The Relationship Between Risk and Capital: Evidence from Indian Public Sector Banks

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The study investigates the relationship between changes in risk and capital in the public sector banking system in India, using both the seemingly unrelated regression (SUR) and the two stage least square (2SLS) method of estimation. Empirical findings establish a negative and significant impact of size on capital, indicating that large banks increased their ratio of capital to risk weighted assets less than other banks. Regulatory pressure is also found to have a negative and significant impact on the ratio of capital to risk weighted assets. *Ceteris paribus*, adequately capitalised banks decrease their capital ratio more prominently than other banks.

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Key Words: Capital, Risk, Regulatory pressure

Introduction

The decade of the seventies witnessed a significant decline in the capital ratios of many banks, especially in the G-10 countries. In an attempt to reverse this decline, the bank regulators issued explicit capital standards for banks (and bank holding companies, as in the United States) in December 1981. These standards required banks to hold a fixed percentage of their total assets as capital. Although these minimum regulatory capital standards have been credited for increasing bank capital levels[1] , the 1980s witnessed a significant number of bank failures. As observed by Lindgren *et al.* (1996), since 1980, over 130 countries, comprising almost three-fourths of IMF's member countries have experienced significant banking problems.

The widespread criticism about declining capital standards of banks and the consequent bank failures led the Basel Committee on Banking Supervision (BCBS) to announce the adoption of risk-based capital standards in 1989. The primary purpose of these standards was to make capital requirements of banks responsive to the risk in the asset portfolio of banks. Although capital ratios at commercial banks have increased since the risk-based standards took effect, the question arose as to what degree these increases are a response to risk-based capital. Furthermore, although the adoption of risk-based standards have focused attention on capital levels and bank lending, insufficient attention was given as to how the adoption of the risk-based standards may impact bank-portfolio risk levels.[2]

Most of the work in this area examines the impact of risk-based standards on capital and risk during a particular period (Shrieves and Dahl, 1992; Jacques and Nigro, 1997). In contrast to these studies, the present paper employs a seemingly unrelated regression (SUR) approach to examine the inter-relationships among bank capital, portfolio risk and the risk-based capital standards over the period 1995-96 to 2000-01. By using SUR technique, the model not only explicitly recognises the endogeneity of changes in capital and risk, but also takes cognisance of the fact that the errors in the equation might be contemporaneously correlated and as such, is preferable to the single equation Ordinary Least Squares (OLS) approach, which assume either capital or risk as exogenous to the bank or assume no correlation in the error structure. In order to test the robustness of the results, the model also employs the two-stage least squares (2SLS) technique. The advantage of the 2SLS technique lies in the fact that it recognises the simultaneity of banks' adjustment in capital and risk and to obtain asymptotically efficient estimates.

The remainder of the paper is organised as follows. The following section examines the available literature in this regard. Section II describes the institutional structure of the Indian banking system. The subsequent two sections discuss the risk-based standards and their limitations. The framework of the model is outlined in section V. The estimation procedure and a discussion of the results are contained in section VI. Finally, the concluding remarks are gathered in section VII.

Section I
Review of Literature

Recent papers have attempted to provide some evidence as to whether banks change the composition of their assets when they face a binding capital constraint, substituting away from high risk-weighted assets. Using data on 1,800 Federal Deposit Insurance Corporation (FDIC) insured banks in the period 1983-87, Shrieves and Dahl (1992) found that banks with capital to assets ratio less than 7 per cent applied by the US authorities at that time increased their ratio on an average by 140 basis points per annum more than other banks. Subsequently, Aggarwal and Jacques (1998) repeated the analysis of Shrieves and Dahl, using cross-sectional US bank data for 1991, 1992 and 1993. They were particularly interested in the impact of bank behaviour of the 1991 Federal Deposit Insurance Corporation Improvement Act (FDICIA) legislation and the prompt corrective action provisions laid down. These provisions obliged supervisors to take specific actions when a bank's capital ratios fell below certain trigger levels. They found that banks in the undercapitalised categories increase their capital target ratios more quickly than other banks with higher initial capital.[3] Using a three-stage least squares (3SLS) framework, Jacques and Nigro (1997) analysed the relation between bank capital, portfolio risk and the risk-based standards. Their results suggested that the median bank reduced its portfolio risk by 3.49 percentage points over the period 1990 to 1991 as a result of the regulatory pressure brought about by the risk-based standards.

Most of the above studies pertain to the banking industry in the US. Two exceptions in this context are Ediz *et al*. (1998) and Rime (2001). The former study employed quarterly data on 94 US banks over the period 1989:Q1 to 1995:Q4, while the latter study used annual data on 154 Swiss banks between 1989 and 1995. The two papers adopted broadly similar specifications. In particular, both introduced among the independent variables dummies for capital pressure, which equals unity when a bank's capital ratio falls into a zone starting above the regulatory minimum. The gap between the starting point of the zone and the regulatory minimum varies across banks and is taken to be proportional to the time-series standard deviation of the bank's own capital ratio. Both papers found regulation to be effective in the sense that the dummy variable in their setup had statistically and economically significant coefficients. In the case of Ediz *et al*. (1998), the ratio of capital to risk-adjusted assets increased by 44 basis points per quarter more for banks in the regulatory pressure zone compared to adequately capitalised banks. In the study by Rime (2001), the impact of regulation (*i.e*., of a dummy for the capital ratio less than one standard deviation above the regulatory minimum) was statistically significant at the one per cent level, although the magnitude was very small.

Section II
Institutional Structure of the Indian Banking System

The scheduled commercial banking system comprises of the foreign banks operating in India, in addition to Indian banks in the public and the private sectors and the Regional Rural Banks. The two rounds of nationalisation-first in 1969 of 14 major private sector banks with deposit liability of Rs. 0.50 billion or more, and thereafter in 1980, of 6 major private sector banks with deposits not less than Rs.2 billion[4] - led to the creation of Public Sector Banks (PSBs) with nearly 92 per cent of assets as at end-March 1991. While there were several private sector and foreign banks functioning at that time, there activities were highly restricted through branch licensing and entry regulation norms.

All commercial banks, whether public, private or foreign, are regulated by the central bank, the Reserve Bank of India (RBI). A process of liberalisation of the financial sector was initiated in 1992, which aimed at creating a more diversified, profitable, efficient and resilient banking system, based on the recommendations of the Narasimham Committee on Financial Sector Reforms (1991). The underlying philosophy was to make the banking system more responsive to changes in the market environment and to that end, engendered a shift in the role of the RBI from micro-management of bank's operations to macro governance.

The reforms sought to improve bank profitability by lowering pre-emptions (through reductions in the cash reserve and statutory liquidity ratios)[5] and to strengthen the banking system through institution of 8 per cent capital adequacy norms, in addition to income recognition, asset classification and provisioning requirements in line with international best practices. Competition was sought to be promoted through entry of new banks in the private sector and more liberal entry of foreign banks. While regulations relating to interest rate policy, prudential norms and reserve requirements have been applied uniformly across bank groups, priority sector credit requirements are quite varied for different categories of banks. Illustratively, while the public sector and private sector banks are required to allocate 40 per cent of their credit to priority sectors (comprising, agriculture, small-scale industry, transport operators, small business, *etc.*), the same for foreign banks stands at 32 per cent. These amounts, for both the public/private and the foreign banks are inclusive of several sub-targets, the former comprising a sub-target of 18 per cent for agriculture, while the latter consists of a sub-target of 10 per cent for exports[6] and 10 per cent for small-scale industries.

Until 1991-92, all PSBs were fully owned by the Government.[7] After the reforms process was initiated, these banks were allowed to access the capital market to raise up to 49 per cent of their equity. Till 2000-01, as many as 12 PSBs accessed to capital market and raised an amount aggregating Rs.64 billion.

Evidence of competitive pressures on the Indian banking industry is evidenced from the decline in the five-bank asset concentration ratio[8] from 0.51 in 1991-92 to 0.44 in 1995-96 and thereafter to 0.41 in 2000-01 and by the increasing number of private and foreign banks (Table 1)[9] .

Table 1: Summary of the Banking Industry: 1990-91 to 2000-01

Year /	1990-91			1995-96			2000-01		
Bank Group	Pub.	Pvt.	Forgn.	Pub.	Pvt.	Forgn.	Pub.	Pvt.	Forgn.

No. of Banks	28	25	23	27	35	29	27	32	41
Total Deposits (Rs. billion)	2087.3	94.3	84.5	3908.2	361.7	306.1	8593.8	1349.2	591.9
Total credit (Rs.billion)	1305.7	49.5	50.6	2075.4	219.3	225.0	4146.3	672.1	429.9
Credit-deposit ratio	0.63	0.52	0.60	0.53	0.61	0.75	0.48	0.50	0.73
Share of									
Total Deposits	92.1	4.2	3.7	85.4	7.9	6.7	81.6	12.8	5.6
Total Credit	92.9	3.5	3.6	82.4	8.7	8.9	79.0	12.8	8.2
Total Income (Rs. billion)	240.4	10.4	15.3	536.7	71.8	74.99	1034.9	163.9	119.8
Net Profit (Rs. billion)	4.7	0.4	1.5	-3.3	15.9	7.4	43.2	12.3	10.2

Pub. Public-sector Banks; Pvt. Private Sector Banks; Forgn: Foreign Banks

The performance of PSBs has become more responsive to changes in the marketplace, with growing emphasis on profitability as an indicator of performance as opposed to non-commercial considerations in the pre-reform era. Illustratively, there was a distinct improvement in the net profit of PSBs (from 4.6 billion in 1992-93 to Rs.43.2 billion in 2000-01). Reflecting the efficiency of the intermediation process, there has been a decline in the spread as attested by the ratio of net interest income to total assets from 3.20 per cent in 1990-91 to 2.84 per cent in 2000-01.

Section III
Risk-Based Standards: The Indian Experience

Capital adequacy has traditionally been regarded as a sign of strength of the financial system in India. In terms of Section 17 of the Banking Regulation Act, 1949, every banking company incorporated in India is required to create a reserve fund and has recently been advised to transfer a sum equivalent to not less than 25 per cent of its disclosed profits to the reserve fund every year.

A capital to risk-weighted assets system was introduced for banks in India since April 1992, in conformity with international standards, under which banks were required to achieve 8 per cent capital to risk weighted-assets ratio. Indian banks with branches abroad were given time till March 31, 1994 (subsequently extended to March 31, 1995) to achieve the norm of 8 per cent CRAR; the capital was to comprise of tier I plus tier II capital, of which tier II should not exceed 100 per cent of tier I. Accordingly, the pattern of assigning risk weights and credit conversion factors were also delineated, broadly in line with those in the original Accord.[10]

Although the switchover to stringent prudential regime did affect the banking system in the initial years, the system exhibited adequate resilience to record substantial improvements in financial strength through higher CRAR over the period. Data for public sector banks reveal that as on March 1996, while only 19 banks satisfied the CRAR of 8 per cent and above (the overall capital adequacy of PSBs was 8.72 per cent), the number increased to 26 in 1999. As at end-March 2001, as many as 25 out of the 27 public sector banks complied with the minimum CRAR

of 9 per cent, with the overall capital adequacy of PSBs having increased to 11.20 per cent.

Section IV
Limitations of Risk-Based Capital Standards

Under an ideal risk-based capital system, any increase in the bank's portfolio risk would be accompanied by an increase in capital to act as a buffer against possible losses arising from the additional risks. This implies that the risk-based capital standards should explicitly link changes in required bank capital with changes in earnings exposure risk. However, conceptual weaknesses in the risk-based standards may undermine the relationship between changes in portfolio risk and changes in required capital. One reason for this is that the current risk-based capital standards account primarily for credit risk. Thus, a capital deficient bank can, at the margin, improve its risk-based capital ratio by substituting low credit risk assets, such as Government bonds, for shorter term and relatively interest-sensitive assets, such as commercial loans. Furthermore, other types of risks, such as interest rate risks, credit concentration risks, are not explicitly recognised by the risk-based standards. Last, but not the least, the risk-based capital standards overlook potential interactions between individual assets. Portfolio theory suggests that the relevant risk of an asset depends not only on its own variability, but also its covariance with other assets in the portfolio. The risk-based standards unfortunately fail to incorporate the latter[11] .

Section V
Model Specification

The preceding sections suggest that a relationship exists between bank capital and portfolio risk, and that the risk-based capital standards may have an impact on both capital and risk. To examine these issues, the simultaneous equations model developed by Shrieves and Dahl (1992) has been modified to incorporate the risk-based capital standards. In that framework, observed changes in bank capital and risk level are decomposed into two components: a discretionary adjustment and a change caused by factors exogenous to the bank such that:

$$\Delta CAP_{j,t} = \Delta^d CAP_{j,t} + E_{j,t} \quad (1)$$

$$\Delta RISK_{j,t} = \Delta^d RISK_{j,t} + U_{j,t} \quad (2)$$

where ΔCAP and ΔRISK are observed changes in capital ratios and risk levels for bank j in period t, Δ^dCAP and Δ^dRISK represent discretionary adjustments in capital ratios and risk levels and E and U are exogenously determined random shocks. In any period, banks may not be able to adjust their desired capital and risk levels instantaneously. Therefore, the discretionary changes in capital and risk is modeled using the partial adjustment framework, such that,

$$\Delta^d CAP_{j,t} = \alpha(CAP^*_{j,t} - CAP_{j,t-1}) \quad (3)$$

$$\Delta^d RISK_{j,t} = \beta(RISK^*_{j,t} - RISK_{j,t-1}) \quad (4)$$

where $CAP^*_{j,t}$ and $RISK^*_{j,t}$ are the target capital and risk levels, respectively and α and β are parameters. In the partial adjustment framework, the discretionary changes in capital and risk are proportional to the difference between the target level and the level existing in period (t-1). Substituting equations (3) and (4) into equations (1) and (2), the changes in capital and risk can be written as:

$$\Delta CAP_{j,t} = \alpha(CAP^*_{j,t} - CAP_{j,t-1}) + E_{j,t} \quad (5)$$

$$\Delta RISK_{j,t} = \beta(RISK^*_{j,t} - RISK_{j,t-1}) + U_{j,t} \quad (6)$$

V.1 Definitions of Capital and Risk

We use the following definition of capital: the ratio of capital to risk weighted assets. This is slightly different from Shrieves and Dahl (1992) who also employ the ratio of capital to total assets as a measure of capital. In contrast, Rime (2001) employs both definitions of capital.

The measurement of risk, on the other hand, is subject to debate. In line with the standard work in this area (Shrieves and Dahl, 1992; Jacques and Nigro, 1997), we employ the ratio of risk-weighted assets to total assets (RWA) as a measure of risk. The rationale for using this measure is that portfolio risk is primarily determined by the allocation of asset across different risk categories. Although the use of RWA as a measure of risk has the advantage of reflecting the banks' decisions on risk taking with timeliness, it, however, pre-supposes that the risk-weights correctly reflect the economic risk of the different asset categories, which might not be necessarily valid in practice.

V.2 Variables Affecting Changes in Bank Capital and Risk

Equations (5) and (6) predict that observed changes in capital and risk in period t are a function of the target capital and risk levels, lagged capital and risk levels and exogenous factors. The target levels of capital and risk are unobservable and assumed to depend on a set of

observable variables. It is to these variables that we turn next.

V.2.1 Size

Size may influence target capital and risk levels due to its relationship with risk diversification, investment opportunities and access to equity capital. The natural logarithm of total assets (LNSIZE) is included in the capital and risk equations to capture size effects.

V.2.2 Current Profits

Current profits may have a positive impact on banks' capital if financial institutions prefer to increase capital through retained earnings than through equity issues, as the latter may convey negative information to the market about the bank's charter value in the presence of asymmetric information. This runs contrary to Jacques and Nigro (1997), who employ the income in the previous period as a proxy for profitability in the current period. However, unlike their study, we employ the Return on Assets (RoA) in the capital equation as a proxy for profitability.

V.2.3 Non-Performing Loans

In the Indian context, studies on non-performing loans (NPLs) suggests that it has a sizeable overhang component arising from infirmities in the existing processes of debt recovery, inadequate legal provisions on foreclosure and bankruptcy and difficulties in the execution of court decrees. Banks also face external constraints such as the dominance of traditional industries in credit portfolios, industrial sickness and labour problems. It has also been observed that several internal factors (diversion of funds for expansion/ modernisation/diversification, inefficient management, strained labour relations and inappropriate technology) as well as external factors (recession, input/power shortage, price escalation) contribute to high NPLs. The level of NPLs tends to weigh down the bank's overall profitability and to that extent, increases the bank's loan loss provisioning. This, in turn, affects the ratio of risk-weighted assets (RWA) to total assets, as it leads to a decrease in the nominal amount of the RWA. Keeping this in view, change in non-performing assets (ΔNON) has been included in both the equations.[12]

V.2.4 Regulatory Pressure

The buffer theory predicts that a bank approaching the regulatory minimum capital ratio may have an incentive to boost capital and reduce risk in order to avoid the regulatory costs triggered by a breach of the capital requirements. However, poorly capitalised banks may also be tempted to take more risks in the hope that higher expected return will help them to increase their capital. We expect regulatory pressure to have a substantial impact on Indian public sector banks behaviour, given the strict supervisory and prudential norms followed by the central bank.

Regulatory pressure can be evaluated in several ways. Shrieves and Dahl (1992) adopt a probabilistic approach wherein the regulatory pressure variable (REG) is unity if the bank's capital is at least equal to the regulatory minimum and zero, otherwise. Ediz *et al.* (1998), on the other hand, adopt a relatively refined approach that reflects the impact of the capital ratio's volatility on the probability of failing to meet the legal requirements. Aggarwal and Jacques (1998), in contrast, measure regulatory pressure using Prompt Corrective Action (PCA) classification between adequately capitalised and undercapitalised categories.

We follow the approach of Shrieves and Dahl (1992) in our analysis. Accordingly, we construct a binary variable (REG), which reflects the degree of regulatory pressure. The variable is unity for banks with total capital ratios below 8 per cent, and zero, otherwise[13] . Additionally, since regulatory pressure may also affect the speed of adjustment of capital levels, therefore an interaction term defined as the product of the regulatory pressure variable and the capital level is included in the capital equation.

Combining our analysis, the target capital ratio (CAP^*) is influenced by a number of explanatory variables including: the natural logarithm of the size of the bank (LNSIZE), bank-wise return on assets (RoA), as a proxy for profitability (Rime, 2001), regulatory influence (REG), changes in non-performing assets ($\Delta NON_{j,t}$) and changes in risk ($\Delta RISK_{j,t}$). In a similar fashion, the target risk ratio (RISK*) is influenced by the natural logarithm of bank size (LNSIZE), regulatory pressure variable (REG), changes in capital ($\Delta CAP_{j,t}$), the composite risk index in the earlier period ($RISK_{j,t-1}$) and changes in non-performing assets (ΔNONj,t).

Substituting linear functions of the natural logarithm of bank size (LNSIZE), regulatory influence (REG), return on asset (RoA) and the change in risk (capital) for the target capital (risk) level yields the model to be estimated, given by equations (7) and (8):

$$\Delta CAP_{j,t} = \lambda_0 + \lambda_1 LNSIZE_{j,t} + \lambda_2 \Delta NON_{j,t} + \lambda_3 \Delta RISK_{j,t} + \lambda_4 RoA_{j,t} + \lambda_5 REG_{j,t} + \lambda_6 CAP_{j,t-1} + \lambda_7 REG_{j,t} \times CAP_{j,t-1} + \mu_{j,t} \quad (7)$$

$$\Delta RISK_{j,t} = \theta_0 + \theta_1 LNSIZE_{j,t} + \theta_2 REG_{j,t} + \theta_3 \Delta CAP_{j,t} - \theta_4 RISK_{j,t-1} + \theta_5 \Delta NON_{j,t} + \psi_{j,t} \quad (8)$$

where μ and ψ are disturbance terms, assumed to be contemporaneously correlated.

Simultaneous estimation of these equations is carried out by the SUR process. Under the null hypothesis that changes in risk and capital do not influence each other, the coefficients λ_2 , λ_3 and θ_3 will not be significantly different from zero. As mentioned earlier, in order to check the robustness of the results, we also estimate the model using the two-stage least squares (2SLS) procedure.

Empirical relationships of (7) and (8) requires measures of both bank capital and portfolio risk. Data on capital adequacy for the period under study has been culled out from the *Report on Trend and Progress of Banking in India*. Bank-wise data on asset items has been culled from the *Statistical Tables Relating to Banks in India*. The asset category is multiplied by the corresponding risk weight to arrive at the risk-weighted measure.

Section VI
Empirical Estimation and Results

The study examined 27 public sector banks (PSBs) for the period 1995-96 to 2000-01, which accounted for about 80-85 per cent of the total assets of the Indian banking system.

Changes in capital and risk are measured on a yearly basis, which represents the highest periodicity for which data is systematically available. Table 2 shows bank characteristics, including changes in risk, capital and non-performing assets for banks. For instance, as on March 31, 1996, the average level of capital of the PSBs was 7.573 per cent with corresponding risk-weighted asset ratio of 42.681 per cent. Over the period, the average level of capital has witnessed a rise with the aforesaid ratio being 10.53 per cent in 2001 and the risk-weighted asset ratio recording an increase to 44.44 per cent. Likewise, the average level of non-performing assets of PSBs has witnessed a steady decline from 18.12 per cent as at end-March 1996 to 12.73 per cent, as at end-March 2001.

Table 2: Means of Variables, by year (End-March)

Year	1996	1997	1998	1999	2000	2001
CAP	7.573	9.214	11.129	10.349	10.565	10.533
NON	18.118	18.529	17.046	16.349	14.196	12.734
RISK	42.681	42.815	42.446	44.499	44.911	44.436
ΔCAP	0.137	1.642	1.915	-0.780	0.216	-0.032
ΔNON	-0.966	0.410	-1.482	-0.697	-2.152	-1.462
ΔRISK	-0.425	0.133	-0.369	2.053	0.411	-0.475
LNSIZE	9.420	9.523	9.676	9.842	9.998	10.133
RoA	-0.429	0.467	0.711	0.434	0.543	0.495

Table 3 presents the simple correlation among all non-categorical variables, including relevant first differences. Correlations are based on the pooled sample (six observations on 27 banks). As suggested in the table, cross-sectional positive correlation (0.144) between levels of CAP and RISK is indicated in table 2, whereas the correlation in first differences is negative (-0.160). This underscores the importance of specifying the dynamics of bank behaviour relative to risk and capital in terms of first differences, rather than levels.

Table 3: Correlations Among the Variables

Variable	NON_{t-1}	$RISK_{t-1}$	ΔCAP_t	ΔNON_t	$\Delta RISK_t$	LNSIZE
CAP_{t-1}	-0.646	0.144	-0.347	0.119	0.172	0.101
NON_{t-1}		-0.413	0.042	-0.249	-0.057	-0.024
$RISK_{t-1}$			-0.047	0.253	-0.289	0.276
ΔCAP_t				-0.249	-0.160	-0.127
ΔNON_t					-0.138	-0.088
$\Delta RISK_t$						0.109

The results for SUR estimation for the entire sample are given in Table 4 (panels A and B). All the variables which were included for their potential impact on target capital and risk levels were statistically significant in one of the two equations. Bank size (LNSIZE) had a negative impact on target capital levels, indicating a relatively lower increase in the ratio of capital to risk-weighted assets for large banks *vis-à-vis* smaller ones. For banks overall, size was negatively

related to the composite risk index. This result might reflect differences in the markets served by larger *vis-à-vis* smaller banks, which in turn affect their product mix, such that banks have a smaller fraction of assets in categories with lower risk weights (such as loans and advances). The parameter estimate on the lagged capital ratio was quite high, thereby implying fairly rapid adjustment of capital ratios to the bank's desired levels. The return on asset (RoA) variable was positive and statistically significant; the result was to be expected, because in equilibrium, riskier banks should have a higher expected income (and thereby profits), and to the extent that higher returns are realised, they would tend to have larger changes in capital[14] . Finally, the results of Table 4 suggest that changes in capital and risk are negatively related. The results are not surprising because an undercapitalised banks can meet the risk-based requirement by raising capital, reducing portfolio risk, or both, while a bank with a ratio above the risk-based minimum may decrease capital or increase risk.

Table 4: SUR Estimates of the Two-Equation Model
Panel A: Dependent Variable = ΔCAP_t

Variable	Parameter Estimate	t-Statistic
Intercept	9.262*	4.34
LNSIZE	-0.251	-1.14
REG	-7.169*	-7.44
CAPt-1	-0.668*	-9.79
CAPt-1*REG	0.209*	2.28
ΔNONt	-0.041	-0.61
ΔRISKt	-0.263*	-5.64
RoA	1.576*	6.78
Number of Banks 27		
No. of observations 162		
Adjusted R-square 0.53		
* significant at 1%		

In Table 4, potential effects of having total capital below the level deemed adequate by regulators (*i.e.,* 8 per cent upto March 1999 and 9 per cent, effective April 2000) are accounted for as an intercept effect (REG) in each of the two equation estimated. Additionally, the interactive term (CAP_{t-1} *x* REG) in the capital equation allows the rate of adjustment of the capital level to vary according to the regulatory classification.

Table 4: SUR Estimates of the Two-Equation Model
Panel B: Dependent Variable = Δ $RISK_t$

Variable	Parameter Estimate	t-Statistic
Intercept	2.220	0.65
LNSIZE	0.619***	1.72
REG	-4.077*	-3.86
$RISK_{t-1}$	-0.176*	-4.27
ΔCAP_t	-0.377*	-4.53

ΔNON_t	-0.115	-1.06

Number of Banks 27
No. of observations 162
Adjusted R-square 0.59

* significant at 1%; *** significant at 10%

The coefficient on REG in panel A equals –7.169, which indicates a negative impact on target capital level; the same is also borne out by the negative sign on the REG coefficient in panel B. Additionally, the coefficient on the interaction term in panel A is positive, and significant at conventional levels. This might be a pointer to the fact that regulatory pressure induces banks to increase their speed of adjustment of target capital levels.

In order to test the robustness of the results, we also estimate the same model by two-stage least squares (2SLS). The results of the analysis are materially similar in both the capital and risk equations (Table 5: panels A and B). Specifically, in the capital equation, the magnitudes of the coefficients are roughly of the same order as in the case of the SUR estimates. Illustratively, in the capital equation, current earning (RoA) has a significant and positive impact on capital, indicating that profitable banks can more easily improve their capitalisation through retained earnings. LNSIZE has a negative and significant impact on capital, suggesting that large banks increased their ratio of capital to risk-weighted assets less than other banks. Regulatory pressure has a negative and significant impact on the ratio of capital to risk-weighted assets. *Ceteris paribus*, adequately capitalised banks decrease their capital ratio more prominently than other banks.

In the risk equation likewise, the regulatory pressure variable has a significant impact on banks' risk, indicating that banks approaching the minimum capital requirements decreased the share of risk-weighted assets in their portfolio. LNSIZE has a positive impact on risk, reflecting big banks disengagement from relatively risk-free assets towards relatively riskier asset categories. In both Tables (5A and 5B), there seems to be a significant negative relationship between changes in capital and changes in risk, confirming the fact that increases in capital ratios are accompanied by decreases in the ratio of risk-weighted assets to total assets.

Table 5: 2SLS Estimates of the Two-Equation Model
Panel A: Dependent Variable = ΔCAPt

Variable	Parameter Estimate	t-Statistic
Intercept	10.235*	4.54
LNSIZE	-0.321	-1.40
REG	-6.999*	-7.06
CAPt-1	-0.701*	-9.76
CAPt-1*REG	0.213*	2.24
ΔNONt	0.001	0.01
ΔRISKt	-0.059	-0.46
RoA	1.600*	6.53

Number of Banks 27
No. of observations 162
Adjusted R-square 0.594

* significant at 1%

Table 4: 2SLS Estimates of the Two-Equation Model
Panel B: Dependent Variable = RISKt

Variable	Parameter Estimate	t-Statistic
Intercept	0.322	0.09
LNSIZE	0.862**	2.33
REG	-3.024*	-2.71
$RISK_{t-1}$	-0.189*	-4.50
ΔCAP_t	-0.092	-0.78
ΔNON_t	-0.024	-0.21

Number of Banks 27
No. of observations 162
Adjusted R-square 0.14

* significant at 1%; ** significant at 5%

Section VII
Concluding Remarks

The study utilises several periods of cross-section data on commercial banks in a simultaneous equation framework to estimate the effect of changes in risk on changes in capital, and changes in capital upon changes in risk. The sample encompasses 27 public sector banks operating in India over the period 1995-96 through 2000-01. Important regularities in the data are interpreted in the light of the existing studies on bank behaviour.

Empirical findings establish a negative and significant impact of size on capital, indicating that large banks increased their ratio of capital to risk weighted assets less than other banks. Regulatory pressure is also found to have a negative and significant impact on the ratio of capital to risk-weighted assets. *Ceteris paribus*, adequately capitalised banks decrease their capital ratio more prominently than other banks.

The results establish that risk exposure and capital levels are simultaneously related, and that the majority of banks mitigate the effects of increases in capital by decreasing asset risk posture, and *vice versa*. The results, however, do not necessarily imply that levels of bank capital are adequate from a public policy perspective.

Notes

[1] Evidence presented by Jackson *et al*. (1999) from the FitchIBCA database as well as the Basel Committee shows that the industry average capital ratio of banks increased from 9.3 per cent in 1988 to 11.2 per cent in 1996.

[2] The New Consultative Paper, put forth by the Basel Committee in June 1999 attempts to address the several shortcomings associated with the old Accord. The Accord rests on three pillars of *minimum capital requirements*, *supervisory review of capital adequacy* and *market discipline*. Under the first pillar, the Committee has proposed to build on the extant minimum capital requirements' by announcing explicit risk weighting structure for different activities and explicit risk weights for other categories of risks such as market risks and operational risks (Basel Committee on Banking Supervision, June 1999).

[3] Their estimates suggest that under-capitalised banks raise their capital ratios by 200 and 800 basis points per annum (depending on the year and the capital ratio in question) more than do well-capitalised banks. All these estimates are significant at the 5 per cent level.

[4] The number has since been reduced to 19, with the merger of two public sector banks in 1993.

[5] As at end-December 2001, the cash reserve ratio was 5.5 per cent (statutory minimum of 3 per cent) and the statutory liquidity ratio was 25 per cent (the legal minimum). The corresponding figures as at end-March 1994 were 14.0 per cent and 34.25 per cent, respectively.

[6] The number has since been revised upwards to 12 per cent in 1996.

[7] The State Bank of India (SBI) was fully owned by the RBI and the 7 associates of SBI were fully owned by SBI itself.

[8] Defined as assets of top 5 public sector banks to total assets of the 27 public sector banks.

[9] The five largest banks (in terms of asset) till 2000-01 were in the state domain.

[10] In line with the specificities of the Indian situation, the risk weights on several on-and off-balance sheet items were adjusted to reflect market realities.

[11] Nachane *et al.,* 2001.

[12] The passage of the Securitisation Bill in the Parliament in 2002 is expected to provide necessary impetus to bankers to ensure sustained recovery.

[13] The figure is 9 per cent for the years 1999-2000 and 2000-01, since banks had to comply with a minimum CRAR of 9 per cent, effective March 31, 2000.

[14] It is of significance to note that Indian public sector banks recorded much lower growth in provisioning as compared to the private banks. As a result, during the period under study, public sector banks were able to increase profit and thus capital by not managing the prospective risk via provisioning. The relationship between RoA and change in capital should thus be treated accordingly.

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