratio" at the end of period t.

$Surp_{i,\,t+1} = \left(\frac{D_{it} S_{it}}{(D_{it} + S_{it} P_{it})^2} \right) dP$, the effect of actual share price change on the BHC's initial capital ratio at time t.

β is the coefficient vector from (2) above.

λ_i is the annual rate of adjustment toward the target capital ratio. Theory requires that $0 \leq \lambda_i \leq 1$, although we do not impose this on our estimations.

$\tilde{\mu}_{it}$ is a random error term.

The specification (3) has three main components. First, the model defines the determinants of each firm's target capital ratio at time t, $\boldsymbol{\beta X_{i,t}}$. Second, it specifies a partial adjustment mechanism by which BHC offset deviations between their actual and their target capital ratios, at the annual rate of λ_1. Third, it specifies a second adjustment process by which the typical bank offsets the effect of share price changes on its actual capital ratio, at the annual rate of λ_2.

Empirical results using annual data indicate that large holding companies' behavior changed noticeably during the 1986-2001 sample period. FR [2004] divided the overall sample period into four sub-periods, whose boundaries roughly correspond to the dates of important changes in supervisory attitudes toward bank failures (1986-89, 1990-93, 1994-97, and 1998-2001). Through 1993, the data reveals no significant tendency to adjust toward a target capital ratio. In the subsequent period, however, the sample's annual adjustment speed climbed to about 30%, and it rose further (to 40-50%) for the sample's last four years (1998-2001). After 1993, the large BHC also manifested an ever-closer (positive) relationship between their risk exposures and the level of their market-valued capital ratios. FR [2004] argue that this increased attention to capitalization reflected enhanced supervisory and market pressures to match capitalization with perceived asset risk.

3. Planned Extensions

Although the estimated adjustment speeds are relatively quick for the *overall* BHC groups, we know nothing about the factors that affect the speed with which *individual* banks restore lost capital. Yet a bank's default probability depends importantly on the ratio of its capital to asset volatility. Holding constant the volatility of BHC earnings, any change in the actual MCR changes the firm's default probability. If the firm quickly restores its capital ratio following a large loss, it will remain riskier only for a short time. Conversely, if BHC are very slow to restore capital under some circumstances, both supervisors and counterparties will notice a persistent increase in default risk.

The adjustment process formulated in (3) is relatively blunt. It does not reflect variations in market conditions or the characteristics of specific banks. Nor does it differentiate between actions that raise capitalization vs. actions that lower it. Supervisors and uninsured bank counterparties should be keenly interested in the determinants of this speed for individual banks, and this constitutes the focus of our proposed research.

For nonfinancial firms, some researchers have added further structure to the adjustment process in (3). For example, Fama and French [2002] adjustment speeds in their dividend specification to be a linear function of firm characteristics. Similarly, we can modify our specification in (3) as:

$$\Delta MCR\_P_{i,\,t+1} \;=\; [\lambda_1(Y)\,\beta]\,X_{i,t} \;-\; \lambda_1(Y)\,EDR_t + \delta_{i,\,t+1} \qquad (4)$$

where ***Y*** is a vector of firm characteristics hypothesized to affect the capital ratio's adjustment speed. (Their specification has no analog to our λ_2 parameter.) We have briefly explored this type of specification using annual BHC data, and find it feasible to carry out this sort of estimation for our sample. Korajczyk and Levy [2002] permit adjustment speeds to depend on macroeconomic variables as well as on firm characteristics. Learning whether banks also have this type of sensitivity would help supervisors react to large (cyclical) deteriorations of many BHCs in the banking system.

Using a specification of the general form (1), we can explore two types of refinements.

1. Extensions maintaining cross-sectional homogeneity in adjustment speeds.

- market characteristics (e.g. Korajczyk and Levy's [2002] nonfinancial corporate profits, two-year trailing return on aggregate equity, and the commercial paper - treasury bill rates spread)
- adjustment when capitalization is above vs. below the target
- adjustment when the share price change reinforces vs. reduces the gap between actual and target capitalization
- regulatory pressure, which might vary across BHC, or over time for all BHC

2. Extensions allowing for cross-sectional heterogeneity in adjustment speeds.

- firm characteristics (including size, risk level, MB, profitability, loan problems)
- regulatory pressure (which might vary across time or with different risk exposures)
- closeness to minimum acceptable regulatory capital ratio ("cushion")
- bond rating

Understanding these features, if any apply, will help market participants and supervisors identify firms that are likely to remain weak following an initial shock.

4. Conclusion

The proposed study will shed light on the process by which banks manage their capital, and how that process may vary with firm characteristics, capital market conditions, and counterparty default exposures. (These conclusions might in turn have implications for nonfinancial firms' choice of capital structure.) We will also evaluate whether supervisory pressure has discernible effects of BHC capitalization. The speed with which BHC adjust to risk changes in particular implies something about a bank's cost of changing its default risk exposure. This information might affect how academics and supervisors assess the distortive effects of government deposit insurance. It should also have implications for the likely success of the "market discipline" Pillar in Basel II.

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APPENDIX

Model Specification from Flannery and Rangan [2004]

Define a firm's *market capital ratio* at time t as:[3]

$$MCR_{it} = \frac{E_{it}}{D_{it} + E_{it}} = \frac{S_{it}P_{it}}{D_{it} + S_{it}P_{it}} \tag{A-1}$$

where D_{it} = book value of all debt (measured in dollars) at time t

E_{it} = market value of firm i's equity at time t. E_{it} is the product of the number of shares outstanding (S_{it}) and the price per share (P_{it}).

It is helpful to note here that MCR can change for three reasons: the bank voluntarily changes the number of shares outstanding, the bank selects a different level of debt, market forces change the share price. That is,

$$dMCR = dD\left[\frac{-SP}{(D+SP)^2}\right] + dS\left[\frac{P}{D+SP} + P\left[\frac{-SP}{(D+SP)^2}\right]\right] + dP\left[\frac{S}{D+SP} + S\left[\frac{-SP}{(D+SP)^2}\right]\right]$$

Re-arranging, we get an expression for the observed change in MCR that becomes useful below:

$$dMCR = \left[\frac{1}{(D+SP)^2}\right]\left[P(D\,dS - S\,dD)\right] + dP\left[\left[\frac{SD}{(D+SP)^2}\right]\right] \tag{A-2}$$

The first term on the RHS of (A-2) measures the impact of voluntary managerial actions on bank capitalization. The second term measures the impact of share price changes, given the bank's beginning-of-period position.

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[3] We use a market-valued definition of capital ratio, in order to capture the firm's true probability of default, which book-valued capital would mis-state.

We are interested in fitting a time-series model of large bank holding companies' market-valued equity ratios. We start with a specification (which is also equation (2) in the text) for the j^{th} bank's desired capital ratio at time t:[4]

$$\boldsymbol{MCR}_{it}^* = \beta X_{it} + \tilde{\mu}_{it} \qquad \text{(A-3)}$$

where $\boldsymbol{MCR}_{it}^*$ is firm i's desired capital ratio, market-valued, at the end of period t;

With frictionless markets and perfect information, firms would always be at their desired capital ratio. However, adjusting capital ratios may entail costs. The firm's actual ***MCR*** need not generally equal $\boldsymbol{MCR}_{it}$*. The vector X may change, β may change (as we model in FR [2004]), or stock market fluctuations might change *MCR* in undesired ways.[5] The firm may also wish to expand its liabilities, and issuing new capital instruments may entail adjustment costs. If a BHC's *MCR* falls, market or regulatory factors might make it costly to issue new stock. Similarly, a late stock runup may be difficult (or impossible) to offset promptly via cash outflows from the firm.

As in Marcus [1983], we therefore estimate a functional form that permits lagged adjustments of the firm's initial capital ratio to its desired capital ratio. Taking the lagged capital ratio as our measure of the bank's "beginning" position in a time period, we can estimate the standard partial adjustment model:

$$\boldsymbol{MCR}_{i,t+1} - \boldsymbol{MCR}_{i,t} = \lambda_1 (\boldsymbol{MCR}_{i,t}^* - \boldsymbol{MCR}_{i,t}) + \mu_{i,t+1} \qquad \text{(A-4)}$$

In this specification, the observed change in ***MCR*** reflects an adjustment speed (λ_1) and the amount of required adjustment ($\boldsymbol{MCR}_{it}^* - \boldsymbol{MCR}_{,t-1}$). The observed change in a firm's leverage

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[4] This specification assumes that the desired capital ratio depends on beginning-of-period firm characteristics, implicitly assuming that the firm does not revise its target during the estimation period. An alternative specification would substitute $\boldsymbol{X}_{i,t+1}$ for $\boldsymbol{X}_{i,t}$ in (2). Our results are robust to this timing change.

[5] During the 1990s in particular, unanticipated stock price fluctuations may have influenced ***MCR*** too sharply for managers to offset the effects fully within a single period.

may constitutes a partial movement from where it is ($\boldsymbol{MCR}_{i,t}$) to where it would like to be ($\boldsymbol{MCR}_{i,t}$*, from equation (A-3)). The typical firm closes a proportion λ_1 of the gap each year.[6]

The smooth partial adjustment in (A-4) may only approximate an individual firm's actual adjustments. With fixed security-issuance costs, firms may not adjust until their actual ***MCR*** is sufficiently far from target (Fischer, Heinkel, and Zechner [1989], Mauer and Triantis [1994]). The adjustment speed (λ_1) is thus the average speed of adjustment for the "typical" firm. Simulation results confirm that this smooth adjustment specification appropriately reflects lumpy firm adjustments derived from fixed adjustment costs.

We add to (A-4) a second partial adjustment process by which managers may offset the undesired effects of share price change:

$$dMCR_{t,\,t+1} = \lambda_1 (MCR_t^* - MCR_t) + (1-\lambda_2)\left(\frac{\partial}{\partial \mathrm{P}}\mathrm{MCR}_t\right)\mathrm{dP} \qquad \text{(A-5)}$$

The second term measures the *net* effect of a share price change, after managers have taken explicit actions to offset a proportion λ_2 of the gross effect. Theory implies that $0 \leq \lambda_i \leq 1$, i = 1,2, although we do not impose this restraint in our estimates.

The derivative inside the brackets in the second term in (A-5) equals

$$\left(\frac{\partial}{\partial \mathrm{P}}\mathrm{MCR}_t\right) = \left(\frac{\mathrm{D}_t \mathrm{S}_t}{(\mathrm{D}_t + \mathrm{S}_t \mathrm{P}_t)^2}\right)$$

so the model we wish to test becomes

$$dMCR_{t,\,t+1} = \lambda_1 (MCR_t^* - MCR_t) + (1-\lambda_2)\left(\frac{\mathrm{D}_t \mathrm{S}_t}{(\mathrm{D}_t + \mathrm{S}_t \mathrm{P}_t)^2}\right) dP + \tilde{\delta}_{t+1} \qquad \text{(A-6)}$$

Subtracting the term multiplying ($1-\lambda_2$) from both sides of the equation yields

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[6] The specification (3) 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.) Simulation results indicate that this gradual adjustment specification accurately estimates the sample's average frequency of major capital adjustments.

$$\mathrm{dMCR}_{t,t+1} - \left(\frac{\mathrm{D}_t \mathrm{S}_t}{(\mathrm{D}_t + \mathrm{S}_t \mathrm{P}_t)^2} \right) dP \;=\; \lambda_1 (MCR_t^* - MCR_t)$$

$$- \lambda_2 \left(\frac{D_t S_t}{(D_t + S_t P_t)^2} \right) dP + \tilde{\delta}_{t+1} \qquad \text{(A-7)}$$

Comparing (A-7) with (A-2), it becomes apparent that the LHS of (A-7) measures exclusively the active *managerial* part of the firm's change in capitalization between t and t+1. This portion of the change in MCR is not correlated with dP and hence we can estimate (A-7) without concern about endogenous regressors.

Substituting (A-3) into (A-7) and re-naming two variables gives our final regression specification (which is also equation (3) in the text):

$$\boldsymbol{\Delta MCR\_P_{i,\,t+1}} \;=\; \boldsymbol{(\lambda_1 \beta)\, X_{i,t}} \;-\; \boldsymbol{\lambda_1 MCR_t} + \boldsymbol{\lambda_2 Surp_{i,\,t+1}} - \tilde{\delta}_{i,t+1} \qquad \text{(A-8)}$$

where $\boldsymbol{\Delta MCR\_P_{i,\,t+1}} = \mathrm{dMCR}_{t,t+1} - \left(\frac{\mathrm{D}_t \mathrm{S}_t}{(\mathrm{D}_t + \mathrm{S}_t \mathrm{P}_t)^2} \right) dP$

$$\boldsymbol{Surp_{i,\,t+1}} = \left(\frac{\mathrm{D}_{it} \mathrm{S}_{it}}{(\mathrm{D}_{it} + \mathrm{S}_{it} \mathrm{P}_{it})^2} \right) \boldsymbol{dP}$$

Given an estimate of λ_1, we can extract estimated β coefficients by dividing the estimated coefficients on X_{it} by the estimated λ_1.

The specification (A-8) exhibits appropriate long-run properties, including:

1) The firm converges on its target capital ratio, $\boldsymbol{\beta X_{i,t}}$.
2) The impact of $\boldsymbol{X_{i,\,t}}$ on the capital ratio is given by its estimated coefficients, divided by λ_1.
3) Capitalization is unrelated to unanticipated share price changes: the price surprise is zero in the long run.