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Modeling Structural and Temporal Variation in the Market's Valuation of Banking Firms

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ABSTRACT

Hidden capital exists whenever the accounting measure of a firm's net worth diverges from its economic value. Such unbooked capital has on-balance-sheet and off-balance-sheet sources. This paper develops a model to estimate both forms of hidden capital and to test hypotheses about their determinants. In effect, the analysis expands the two-index model by endogenizing the market and interest-rate sensitivities of any stock and decomposing each sensitivity into on-balance-sheet and off-balance-sheet elements. For a sample of banks during 1975–1985, the model finds considerable variation in both forms of hidden capital.

TO THE EXTENT THAT an accounting representation of a firm's net worth diverges from its economic value, the firm is said to have hidden capital. Two sources of hidden capital exist: accountants' misvaluations of portfolio positions that accounting principles designate as on-balance-sheet items and the systematic neglect of off-balance-sheet sources of value that these principles do not permit to be formally booked.

This paper develops a model for estimating both types of hidden capital. The model makes direct use of accounting information on the bookable positions of a firm and separates bookable from unbookable sources of value. We use regression analysis to partition the market value of a firm's stock (i.e., its market capitalization, MV) into two components: recorded capital reserves and unrecorded (or hidden) net worth. Hidden capital is, in turn, allocated between values that are unbooked but bookable through asset turnover or writedowns on a historical-cost balance sheet under Generally Accepted Accounting Principles (GAAP) and values which GAAP currently designates as an unbookable off-balance-sheet item.

We estimate the net unbooked value of on-balance-sheet positions by estimating an intermediate variation ratio, k. This variable expresses the ratio of the market value to the book value of the collected components of a firm's bookable

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equity. Applying the valuation ratio to BV, the value of accounting or book net worth, assigns a market value B to bookable assets and liabilities. Subtracting this estimate from market capitalization assigns a value to off-balance-sheet items. This statistically appraised value of unbookable equity, U, expresses the net value of unbookable assets and liabilities.

We develop estimates of k and U by regressing cross-sectionally the market value of corporations' equity shares on the book value of their accounting net worth. We call this regression equation, the Statistical Market Value Accounting Model, SMVAM.

Formal links are derived between this model and two-index forms of the traditional market model. The linkage endogenizes changes in k and U as functions of ex post holding-period returns on stocks and bonds. This formulation permits us not only to test hypotheses about the determinants of both forms of hidden capital, but to use the model to explain variation in the interest and market sensitivities of a firm's stock.

Economists conventionally assess these sensitivities as the regression coefficients fitted to market returns and interest rates in an expanded market model (e.g., Sweeney and Warga, 1986). A market model uses capital-market data to estimate a fixed-parameter stochastic process presumed to generate periodic returns to stockholders.

Our model is estimated for 43 quarters of 1975–1985 across a sample of bank stocks. Rapid expansion in banks' fee-based service activity and in the policy problems that off-balance-sheet activities pose for deposit insurers (Kane, 1985) has intensified the demand by policymakers and financial analysts for market-based measures of banks' off-balance-sheet activities.

Bank stock shares have shown weak and sporadic sensitivities to interest rates rather than strong and consistent ones, even though the value of a bank's individual asset and liability positions is inherently interest-sensitive. Our analysis recasts market and interest-rate sensitivities as varying parameters by extracting them from a time series of cross-section regressions that use accounting and rate-of-return information to explain the market value of stockholder equity.

A fixed-parameter model seems poorly suited to analyzing 1975–1985, a period in which macroeconomic conditions, policy rules, financial technology, and regulatory freedoms changed rapidly. We envisage the parameters of the interest-sensitivity and market-sensitivity equations as undergoing evolutionary change during 1975–1985. Goldfeld and Quandt's [(1972), (1973), (1976)] switching regression method, GQSRM, is used to study the temporal variability of model parameters. GQSRM estimates three attributes of regime variation: specific shift dates, the gradualness of each shift, and the parameters of the stochastic process governing each regime.

In Sections I and II, we present our model as a flexible functional form that incorporates structural detail aggregated away in a market model. Section III describes the data set. The SMVAM is estimated in Section IV, using accounting data to focus structurally on market participants' nonstationary (but ex ante) valuation decisions rather than forcing holding-period returns to conform to a stationary process. The analysis in Sections V and VI endogenizes temporal movements in the degree of market and interest sensitivity of capital positions that develop on and off a bank's conventional balance sheet. The resulting evidence of variation in market and interest sensitivity over time reconciles some conflicting findings in market-model studies of market and interest sensitivity. Section VII conducts a number of sensitivity experiments. Sections VIII and IX describe directions for future research and summarize the paper.

I. The Statistical Market-Value Accounting Model

If markets are efficient, financial analysts see through smoke and mirrors raised by contemporary accounting rules. Our analysis develops separate estimates for bookable and unbookable elements of the market and interest sensitivity of a depository firm's generalized balance sheet.

At any time, a firm's market capitalization, MV, is the product of its share price and number of shares outstanding. Invoking the principle of value additivity, MV may also be expressed as the market value of bookable and unbookable assets, $(A_m + A_m^{'})$, minus the market value of bookable and unbookable liabilities, $(L_m + L_m^{'})$.

Since bookable assets and liabilities are carried at historical cost, even $(A_m - L_m)$ cannot be observed directly. A parsimonious way to proceed is to assume that market participants estimate the market value of elements of bookable equity by applying appropriate mark-up or mark-down ratios, k_a and k_l, to the accounting values reported by the institution. This approximation lets us write

$$MV = (A_m^{'} - L_m^{'}) + k_a A_b - k_l L_b, \tag{1}$$

where subscripts a, l, and b represent assets, liabilities, and booked values, respectively.

In principle, A_b and L_b are jointly determined variables, affected by many of the same unknown exogenous variables. Treating A_b and L_b as separate and exogenous regressors could introduce interpretive problems. Fortunately, at every date for every bank class, the coefficient constraint that $k_a = k_l$ not only proves impossible to reject, but is virtually an unconstrained regression result. This supports simplifying the model by applying a single valuation ratio k to each institution's book equity, $BV = A_b - L_b$.

Expressing the market value of unbookable equity $(A_m^{'} - L_m^{'})$ as U and allowing for approximation error, we obtain equation (2):

$$MV = U + kBV + e\,. \tag{2}$$

We term this equation, which can be estimated from time-series or cross-sectional data sets, the Statistical Market-Value Accounting Model, SMVAM.

As with many statistical models employed in finance, equation (2) can be justified most satisfactorily as a "flexible functional form." The specification's virtues lie in having a small number of readily interpretable parameters and in incorporating several testable restrictions. Our specification treats e as an approximation error.

A. Parameter Restrictions

In principle, each bank i has a different U and k at each date. To estimate the model, it is necessary to restrict parameter variation either across time or across banks. To give full play to the mutability of the 1975–1985 environment, we restrict SMVAM parameters across banks rather than across time.

In applying the model cross-sectionally, we restrict the valuation ratio k_{it} applicable to bank i at time t to have the same value k_t across each bank class. To lessen damage from this restriction, it is necessary to focus on relatively homogeneous subsamples of banks. Although we do not do so in this paper, in future work we plan to develop a scheme for justifying homogeneity assumptions by applying pooling tests to stacked individual-bank regressions.

A set of what should be seen as identifying restrictions follows from reformulating (2) as a two-equation model of U and B:

$$U = a_u + b_u\,BV + e_1, \tag{3}$$

$$B = a_B + b_B\,BV + e_2.$$

With only one instrumental variable, four coefficients cannot be identified. Equation (2) overcomes this problem by restricting b_u and a_B each to zero. To the extent that either U is not uncorrelated with book value or a_B is nonzero, the neglected coefficients bleed into our estimates of k and U. Such bleeding limits our capacity to separate the components of hidden reserves.

A third restriction is that (2) and (3) are *linear*. However, using a linear approximation to what is presumed to be a monotonically increasing function is less damaging when the range of upside and downside variation is controlled by outside forces. On the upside, takeover discipline limits a bank's willingness to hold large amounts of capital because, holding asset size constant, high levels of capital depress a bank's stock price by foregoing potential deposit-insurance subsidies. Takeover artists can make a profit by buying up the stock and reducing its capital. On the downside, the FDIC introduces increasing regulatory penalties whenever a bank's book value heads toward zero (see, e.g., Buser, Chen, and Kane, 1981). (Because the Federal Savings and Loan Insurance Corporation in its final years virtually abandoned capital discipline, the model might work less well for S&Ls.)

A fourth restriction lies in treating BV_{it} as exogenous. Because GAAP gives bank managers options to realize unbooked gains and losses as "nonrecurring items" and authorities penalize low BV_i, individual banks have an incentive to sell assets with unrealized gains when the book value of their capital appears inadequate. This means k_i may be low for low BV_i and tradable elements of U_i may fall when BV_i does. In contrast, no reason exists to expect k_i to be a function of size and estimated rank orderings of k_i against bank size class do vary over time.

B. Interpretability Issues

The model's coefficients describe the *de facto* deceptiveness of GAAP. Unless both $U = 0$ and $k = 1$, the accounting or book value of a bank's capital represents a biased estimate of the market value of stockholder equity. If the estimated intercept is significantly positive (negative), unbookable assets and liabilities serve as a net source of (drain on) institutional capital. Financial analysts know that problems exist in both directions. On the drain side, at yearend 1986, off-balance-sheet liabilities at the five largest U.S. banking firms totaled $1.16 trillion. This value is more than twice the $546 billion book value of these banks' assets (Forde, 1987). These off-balance-sheet liabilities include: loan commitments; standby letters of credit; municipal bond insurance; interest-rate swaps; and commitments related to futures, forward, lease, and collateralized contracts. Also, U.S. institutions habitually overstate the capital contribution derived from their loan-loss reserves by not deducting an allowance for anticipated losses that they have not yet formally realized. On the asset side, institutions do not book: the value of options to pursue new business or to pursue old business in more efficient ways; the capitalized value of their fee-for-service business and customer base; or the explicit and conjectural deposit-insurance insurance guarantees they receive.

If only intercept bias were to exist, *changes* in accounting values would be unbiased estimates of *changes* in the market value of on-balance-sheet assets and liabilities. However, a slope bias may also exist. We interpret $(1 - k)$ as a premium when $k > 1$ and as a discount factor when $k < 1$.

II. Building Market and Interest-Rate Sensitivity into the SMVAM

The parameters of the SMVAM are U and k. When stock and bond returns change over time, these parameters should respond. Using a quarterly time frame, we model this response as a linear function of market returns and interest rates:

$$U_t - U_{t-1} = \beta^u + \beta_m^u R_{mt} + \beta_r^u R_t + v_t\,, \tag{4}$$

$$k_t - k_{t-1} = \beta^k + \beta_m^k R_{mt} + \beta_r^k R_t + w_t\,. \tag{5}$$

R_{mt} and R_t represent a market return and an interest-rate proxy; the v_t and w_t are regression errors. The slope coefficients measure the market and interest-rate sensitivity of SMVAM's parameters.

Equations (4) and (5) are flexible functional forms that parameterize in an interpretable and parsimonious way revaluation decisions that take place continually. The true models that (4) and (5) approximate may be nonlinear in R_{mt} and R_t and may include unspecified other variables as well. Because our equations are conceived as approximations, we cannot constrain the intercepts β^u and β^k. For the same reason, we subject parameter estimates to Goldfeld-Quandt tests for regime shifts. In an era of rapid financial change, the parameters of such approximations need to be recalibrated whenever movements in omitted variables (such as authorities' closure rules) or nonlinearities threaten to decrease a model's explanatory power.

Equations (4) and (5) may be linked to a two-index market model, which expresses the return on asset p as

$$R_p = \beta_o + \beta_m R_m + \beta_r R + e_p\,. \tag{6}$$

In (6), the betas measure the asset's systematic market and interest-rate sensitivities and e_p is a regression error. Except that R may be interpreted as an "industry factor" (Lee and Brewer, 1985; Sweeney and Warga, 1986), the market model ignores the structural characteristics of individual institutions and the markets in which they operate. One source opines that "studies of bank stocks describe the pricing of steel industry stocks as well as they do the pricing of bank stocks" (Federal Reserve Bank of New York, 1986, p. 58).

Kane and Unal (1988) show that during 1975–1985 the parameters of (6) undergo significant change. Equations (4) and (5) implicitly endogenize such parameter changes by conditioning market participants' revaluation decisions on the same variables that are taken to be exogenous in the two-index model. Equations (4) and (5) decompose the overall market sensitivity, β_m, and the interest sensitivity, β_r, of equity returns in model (6). These market-model betas are weighted sums of the respective slopes of (4) and (5). Linking the SMVAM to the two-index model in this way allows the righthand-side betas and the weights to vary over time with market values and the balance-sheet structure of sample institutions.

III. Data Set Used

End-of-quarter share prices, number of shares, and book values for a set of large banks and bank holding companies are obtained from BANK COMPUSTAT, 1986. Between 1975 and 1985, the number of banking entities showing complete records on the BANK COMPUSTAT tape expands from 104 to 147 NYSE, AMEX and over-the-counter issues. Market values are determined as the product of end-of-quarter share price and number of shares outstanding. BANK COMPUSTAT provides data on the book values of the consolidated entity, defined as the total equity of the common stockholders in the capital of the entity which includes the par value of common stock, surplus, undivided profits, reserves for contingencies and other capital reserves.

A. Sampling Issues

It is difficult to develop a representative sample of data from which to estimate SMVAM. Stock in few U.S. deposit institutions trades directly or regularly. Many thrift institutions are still mutual organizations, while small stockholder institutions are often privately held. For large institutions, to exploit regulatory and tax benefits, stock is typically owned indirectly through a holding company, HC. A bank (or a saving and loan) HC may own more than one depository and may own nondepository assets as well.

Use of HC data leads us to reinterpret U and k. For an HC, U captures off-balance-sheet activities of banks and their HC affiliates. Similarly, k will reflect unbooked gains and losses in on-balance-sheet positions. This approach is used because data on subsidiaries are not available quarterly and because in the absence of proposed firewalls regulators conceive of affiliate activity as if it were an activity of the bank.

B. Proxy Choices

Our market proxy is the CRSP equal-weighted NYSE and AMEX monthly stock index adjusted for dividends. Because empirical research shows no reliable role for short-term rates in traditional two-index models of bank stock (Kane and Unal, 1988), the interest-rate index used is the monthly holding-period return on long-term government bonds constructed by Ibbotson Associates, 1986. Monthly returns are compounded to produce quarterly returns.

We interpret movements in holding-period returns as dominated by what rational-expectations models term "interest-rate surprises." Although the construction of holding-period returns parallels the CRSP proxy, such returns reverse the economic interpretation of the sign of an interest-rate coefficient. Bond-price reductions induced by interest-rate increases *decrease* holding-period returns. Hence, a rise in holding-period returns corresponds to a fall in interest rates, an event widely believed to benefit the stock of a typical bank.

IV. Parameter Estimates for *SMVAM*

Estimation proceeds stepwise. From cross-section values for the MV and BV of individual banks, U and k are estimated by ordinary least squares for each of the 43 sample quarters. Then, to estimate (4) and (5), the quarterly changes in k and U are regressed on time series of stock and bond returns.

To control statistically for heteroskedasticity and cross-sectional differences in k and U, we classify BANK COMPUSTAT sample banks into three asset-size classes. For each class, the SMVAM is estimated separately. The three size groups consist of the largest 25 banks, the smallest 25 sample banks, and 54 to 97 other banks that we term medium-size banks. Banks of similar size may be presumed to operate in broadly similar ways and to be disciplined or assisted by deposit-insurance authorities in similar fashion.

For SMVAM, Table I reports quarterly cross-sectional regressions for each size class. These regressions show that accounting representations of the economic performance of major banks are deceptive. For the largest banks, t-tests reject the *combined* $U = 0$ and $k = 1$ condition necessary for recorded equity to be an unbiased estimate of market value except in nine quarters (for medium-size banks, except in nineteen quarters). Moreover, our data indicate that the larger a bank becomes, the wider is the range of values over which k and U vary.

Deviations of U from zero show a definite time pattern. Before 1980, the market value of unbookable equity is negative for every bank group in every quarter. This suggests that off-balance-sheet items serve as a drain on capital values before 1980. At the largest banks, this drain remains statistically significant until mid-1979, but becomes insignificant thereafter. A broadly similar pattern holds for the other two bank groups: U remains negative throughout 1975–79, while its sign becomes less regular during 1980–85.

The ratio of mean U to mean MV varies sharply between the 1975–79 and 1980–85 subperiods. During the first subperiod, this ratio is -31 percent for the largest banks, -15 percent for medium banks and -25 percent for small banks.

Table I

Estimates of the Statistical Market-Value Accounting Model

The model is $MV = U + kBV + e$. MV and BV are market value and book value of bank equity. In each quarter, the sample includes all banks for which complete records appear on the 1986 BANK COMPUSTAT tape. N is the number of banks in the medium-size bank group in a given quarter. The number of banks in the other samples is always 25.

	Largest 25 Banks			Medium-Size Banks				Smallest 25 Banks		
Year·Qtr	U	k	R^2	U	k	R^2	N	U	k	R^2
1975·1	−365*	1.59**	.80	−9	0.77**	.70	54	−2	0.78	.60
·2	−420*	1.83**	.80	−18	0.90	.76	54	−4	0.86	.63
·3	−266*	1.28**	.82	−6	0.69**	.75	54	−9	0.82	.69
·4	−329*	1.42**	.82	−13	0.74**	.74	55	−11	0.85	.75
1976·1	−402*	1.66**	.84	−19	0.89	.75	54	−13	0.93	.70
·2	−422*	1.73**	.84	−25	0.93	.70	55	−18	0.99	.75
·3	−334*	1.46**	.86	−25*	0.91	.76	55	−22*	1.03	.76
·4	−372*	1.60**	.87	−29*	1.03	.75	55	−22*	1.17	.80
1977·1	−267*	1.32**	.89	−23	0.93	.75	55	−17	1.00	.81
·2	−246*	1.28**	.91	−27*	0.97	.78	55	−19	1.02	.80
·3	−225*	1.20**	.90	−20	0.88	.73	56	−10	0.90	.80
·4	−162	1.07	.90	−17	0.88	.72	56	−28*	1.10	.70
1978·1	−132	0.98	.89	−10	0.84**	.74	67	−7	0.92	.57
·2	−128	1.01	.92	−15	0.90	.75	67	−8	0.95	.56
·3	−191*	1.15**	.91	−16	0.93	.75	67	−10	1.01	.65
·4	−198*	1.04	.89	−13	0.80**	.76	67	−22	1.06	.67
1979·1	−167	0.98	.90	−15	0.83**	.77	67	−29*	1.14	.72
·2	−184*	1.05	.92	−17	0.84**	.76	67	−21	1.02	.66

Table I—*Continued*

	Largest 25 Banks			Medium-Size Banks				Smallest 25 Banks		
Year·Qtr	U	k	R^2	U	k	R^2	N	U	k	R^2
·3	−146	1.01	.90	−22	0.90	.74	67	−26	1.13	.70
·4	−173	0.97	.89	−16	0.80**	.69	67	−34*	1.11	.67
1980·1	−123	0.79**	.88	−10	0.64**	.66	67	−19	0.82	.67
·2	−94	0.87**	.89	−10	0.75**	.63	67	−18	0.86	.69
·3	−23	0.76**	.88	−12	0.78**	.57	66	−1	0.76	.46
·4	−108	0.92	.87	−11	0.80**	.49	67	20	0.58**	.25
1981·1	31	0.81**	.86	−20	0.90	.45	67	−10	0.91	.40
·2	72	0.85**	.88	−41	1.06	.46	67	9	0.77	.28
·3	74	0.75**	.86	−9	0.78**	.44	67	−1	0.77	.34
·4	140	0.70**	.87	−4	0.81	.41	67	25	0.61	.17
1982·1	40	0.68**	.90	−7	0.74**	.56	89	8	0.69**	.55
·2	−19	0.64**	.88	−22	0.76**	.59	89	6	0.72	.53
·3	−31	0.68**	.89	−16	0.79**	.60	89	6	0.74**	.76
·4	−83	0.79**	.90	−31	0.95	.61	89	−3	0.90	.69
1983·1	−177	0.92	.90	−31	1.02	.66	97	−1	0.94	.89
·2	−33	0.87**	.90	−37	1.13**	.68	97	3	0.99	.85
·3	80	0.75**	.87	−45*	1.20**	.74	97	−1	1.20	.69
·4	36	0.77**	.89	−29	1.11	.78	97	1	1.11	.80
1984·1	46	0.71**	.90	−11	0.99	.70	97	7	1.00	.75
·2	74	0.60**	.84	−7	0.92	.71	97	1	1.01	.76
·3	95	0.70**	.85	−25	1.08	.79	97	−3	1.07	.85
·4	−13	0.76**	.89	−19	1.11	.81	97	−9	1.21	.85
1985·1	−68	0.83**	.88	−46*	1.28**	.83	97	−11	1.27**	.85
·2	−134	0.95	.88	−35	1.39**	.82	97	−24	1.47**	.76
·3	75	0.72**	.82	65*	0.97	.70	97	−28	1.50**	.73

* Indicates an estimate of U that differs significantly from zero at 5 percent.
** Indicates an estimate of k that differs significantly from unity at 5 percent.

During the 1980–85 period, the ratio shrinks dramatically, becoming −1 percent for the largest and smallest banks, and −9 percent for medium-size banks. After 1980, unbookable equity seldom acts as a significant reservoir of hidden losses. This observation is consistent with the hypothesis that after 1980, the value of federal deposit-insurance guarantees increased (as hypothesized in Kane, 1985). Largest banks' algebraic rise in the U/MV ratio may reflect different economic forces from those operative at other banks. The upward surge of U at very large institutions may be driven by administrative and political difficulties that persuade regulatory authorities to overlook a capital deficiency (caused, for example, by unrealized losses on LDC loans) and to regard these institutions as "too big to fail" (Seidman, 1986). Inferences about small and medium-sized banks are made difficult by changes in sample composition caused by secular expansion in the number of institutions sampled. For both sets of banks, unbookable franchise values ought to have risen with the opening up of extralocal sources of retail deposits and a broader range of potential acquirers, acquisitions, and future activities.

Turning to k, the largest banks usually show a significant premium ($k > 1$) for recorded equity before 1980. However, k drops significantly below unity in 1980 and in most quarters thereafter. For other size classes, patterns differ. At medium-size banks, except for two scattered observations, k stays below one until 1983. From then on, k lies above unity most of the time. The smallest banks' pattern resembles that of medium-size banks, but the turn comes later, in 84/3. From this date on, the departure from unity is substantial.

White (1980) develops a chi-squared test for the correctness of the regression model's specification of the first and second moments of the regressand. White's test statistic evaluates the joint hypothesis that regression errors are homoskedastic, that they are independent of the regressors, and that a series of other regularity conditions hold. For the 43 quarters examined here, White's test rejects the null hypothesis at 5 percent significance at 8 dates for the largest banks, 7 dates for the medium-size banks, and 27 dates for the smallest banks. This supports the use of White's alternative heteroskedasticity-consistent estimate of coefficient standard errors in these 42 cases. This procedure reduces by only a total of three the significant deviations of k from unity and of U from zero noted in Table 1 for the two larger size classes. For the smallest-bank subsample, however, the tests using White's standard errors *increase* the number of significant deviations by 7. These results indicate some lack of robustness for the sample of 25 smallest banks. These banks show substantial heteroskedasticity and perhaps important intrasample differences in U and k.

V. Digression on Switching Regression

We investigate the temporal variability of the parameters of the second-stage equations (4) and (5) by Goldfeld and Quandt's switching regression method (GQSRM). This section illustrates the method for an n-regime specification of equation (4):

$$\Delta U_t = \beta_j^u + \beta_{mj}^u R_{mt} + \beta_{rj}^u R_t + v_{jt}, \quad j = 1, \ldots, n; \quad t = 1, \ldots, T. \tag{7}$$

In (7), ΔU_t is $U_t - U_{,t-1}$, j indexes the n regimes and v_{jt} is a disturbance term assumed to be distributed $N(O, \sigma_{vt}^2)$. Equation (7) cannot be estimated as a dummy-variable regression because the number and timing of regime shifts are unknown a priori. GQSRM estimates the frequency and nature of regime shifts statistically. In all cases, the hypothesis $n - 1$ is rejected. For large n, the likelihood function that applies when each observation is conceived as a combination of n regimes could easily employ more parameters than we have observations. To conserve degrees of freedom, GQSRM uses transition-smoothing dummy variables, D_{tj}. If the observations come from n regimes, than $(n = 1)$ switch dates Z_j^* and $(n - 1)$ gradualness parameters σ_j^* are used. The D_{tj} may be viewed as potential step functions that are approximated by a normal CDF with mean Z_j^* and variance σ_j^{*2} :

$$D_{tj} = \int_{-\infty}^{t} [(2\pi)^{1/2} \sigma_j^*]^{-1} \exp \{- 1/2 [(\xi - Z_j^*)/\sigma_j^*]^2\} \, d\xi , \tag{8}$$

where j now runs from 1 to $n - 1$ and the endpoint values are defined as $D_{tn} = 0$ and $D_{t0} = 1$. The value of σ_j^* gives information about the smoothness (or nonsharpness) of the structural change. The smaller σ_j^* is, the more "steplike" is the transition between the regimes. If σ_j^* is close to zero, the mass of the density is concentrated at Z_j^* and the CDF approaches a step function. Larger values of σ_j^* indicate more gradual change.

In (7) the equation representing the *s-th* regime is than multiplied by $\gamma_{ts} = \prod_{j=0}^{s-1} D_{tj} \prod_{w=s}^{n} (1 - D_{tw})$. The resulting equations for n regimes are added together t obtain the composite equation that we estimate:

$$\sum_{s=1}^{n} \Delta U_t \gamma_{ts} = \sum_{s=1}^{n} \{(\beta_s + \beta_{ms} R_{mt} + \beta_{rs} R_{it} + v_{ts})(\gamma_{ts})\} . \tag{9}$$

Assuming $\Delta U_t \gamma_{ts}$ to be normally distributed with mean $\sum_{s=1}^{n} \{(\beta_s + \beta_{ms} R_{mt} + \beta_{rs} R_{it})(\gamma_{ts})\}$, and variance $\sigma_{vt}^2 = \sum_{s=1}^{n} (\sigma_{vs}^2)(\gamma_{ts}^2)$, the log-likelihood function for an n-regime specification then becomes

$$\log L = -T/2 \log 2\pi - 1/2 \sum_{t=1}^{T} \log \sigma_{vt}^2 - 1/2 \sum_{t=1}^{T} [\sum_{s=1}^{n} v_{ts} \gamma_{ts}]^2 / \sigma_{vt}^2 . \tag{10}$$

Maximizing (10) with respect to the unknown parameters generates maximum-likelihood estimates of: the parameters of equation (10), the mean switch dates Z_j^* , and the gradualness parameters σ_j^* .

Maximizing the likelihood functions developed in this paper requires numerical optimization. GRADX (an algorithm using the quadratic hill-climbing method) in Princeton University's GQOPT package is used.

VI. Changes in the Market and Interest-Rate Sensitivity of k and U

Substantive interest focuses on the market sensitivity (β^u_{mj} and β^k_{mj}), interest-rate sensitivity (β^u_{rj} and β^k_{rj}), and residual variance (σ^u_{vj} and σ^k_{wj}) of unbookable equity and the valuation ratio. Tables II to V summarize GQSRM results. Table II sorts out the number of regimes and individual significance of the many individual coefficient shifts allowed.

Table II reports two regimes for the market and interest sensitivity of unbookable equity for the largest and the smallest 25 banks. Medium-size banks experience three regimes. In all three size classes, the market and interest sensitivities of the valuation ratio show the same number of regimes (although not always the same shift dates) as unbookable equity.

Table III reports the dates and gradualness of the shifts. Panel A focuses on the market and interest sensitivity of unbookable equity. For the largest banks, the only switch occurs at 78/3. This switch point estimate has a standard error of 2.07 quarters. This means that the two-standard-error confidence interval for this switch date runs from roughly 77/3 to 79/3. The estimated associated gradualness parameter is 4.33 quarters meaning the switch is gradual. Approximating the length of the transition by twice the gradualness parameter implies this gradual switch (given an estimated starting point) completes itself in nine quarters.

Medium and small banks' first switch is estimated at 77/2; medium banks' second switch at 81/1. GQSRM cannot reject the hypotheses that these switches are abrupt.

Panel B of Table III develops parallel results for the valuation ratio. Large and small banks show one switch, while medium banks experience two. The largest banks experience a gradual shift: the mean date is 77/3 and the associated gradualness parameter is 3.47 quarters. The drift in the market and interest sensitivity of the largest banks' valuation ratio takes 7 quarters. Medium banks' first and second switches occur abruptly at 77/2 and 80/4. Small banks' second regime starts at 77/1.

For all banks, GQSRM labels mid-1977 as a time of sea change. Around this date, sample banks experience structural changes in their sensitivities to stock returns and bond yields. This dating pattern supports the view that the Fed's October 1979 change in operating procedures is better conceived as an endogenous response to changes in the economic and political environment affecting the stock of its client firms rather than as an exogenous event. For the largest banks, the structural drift tails off when the Federal Reserve's regime change was announced. Medium-size banks differ in experiencing a second structural change at the end of 1980.

Table IV reports sensitivities for unbookable equity in each regime. For the largest banks, the market sensitivity of unbookable equity (β^u_m) proves negative and significant early in its 75/2-78/3 drift. But over time this sensitivity becomes positive and loses its significance by 78/4. This indicates that largest banks' off-balance-sheet positions hedge market variation only during the 1975–78 period. After 1978, off-balance-sheet positions lose their relation to market returns on stock. Table II confirms that the shift in market beta is significant.

Table II

Outcomes of Goldfeld-Quandt Likelihood-Ratio Tests of Shifts in Second-Stage Model Parameters for Market and Interest-Rate Sensitivity of Unbookable Equity (U_t) and Valuation Ratio (k_t)

In Panel 1, the model is $U_t - U_{t-1} = \beta_j^u + \beta_{mj}^u R_{mt} + \beta_{rj}^u R_t + v_{jt}, j = 1, \ldots, n; t = 1, \ldots T$. In Panel 2, the model is $k_t - k_{t-1} = \beta_j^k + \beta_{mj}^k R_{mt} + \beta_{rj}^k R_t + w_{tj}, j = 1, \ldots n; t = 1, \ldots T$. U is the intercept and k is the slope of the Statistical Market Value Accounting Model (SMVAM) cross-sectionally estimated for each quarter between first quarter of 1975 and third quarter of 1985. These values are given in Table I. R_{mt} is the CRSP equal-weighted monthly stock index adjusted for dividends and R_t is the monthly holding-period return on long-term government bonds constructed by Ibbotson Associates, 1986. Monthly returns are compounded to produce quarterly returns. j indexes the n regimes, t indexes time.

Tests for shifts in both models proceed stepwise and cover two stages, A and B. Initially, maximum-likelihood values for one-regime (L_1) and two-regime (L_2) models are obtained. The null hypothesis that no regime switch occurs is tested against the alternative that two regimes exist. Asymptotically, the likelihood-ratio test statistic, $-2\ln(L_1/L_2)$, has a chi-squared distribution with degrees of freedom (d.f.) equal to the number of restrictions under the null hypothesis. Whenever the null hypothesis is rejected, the number of regimes is incremented and the likelihood-ratio test rerun until we fail to reject the null hypothesis.

In the second stage, the parametric nature of the shifts established in the first stage is investigated. To illustrate, let us assume x regimes are established in step one. The likelihood function for x regimes is remaximized subject to the parameter equality constraint under examination, where the maximum-likelihood value is written as L_{xR}. The likelihood-ratio test statistic $-2\ln(L_{xR}/L_x)$ has asymptotically a chi-squared distribution with one d.f.

	Largest 25 Banks	Medium Banks	Smallest 25 Banks
Panel 1. Unbookable Equity			
A. Likelihood-Ratio Test Results to Determine the number of Regimes			
One vs. two regimes	18.94	49.62	17.36
Two vs. three regimes	8.92*	15.34	4.78*
Three vs. four regimes	—	5.90*	—
B. Likelihood-Ratio Test Results to Determine Parameter Equality Across Regimes			
$\beta_1^u = \beta_2^u$	6.08*	0.38	0.12
$\beta_2^u = \beta_3^u$	—	1.82	—
$\beta_{m1}^u = \beta_{m2}^u$	7.36	1.44	0.10
$\beta_{m2}^u = \beta_{m3}^u$	—	2.88	—
$\beta_{r1}^u = \beta_{r2}^u$	1.88	5.58**	0.10
$\beta_{r2}^u = \beta_{r3}^u$	—	0.24	—
$\sigma_{v1}^u = \sigma_{v2}^u$	7.92**	1.70	17.02**
$\sigma_{v2}^u = \sigma_{v3}^u$	—	41.26**	—
Panel 2. Valuation Ratio for Bookable Equity			
A. Likelihood-Ratio Test Results to Determine the Number of Regimes			
One vs. two regimes	25.12	26.86	17.14
Two vs. three regimes	6.44*	14.32	8.10*
Three vs. four regimes	—	8.70*	—
B. Likelihood-Ratio Test Results to Determine Parameter Equality Across Regimes			
$\beta_1^k = \beta_2^k$	9.30**	0.02	1.12
$\beta_2^k = \beta_3^k$	—	0.00	—
$\beta_{m1}^k = \beta_{m2}^k$	6.92**	0.00	0.04
$\beta_{m2}^k = \beta_{m3}^k$	—	1.94	—
$\beta_{r1}^k = \beta_{r2}^k$	2.64	4.76**	0.02
$\beta_{r2}^k = \beta_{r3}^k$	—	0.04	—
$\sigma_{w1}^k = \sigma_{w2}^k$	3.34	3.54	16.84
$\sigma_{w2}^k = \sigma_{w3}^k$	—	29.80**	—

* The null hypothesis that an additional regime is unnecessary cannot be rejected at 5 percent. The critical value for 6 d.f. at 5 percent significance is 12.592.

** Parameter equality restriction is rejected at 5 percent. The critical value for one d.f. is 3.84.

Table III

Switch Dates and Gradualness of Switches

Panel A gives the outcome of Goldfeld-Quandt likelihood-ratio tests identifying most likely switch dates and gradualness of switches in the market and interest-rate sensitivities of unbookable equity. The same information is provided for the valuation ratio in Panel B. Each switch date and gradualness parameter is a maximum-likelihood estimate. Sample banks are those whose BANK COMPUSTAT records in any calendar quarter are complete. Standard errors are given in parentheses.

	First Switch	Second Switch
A: Market and Interest-Rate Sensitivity of Unbookable Equity		
Largest 25 Banks		
Implied Date (Z^*)	78/3	
	(2.07)	
Gradualness parameter (σ^*)	4.33	
	(2.56)	
Medium Banks		
Implied Date (Z^*)	77/2	81/1
	(1.23)	(2.30)
Gradualness parameter (σ^*)	0.08	0.56
	(1.00)	(1.06)
Smallest 25 Banks		
Implied Date (Z^*)	77/2	
	(0.72)	
Gradualness parameter (σ^*)	0.34	
	(0.48)	
B: Market and Interest-Rate Sensitivity of the Valuation Ratio		
Largest 25 Banks		
Implied Date (Z^*)	77/3	
	(2.25)	
Gradualness parameter (σ^*)	3.47	
	(1.96)	
Medium Banks		
Implied Date (Z^*)	77/2	80/4
	(1.09)	(1.87)
Gradualness parameter (σ^*)	1.19	0.59
	(1.47)	(0.41)
Smallest 25 Banks		
Implied Date (Z^*)	76/4	
	(3.04)	
Gradualness parameter (σ^*)	0.20	
	(4.00)	

In both regimes largest banks' unbookable equity proves negatively correlated with bond returns. This implies that the value of unbookable equity at large banks increases when bond returns fall (i.e., when interest rates rise). This is consistent with Kane's (1985) hypothesis that increases in the value of unbookable FDIC guarantees offset much of interest-induced losses on net bookable assets at banks the FDIC professes to be too big to liquidate. Although we observe no significant shift between regimes, β_r^u remains negative but loses significance during the second regime.

For medium banks, the market sensitivity of unbookable equity is negative and significant in all three regimes. Compared to large banks, medium-size banks' off-balance-sheet positions better hedge market variations after 77/3. Medium

Table IV

Maximum-Likelihood Estimates of Regime Parameters for the Second-Stage Model for the Market and Interest-Rate Sensitivity of Unbookable Equity

The Model is $U_t - U_{t-1} = \beta_j^u + \beta_{mj}^u R_{mt} + \beta_{rj}^u R_t + v_{tj}$. U is the intercept term of the Statistical Market Value Accounting Model (SMVAM) cross-sectionally estimated for each BANK COMPUSTAT bank in each quarter between the first quarter of 1975 and the third quarter of 1985. R_{mt} is the CRSP equal-weighted monthly stock index adjusted for dividends and R_t is the monthly holding-period return on long-term government bonds constructed by Ibbotson Associates, 1986. Monthly returns are compounded to produce quarterly returns. j indexes the n regimes, and t indexes time. Asymptotic t statistics are in parentheses.

Regime	Largest 25 Banks	Medium Banks	Smallest 25 Banks
Starting Year/Qtr	75/2	75/2	75/2
β_1^u	58.54*	2.00	−1.59
	(3.95)	(1.28)	(1.36)
β_{m1}^u	−432.04*	−28.12*	6.91
	(3.71)	(2.27)	(0.73)
β_{r1}^u	−795.46*	−81.85*	−26.60
	(2.32)	(2.17)	(0.93)
σ_{v1}^u	35.20	3.61	2.74
R^2	0.76	0.69	0.10
Ending Year/Qtr.	78/3	77/2	77/2
Starting Year/Qtr.	78/4	77/3	77/3
β_2^u	−1.28	3.13*	−0.71
	(−0.07)	(3.09)	(0.29)
β_{m2}^u	185.60	−34.68*	15.29
	(1.00)	(3.43)	(0.59)
β_{r2}^u	−220.36	9.57	−14.15
	(1.11)	(0.88)	(0.49)
σ_{v2}^u	77.74	3.04	11.97
R^2	0.06	0.42	0.01
Ending Year/Qtr.		81/1	
Starting Year/Qtr.		81/2	
β_3^u		7.84	
		(1.17)	
β_{m3}^u		−160.33*	
		(2.23)	
β_{r3}^u		52.58	
		(0.58)	
σ_{v3}^u		24.44	
R^2		0.20	
Ending Year/Qtr.	85/3	85/3	85/3

* Significant at 5 percent.

banks' unbookable equity is related negatively to holding-period yields prior to 1977. However, the relation becomes insignificantly positive after 77/3.

The specification for unbookable equity works poorly for the smallest banks. R^2 values prove much lower and slope coefficients are insignificant in both regimes. This may trace to heteroskedasticity, greater diversity in the way members of this class operate, or to the FDIC's willingness to enforce capital requirements closely enough to keep the capitalized value of FDIC guarantees close to zero for this size class. For small banks, Table II shows that for the 77/2 shift we can't reject the hypothesis that market and interest sensitivities remain unchanged, so that the shift may be modeled simply as a significant increase in residual variance.

Market and interest sensitivities for the valuation ratio are found in Table V.

Table V

Maximum-Likelihood Estimates of Regime Parameters for the Second-Stage Model for the Market and Interest-Rate Sensitivity of the Valuation Ratio

The Model is $k_t - k_{t-1} = \beta_j^k + \beta_{mj}^k R_{mt} + \beta_{rj}^k R_t + w_{tj}$. k is the slope term of the Statistical Market Value Accounting Model (SMVAM) cross-sectionally estimated for BANK COMPUSTAT banks in each quarter between first quarter of 1975 and third quarter of 1985. R_{mt} is the CRSP equal-weighted monthly stock index adjusted for dividends and R_t is the monthly holding-period return on long-term government bonds constructed by Ibbotson Associates, 1986. Monthly returns are compounded to produce quarterly returns. j indexes the n regimes and t indexes time. Asymptotic t statistics are in parentheses.

	Largest 25 Banks	Medium Banks	Smallest 25 Banks
Starting Year/Qtr	75/2	75/2	75/2
β_1^k	−0.23*	−0.06*	0.02
	(3.52)	(3.21)	(1.61)
β_{m1}^k	1.67*	0.71*	0.23*
	(3.71)	(5.41)	(3.05)
β_{r1}^k	2.60*	1.17*	0.26
	(1.91)	(2.47)	(0.92)
σ_{w1}^k	0.12	0.04	0.02
R^2	0.81	0.90	0.69
Ending Year/Qtr.	77/3	77/2	76/4
Starting Year/Qtr.	77/4	77/3	77/1
β_2^k	−0.04*	−0.05*	−0.01
	(2.18)	(7.24)	(0.37)
β_{m2}^k	0.33*	0.72*	0.28
	(1.94)	(10.15)	(1.05)
β_{r2}^k	0.49*	0.16*	0.30
	(2.60)	(2.11)	(1.01)
σ_{w2}^k	0.08	0.02	0.12
R^2	0.40	0.92	0.10
Ending Year/Qtr.		80/4	
Starting Year/Qtr.		81/1	
β_3^k		−0.04	
		(1.38)	
β_{m3}^k		1.18*	
		(3.70)	
β_{r3}^k		0.08	
		(1.93)	
σ_{w3}^k		0.11	
R^2		0.50	
Ending Year/Qtr.	85/3	85/3	85/3

* Significant at 5 percent.

For the largest banks, β_m^k is positive and significant in both regimes. This positive sign indicates that when stock returns increase, so does the valuation ratio for book equity. For fixed interest rates, this means that in a rising stock market book values increasingly underestimate the market value of net bookable assets. The market and interest-rate sensitivities of the valuation ratio for the largest banks decline after the 77/3 shift, but only the decline in market beta proves significant. During both regimes, the relation between k and holding-period returns on bonds is positive. This indicates that the institution's bookable assets are more interest-sensitive than its bookable liabilities. The robustness of the coefficient restraint $k_a = k_l = k$ used to develop equation (2) suggests that interest-rate variation may affect the default and prepayment capacities of banks and borrowers. Such a response could make the durations of the actual payment streams thrown off by assets and liabilities differ from the durations of the hypothetical payments called for in various contracts.

For medium banks, the valuation ratio also shows a consistently positive market-sensitivity. During the first two regimes, β_m^k is unchanged, while the increase observed after 1981 is insignificant. The valuation ratio correlates positively with holding-period yields during each regime, but after the first switch on 77/2, the coefficient shifts significantly downward. In the last 7.5 years of the sample, what we could term the "effective durations" of payments actually made on bookable assets and liabilities (Kaufman, 1984) appear to be more nearly matched.

For the smallest banks, the valuation-ratio market sensitivity is significant and positive prior to the 76/4 switch. Once the switch occurs, the model deteriorates, with no beta remaining significant. Once again, the insignificance of the slope coefficients suggests viewing the shift as merely an increase in residual variance.

A. Comparison with Related Studies

Our results help to explain the diversity of interest-sensitivity estimates reported in previous studies (Lloyd and Shick, 1977; Lynge and Zumwalt, 1980; Chance and Lane, 1980; Flannery and James, 1984; Kane and Unal, 1988). Market models estimated from CRSP and DRI data show bank equity returns becoming interest-rate sensitive only after 1979. Prior to 1979, market-model evidence indicates insensitivity to interest rates. Table VI realigns the shift date by estimating equation (6) separately for the seven regimes featured in Table IV.

Tables IV and V show that ΔU is negatively and Δk is positively correlated with bond returns prior to the first switch. During the first sample regimes for large and medium-size banks, the impact of the separately significant β_r^u and β_r^k are offsetting. The resulting "tendency to cancel out" clarifies how researchers could estimate an insignificant interest-rate beta (β_r) for the two-index model with data drawn from this interval. For the largest and medium-size banks that the cited authors studied, U loses its significant link to bond returns during 1979–85. Deleting this offsetting force permits movements in bank stocks' overall interest sensitivity β_r to be dominated by movements in the interest sensitivity of the valuation ratio.

Table VI

Estimates of the Expanded Market Model

The Model is $R_p = \beta_o + \beta_m R_m + \beta_r R + e_p$. R_p is the return on an equally weighted portfolio of BANK COMPUSTAT banks in each quarter, R_m is the CRSP equal-weighted monthly stock dividends and R_t is the monthly holding-period return on long-term government bonds constructed by Ibbotson Associates, 1986. Monthly returns are compounded to produce quarterly returns. The model is estimated for the regimes identified for market interest-rate sensitivity of unbookable equity. Asymptotic t statistics are in parentheses.

Regime	Largest 25 Banks	Medium Banks	Smallest 25 Banks
Starting Year/Qtr.	75/2	75/2	75/2
β_{01}	−0.06*	−0.03*	−0.02
	(3.07)	(2.04)	(0.89)
β_{m1}	0.99*	0.79*	0.39
	(5.76)	(6.07)	(2.01)
β_{r1}	0.82	0.42	0.92
	(1.70)	(1.06)	(1.58)
Starting Year/Qtr.	78/4	77/3	77/3
β_{02}	−0.02	−0.02	−0.00
	(1.20)	(1.93)	(0.10)
β_{m2}	0.58*	0.83*	0.48*
	(4.10)	(7.53)	(2.83)
β_{r2}	0.44*	0.32*	0.22
	(2.79)	(2.66)	(1.14)
Starting Year/Qtr.		81/2	
β_{03}		0.01	
		(0.61)	
β_{m3}		0.83*	
		(3.86)	
β_{r3}		0.25	
		(0.92)	

* Significant at 5 percent.

A stock's overall interest sensitivity reflects the net contribution of both interest-rate betas. For the largest and medium-size banks, the interest-sensitivity of off-balance-sheet items begins a drift to insignificance in 1977. One cannot reject the hypothesis that once the shifts completed themselves, the interest sensitivity of bank stock in these size classes depended entirely on the interest sensitivity of the valuation ratio.

VII. Diagnostic Regression Experiments

Table VII reports a series of regressions that investigate for the SMVAM how well our three-way size partition controls for a specific form of heteroskedasticity and intrasample differences in k and U. The first panel estimates k and U for the country's nine largest banks. These money-center banks are Citibank and the eight banks that Sinkey (1986, p. 249) reports that its staff labels as close competitors. Without exception, estimates of k lie above and estimates of U lie below estimates for the 25 largest banks reported in Table I (often substantially so). The magnitude of these differences suggests that these giant banks deserve a class of their own and lead us to ask whether the 16 other large banks might be reclassified into the medium group. Moreover, the very high k values assigned money-center banks in the early quarters of our sample are inconsistent with a zero correlation at these dates between book value and unbookable equity (which for these giant banks includes the value of numerous affiliates).

As an alternative to reclassification, the second panel of the table examines what happens when for the largest 25 banks the flexible form (2) is respecified as a quadratic equation:

$$MV = U + (k_0 + k_1\, BV)\, BV + e_Q\,. \tag{11}$$

Equation (11) models the valuation ratio k as a function of BV. Table VII tells us that for large banks k generally increases with bank size; but after 1980 never significantly so. Substantial bleeding of unbookable equity into k seems to be limited primarily to money-center banks during 1975–79. Parallel but unreported runs for medium and small banks reveal different patterns. Medium banks generally show a negative k_1; this coefficient proves significant two-thirds of the time before 1980 but only one-third of the time thereafter. At small banks, k_1 varies in sign and is almost never significant.

The third panel of Table VII estimates the SMVAM for the 25 largest banks after deflating all variables in equation (2) by BV. This deflation would correct exactly for heteroskedasticity if e in (2) were to equal the product of a homoskedastic random error e_D and BV. In any case, the indicated transformation reweights individual observations, raising the weight of observations drawn from smaller members of the large-bank sample relative to money-center banks. Before 1980, deflated estimates of U and k for large banks lie closer to the undeflated estimates for medium than for large banks. From 1981 on, the deflated estimates for large banks look much like the undeflated ones. This supports the view that before 1980 the SMVAM should be estimated separately for money-center banks. Results from fitting the deflated model to money-center banks (not presented here) confirm this. In the money-center subsample, pre-1980 estimates of k and U are broadly similar to those of the undeflated model. The main difference is that three-fourths of the U estimates become significant at 5 percent. Using this information to interpret the third panel of Table VII assures us that deflated pre-1980 estimates of unbookable equity at the next 16-largest banks would be positive, with valuation ratios much more like those shown for medium-size banks in Table 1. Taken together, these sensitivity tests underscore the value of undertaking pooling tests to partition sample banks optimally.

We also tested the unit constraint on the lagged coefficients for U and k built into the first-difference specifications (4) and (5). To do this, we ran unconstrained regressions of U_t and k_t on their respective $(t-1)$-values, R_{mt}, and R_t over the time span of each regime identified in Table II. Only one of the 14 lagged coefficients differs significantly from unity at 5 percent.

VIII. Directions for Further Research

The methods used in this paper suggest four directions for future research: sequential estimation, model respecification, sample selection, and data partition.

Table VII

Diagnostic Regressions of the Statistical Market Value Accounting Model (SMVAM)

In the following three models, MV and BV denote market and book values of bank equity. In models II and III, the sample consists of the 25 largest banks with complete records in BANK COMPUSTAT, 1986.

	SMVAM for 9 Money Center Banks			Quadratic Specification of SMVAM for 25 Largest Banks				Deflated SMVAM for 25 Largest Banks		
	Model I: $MV = U + kBV + e$			Model II: $MV = U + k_0BV + k_1BV^2 + e_Q$				Model III: $MV/BV = U\left(\frac{1}{BV}\right) + k + e_D$		
	U	k	R^2	U	k_0	k_1	R^2	U	k	R^2
75/1	−1005	2.05**	0.80	312	−0.31**	0.0009*	0.88	−6	0.96	0.00
2	−1098	2.31**	0.79	310	−0.17	0.0009*	0.87	−4	1.12	0.00
3	−779	1.63	0.83	234	−0.06**	0.0006*	0.88	19	0.81	0.00
4	−933	1.82**	0.83	265	−0.14**	0.0007*	0.89	10	0.86	0.00
76/1	−1109	2.12**	0.85	295	−0.13**	0.0007*	0.91	−10	1.03	0.00
2	−1128	2.17**	0.85	271	−0.01	0.0007*	0.90	−22	1.09	0.00
3	−928*	1.82**	0.87	243	0.06**	0.0005*	0.92	−20	0.98	0.00
4	−1017	1.96**	0.87	267	0.10**	0.0006*	0.92	−28	1.08	0.01
77/1	−746	1.59**	0.89	202	0.24**	0.0004*	0.93	−3	0.94	0.00
2	−655	1.50**	0.91	140	0.41	0.0003*	0.94	−28	0.96	0.01
3	−615	1.41	0.89	116	0.45	0.0003*	0.92	−33	0.93	0.01
4	−524	1.25	0.90	150	0.40**	0.0002*	0.93	−1	0.85	0.00
78/1	−487	1.16	0.88	143	0.41**	0.0002*	0.91	12	0.79**	0.00
2	−463	1.17	0.92	146	0.45**	0.0002*	0.93	12	0.83	0.00
3	−630	1.35	0.91	146	0.49	0.0002*	0.93	−28	0.95	0.01
4	−651	1.24	0.89	162	0.35**	0.0002*	0.92	−31	0.84	0.01
79/1	−585	1.17	0.90	132	0.43**	0.0002*	0.92	−28	0.82	0.01
2	−602	1.22	0.92	99	0.54	0.0001*	0.93	−62	0.91	0.04
3	−592	1.19	0.90	141	0.51	0.0001	0.91	−24	0.88	0.00
4	−638	1.15	0.90	147	0.42**	0.0001*	0.91	−38	0.83	0.01

Table VII—*Continued*

	SMVAM for 9 Money Center Banks			Quadratic Specification of SMVAM for 25 Largest Banks				Deflated SMVAM for 25 Largest Banks		
	Model I: $MV = U + kBV + e$			Model II: $MV = U + k_0BV + k_1BV^2 + e_Q$				Model III: $MV/BV = U\left(\frac{1}{BV}\right) + k + e_D$		
	U	k	R^2	U	k_0	k_1	R^2	U	k	R^2
80/1	−422	0.91	0.87	82	0.45**	0.0001	0.90	−32	0.70**	0.04
2	−456	1.00	0.91	145	0.48**	0.0001	0.96	41	0.73**	0.01
3	−362	0.88	0.90	227	0.37**	0.0001	0.90	66	0.67**	0.03
4	−593	1.09	0.90	268	0.36**	0.0001	0.89	38	0.79	0.01
81/1	−357	0.94	0.91	310	0.40**	0.0001	0.87	104	0.75	0.04
2	−220	0.94	0.95	159	0.72	0.0000	0.88	49	0.88	0.01
3	−237	0.85	0.94	221	0.55	0.0000	0.86	161	0.67**	0.06
4	−133	0.79**	0.97	271	0.53	0.0000	0.87	209	0.64**	0.10
82/1	−176	0.76**	0.96	162	0.53**	0.0000	0.90	114	0.62**	0.05
2	−303	0.73**	0.94	172	0.39**	0.0001	0.89	89	0.55**	0.06
3	−300	0.76**	0.90	180	0.42**	0.0001	0.90	63	0.60**	0.02
4	−405	0.89	0.91	155	0.51**	0.0001	0.91	8	0.73**	0.00
83/1	−631	1.06	0.88	261	0.41**	0.0001*	0.92	−25	0.81**	0.00
2	−599	1.02	0.92	311	0.48**	0.0001	0.91	25	0.83	0.00
3	−377	0.87	0.89	310	0.49**	0.0001	0.88	94	0.75**	0.03
4	−482	0.90	0.90	373	0.39**	0.0001	0.90	105	0.72**	0.05
84/1	−426	0.83	0.92	337	0.40**	0.0001	0.91	130	0.66**	0.06
2	−273	0.68**	0.87	341	0.31**	0.0001	0.85	59	0.62**	0.01
3	−216	0.77	0.85	377	0.40**	0.0001	0.86	47	0.74**	0.01
4	−298	0.82	0.88	199	0.54**	0.0000	0.89	−15	0.76**	0.00
85/1	−348	0.89	0.84	187	0.58	0.0000	0.89	−105	0.86	0.04
2	−613	1.06	0.87	228	0.60	0.0001	0.89	−91	0.93	0.01
3	−428	0.83	0.83	482	0.33**	0.0001	0.84	119	0.70**	0.02

* Indicates an estimate of U or k_1 that is significantly different from zero at 5 percent.

** Indicates an estimate of k or k_0 that is significantly different from unity at 5 percent.

Under the identifying restrictions and recursive structure employed here, sequential estimators of U, k and the various betas can be regarded as consistent instrumental-variable or method-of-moment estimators (Kmenta, 1971, pp. 559–567; Newey, 1984). To the extent that the recursive model is only an approximation or U and k are improperly identified, the estimates of k and U employed as input into second-round regressions add a measurement error to the model-approximation errors envisaged in (4) and (5). Although this complication could be addressed by estimating k, U, and the betas simultaneously, this would greatly expand the parameter space over which costly Goldfeld-Quandt search routines would have to operate. In our judgment, a more promising approach is to await the development of attractive instrumental-variable equations for the bookable and unbookable components of MV. Given a specification with less-oppressive identifying restrictions than our own, the GQSRM procedure could be adapted to explaining time-series observations for individual banks.

Model respecifications ought to focus on the possibility of finding omitted variables and the desirability of disaggregating accounting net worth into detailed asset and liability components. In principle, one could expand either stage of the model. Following the lead of arbitrage-pricing theory, one could expand the set of macroeconomic risk factors employed as regressors in the second-stage equations. In (2), one might also estimate distinctive valuation ratios for different classes of assets and liabilities. Our own preliminary attempts to make these extensions failed to improve upon the specifications reported here. It is difficult to expand the specification without developing a simultaneous-equations model of a bank's asset and liability decisions. Because existing bank portfolio models treat banks as enjoying monopoly power in at least some deposit and loan markets, they are ill-suited to representing the operations of large banks in 1975–1985. However, one might adapt Goldfeld's (1966) empirical model of bank behavior to serve this end.

At least three sample-selection issues merit attention. First, this study includes no observations on either mutual institutions or stock savings-and-loan associations and savings banks. Second, introducing data on the value of individual HCs' nonbank subsidiaries would sharpen the interpretation of U. Third, survivorship bias could be studied by applying the model to a set of institutions that went out of business between 1975 and 1985.

Finally, repartitioning our data would let us reinterpret our quarter-by-quarter models in at least two ways. One is to test and correct our regressions for richer forms of heteroskedasticity. A second is to use pooling tests for parameter variation to isolate the nature of meaningful differences in bank behavior. The size breakdown we employ represents a preliminary attempt at developing interpretable patterns of parameter similarities and differences, in which the partition itself is not tested for significance. Investigations aimed at finding optimal pooling procedures would also track changes over time in the composition of relevant classes.

IX. Summary

The paper identifies and models two sources of hidden capital: the misvaluation of a firm's on-balance-sheet positions and the neglect of its off-balance-sheet items. Our analysis extends the two-index model of stock returns by combining accounting estimates of a corporation's net worth with capital-market information to estimate the values of the firm's net bookable and unbookable assets. This three-equation model portrays the parameters of the two-index model as varying over time.

When this model is applied to a sample of bank stocks, the interest and market sensitivities of bookable and unbookable values often prove offsetting in sign. In particular, the evolution of the value and sensitivity of hidden capital at the nation's 25 largest banks during the interest-rate spike of 1978–1982 is consistent with the hypothesis that during this period increases in the unbookable value of FDIC guarantees and enhancements in franchise values fed by technological change and relaxations of regulatory restrictions cushioned a sharp decline in the valuation ratio for their net bookable assets.

Although we apply the model only to bank stock shares, in principle it could be used for any corporation. By permitting regime changes in the valuation models that reset market values each quarter, our methods provide new insight into changes in: (1) the market and interest sensitivity of a corporation's stock and (2) the impact of off-balance-sheet positions on a firm's stock price.

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