Risk, capital and operating efficiency: Evidence from Indian public sector banks

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Reserve Bank of India

June 2004

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Introduction

Understanding the determinants of risk taking behaviour of banks has recently become a subject of rigorous theoretical and empirical research. Available literature on this front tends to suggest that risk-taking by banks tends to be affected by a number of factors, including, among others, moral hazard provided by mispriced deposit insurance, agency problems, ownership structure and managerial incentives. Furthermore, theory also suggests that attempts to raise capital *via* stock issues could be costly to shareholders because such efforts act as a signal that the management has adverse news about the bank.

While the moral hazard of deposit insurance would suggest that banks would increase their risk positions as capital declines, in practice, such risk-shifting activities of banks is not common as evidenced from the work of Duan *et al.* (1992) for the US and Nachane *et al.* (2000) for India. This lack of convincing evidence on moral hazard behaviour of insured banking firms may be the result of effective regulatory oversight and market discipline that limits bank risk taking.

Another strand of literature on bank risk-taking focuses on the agency problems between bank management and shareholders. Since human capital cannot be easily diversified, managers might be more risk averse than bank owners. This argument finds support in the work of Saunders *et al.* (1990), who observe that 'stockholder controlled' banking firms tend to take more risk than 'managerially controlled' firms.

A slightly different angle on the managerial risk preference hypothesis has been offered by Hughes *et al.* (1995), who link risk taking and operational efficiency of banks. They observe that traditional production functions and efficiency estimates are derived under the assumption of risk neutrality. However, since the penalties for being wrong in company as less severe than for being wrong in isolation, risk-averse managers might be willing to trade off reduced earnings for reduced risk, especially when a substantial portion of their wealth (or human capital) is tied to the performance of the firm. In doing so, they might incur additional costs in making higher quality

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loans and in monitoring loan performance, which would tend to manifest itself in measured inefficiencies.

However, the theoretical case for higher capital standards leading to greater risk assumption and possibly, higher probability of failure is not as clear-cut as it seems at first sight. Koehn and Santomero (1980) and Kim and Santomero (1988) demonstrated that increased regulatory capital standards might have the unintended effect of causing utility-maximising banks to increase portfolio risk[2]. This runs contrary to the work of Benston *et al.* (1986) who note that bank capital and portfolio risk may be negatively correlated, as banks maximise the option value of deposit insurance by reducing capital and increasing risk. The associated benefit to bank shareholders is termed as 'deposit insurance subsidy'. Bank capital regulation therefore acts as a check on the tendency of banks to exploit this subsidy and reduces the risk exposure of banks. In a pair of studies, Furlong and Keeley (1989) and Keeley and Furlong (1990) argued that the framework used in prior studies takes the expected cost of deposits as a constant (i.e., independent of the bank's capital position or risk). This assumption of independence might not be correct, because it ignores the states in which bank fails. When the model is adjusted so that the cost of deposits is a decreasing function of the risk of failure (because the deposit insurance agency pays depositors when the bank fails), then the results of prior studies do not hold. Banks' incentive to take more risk is greater at low capital levels, and the incentive decreases with increase in capital. Subsequently, Gennotte and Pyle (1991) incorporated an adjustment for the value of deposit insurance as suggested by Keeley and Furlong and also allowed the expected return on the asset to decrease as a bank increases its holdings. Their findings reveal that if an interior optimum for size and risk exists, then a rise in capital level will lead to increased investment in the risky asset and a greater probability of failure. Avery and Berger (1991) argued that, even if Gennotte and Pyle's results for increased risk of default hold, the expected losses to the deposit insurer are decreasing in the absence of dead-weight liquidation costs of failure or extreme assumptions about the distribution of asset returns.[3]

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[2] *Rochet (1992) has demonstrated that (a) if the objective of commercial banks is maximization of the market value of their future profits (value maximizing banks), capital regulations cannot prevent banks from choosing very specialized and very risky portfolios, and, (b) if banks behave as portfolio managers (utility maximizing banks), regulations can be effective, but only if the weights used in the computation of the ratio are proportional to the systemic risks of the assets.*

[3] *Calem and Rob (1996) developed a model of changes in bank's asset choice and capital ratios and simulated the model using parameters estimated over the 1984-93 period. They found that while severely undercapitalised banks take more risks in response to higher capital requirements, banks with minimally adequate capital reduce their risk exposure, whereas well -capitalised banks increase their risk exposure to offset the increase in capital.*

While the theoretical evidence is mixed, available empirical evidence generally suggests that higher capital standards may be, at most partially, offset by increased risk, but do not increase the probability of failure. In their study of US banks, Shrieves and Dahl (1992) found that, for commercial banks with assets more than US$100 million during 1983-87, an increase in capital is associated with an increase in risk. This lends support to the work of Levonian (1991), who found that bank holding companies witnessed an increase in both asset risk and capital.

While the relationship between capital and risk has been extensively studied, not much evidence is available on their relationship with operating efficiency. There are reasons to believe that both risk and efficiency might be endogenously determined, so that such a situation is best examined in a simultaneous equation setup. In the '1980s, a study by Jensen (1986) observed that there are theoretical reasons to believe that agency costs and asymmetric information might significantly impact the trade-offs among risk, leverage and efficiency. The study finds empirical support in the work of Kwan and Eisenbis (hereafter KE, 1997), who, in their study of bank holding companies in the US from 1986:2 to 1995:4, found a positive effect of inefficiency on risk-taking and the level of capital.

Almost all of the studies adhered to above have primarily been from a developed country viewpoint. However, from a developing country perspective, the interplay among capital, risk and operating efficiency might not be necessarily unambiguous. For one, banking systems in several emerging economies still tend to be predominantly Government-owned, so that any such relationship needs to take cognizance of this fact. To provide an example, as at end 1998, share of PSBs in India were 82 per cent. The comparable figures for China, Indonesia and Brazil during the same period were 99 per cent, 85 per cent and 47 per cent, respectively (Hawkins and Turner, 1999). Second, prudential norms also differ widely across countries, so that studies on such banking behaviour in one country, as for the US by KE (1997) might not provide consistent inferences about the same in another country. For instance, a norm for classification of an asset as non-performing varies from 6 months (2 quarters) in India[4] to 'overdue' as in China to 2 months as in Brazil. More importantly, even *within* a country, not all banks would be equally well placed to attain such standards. This brings into prominence the concept of regulatory pressure that such banks face towards attaining such standards. Finally, several countries have directed credit programmes, meant to provide concessional credit to the neglected sectors of the society, so that any such analysis would need to factor such considerations into account.

The purpose of the study can presently be outlined. The aim of the study is to examine the interrelationships among risk, capital and operating efficiency for the PSBs in India. While

[4] *Effective April 2001.*

there are certain similarities between the present study and the one by KE (1997), there are also significant differences. For one, in line with the work of Jacques and Nigro (1997), the concept of regulatory pressure is explicitly incorporated into our analysis, in order to segregate banks into undercapitalized and adequately categories[5], whereas in the KE paper, regulatory pressure is an implied concept and not modeled explicitly. Second, given the overwhelming presence of the Government in the banking sector in India, the study seeks to understand whether, and to what extent, do such interrelationships among risk, capital and operating efficiency hold good, more so in the presence such Government ownership of banks (Das amd Ghosh, 2004). Thirdly, in view of the statutory stipulation of priority sector lending by the PSBs in India, the advances portfolio is categorized in terms of priority and other sectors[6], whereas in the KE paper it is modeled as loans to specified sectors (*viz.*, real estate and commercial sectors).

2. The Model Specification

The prior literature suggests that bank risk-taking might be dependent, among others, upon operating efficiency. The managerial discretion in risk-taking is partially dependent on the quality of management. As a consequence, an efficient bank with a superior management might be better placed in assuming additional risks *vis-à-vis* a less efficient one, *ceteris paribus*. This however needs to be tempered by the fact that an efficient banking firm, in an attempt to protect its franchise value, might be less inclined to assume greater risks than a less efficient one. The relationship is further compounded by the agency problems between management and shareholders. If, for instance, entrenched management is associated with lower operating efficiency, it is not altogether clear whether the relation between efficiency and bank risk is positive (Saunders *et al.*, 1990) or negative (Gorton and Rosen, 1995).

Table 1: Select studies on Risk, Capital and Efficiency

Author/Year	Country/ Period	Issue
Shrieves and Dahl (1992)	US banks 1984-86	Relationship among risk and capital
Kwan and Eisenbis (1997)	US banks 1986-95	Interrelationships among capital, risk and efficiency
Jacques and Nigro (1997)	US banks 1991	Risk and regulatory (capital) pressure
Ediz *et al.* (1997)	UK banks 1989-94	Capital regulation and risk-taking
Rime (2001)	Swiss banks 1989-95	Risk and capital

[5] *Adequately capitalised banks are those which meet the prescribed minimum capital adequacy standards. Reverse is the case for undercapitalized banks.*

[6] *Since the loan portfolio is classified into priority and non-priority (other) sectors, the two could be contemporaneously correlated; hence, we consider only loans to priority sector in the analysis.*

At the same time, bank risk might impinge upon operating efficiency. Risks may be costly to manage, since a high-risk firm might require more inputs produce a given level of output as compared with a firm which assumes less-risk. Put differently, while the attainment of a given level of risk might not be costly, it might be difficult to reduce the same, in view of the problems of identifying (and even more difficulty in weeding out) high-risk loans during the loan sanctioning process. This, in its wake, implies a positive effect of bank risk on operating efficiency. The nature of interplay between risk and efficiency implies that it may be best modeled within a simultaneous equation framework.

Two sources of bank risk are considered in the study. These include, credit risk and leverage. Credit risk is the risk of default of the assets of the banking firm, consisting primarily of loans and Government securities. Leverage, on the other hand, refers to the amount of borrowing relative to the level of capital provided by shareholders. Since a banking firm can achieve a certain level of overall risk exposure by convex combinations of credit risk and financial leverage, these two types of bank risk are modeled as simultaneously determined.[7] In the present study, credit risk is measured by the ratio of gross non-performing loans to gross advances (GNPA), which is more indicative of the quality of credit decisions made by bankers[8][9]. Financial leverage, on the other hand, is measured by the ratio of capital to risk weighted assets (CRAR).

The crucial issue in this context is the measurement of operating inefficiency. In the present framework, to measure operating inefficiency, we focus on X-inefficiency in a more general sense to describe any excess cost of production not caused by sub-optimal scale or scope. Analogous to the specification by Battese and Coelli (1992), a stochastic frontier cost function with composite error terms and standard distributional assumptions was specified[10]. The total cost is approximated by a translog function with multiple inputs and outputs. It is widely

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[7] *Another important source of risk is interest rate risk. It refers to the risk sensitivity of a banking firm's market value to changes in interest rates, stemming from mismatches between assets and liabilities' repricing intervals. Owing to non-availability of data on the same for PSBs, this risk has not been considered in the study.*

[8] *It needs to be mentioned that GNPA is a good measure of ex-post credit risk. The study would have enriched had one been able to consider a measure that considers ex-ante credit risk, but for most developing countries including India, such measures are not available.*

[9] *In order to test the robustness of the results, net non-performing loans as ratio of net advances (NNPA) was also employed instead of GNPA. There were two major differences in the results obtained thereof. First, in the CRAR equation, NNPA was found to have a negative and significant effect for large, medium and small banks. Since NNPA is GNPA adjusted for obligatory provisioning, this reiterates the mutually reinforcing relationship between capital and adjusted credit risk. Secondly, in the INEFFICIENCY equation, the coefficient on NNPA was positive and significant for all classes of banks, lending credence to the fact that operating inefficiency stems from managing bad assets. The results are available upon request from the authors.*

[10] *The detail of the comparison among various frontier efficiency methods and their application in examining efficiency of financial institutions is detailed in Bauer et al. (1998).*

acknowledged that efficiency measures depend on the choice of inputs and outputs, especially in the banking literature where there is a long-standing disagreement over what banks produce (outputs) and the resources employed in the process (inputs). In the Indian context, in particular, the commercial banks, and especially the PSBs, serve manifold purposes. As a business entity, they have a profit-maximizing objective, while given the governmental concerns for ensuring allocation of credit to neglected sectors of the economy (e.g., small scale industries, agriculture, transport operators, small business, *etc*), they have to serve a social objective as well. The central bank, on the other hand, has a regulatory objective of fostering equitable economic growth, whilst addressing the concerns of financial stability (Leightner and Lovell, 1998). However, with the greater emphasis on the growth objective since the liberalization process initiated in 1991-92 and following *intermediation approach*, three inputs, *viz*., deposit, borrowing and number of employees of the bank have been considered, while, on the output side, two variables, *viz*., investment and bank credit have been employed. In order to mitigate the price effects, the relevant variables have been deflated by a uniform GDP deflator. Accordingly, the cost of deposit, cost of borrowing and per employee establishment cost has been taken as the required input prices. Available studies in the Indian context reveal that PSBs have less technical efficiency and a substantial portion of the output forgone is the result of underutilization or wastage of resources (Das, 1997; Das, 1998).

Summing up the aforesaid discussion, in the present setup, GNPA, CAPITAL and INEFFICIENCY represent the three endogenous variables in each of the three equations. The model is closed by including exogenous variables that have explanatory power for each of the above exogenous variables. It is to these variables that we turn next.

The GNPA is expected to be related to the composition of the loan portfolio, since different asset categories have different default characteristics. Therefore, in the GNPA equation, we include the ratio of priority sector loans to total loans as a separate variable. Available data in the Indian context seem to suggest that, for the PSBs, the share of non-performing loans obtaining from priority sector declined from over 48 per cent in March 1996 to around 45 per cent in March 2001 (RBI, 2001). Since loans to priority sector have been prescribed not to exceed the Prime Lending Rate (the rate charged to the borrowers of the bank with highest rating), it remains to be examined whether higher priority sector loans lead to higher GNPA. The effect of loan growth on the quantity of bad loans is controlled by using the one-year loan growth rate (ADVGR). To allow for the possibility of a U-shaped relation between loan growth and bad loan, the square of loan growth term (ADVGRSQ) has also been included as a separate variable to explain bad loan. Finally, the effect of economic conditions on non-performing loans (*ceteris paribus*, non-

performing loans tend to be higher in bad times than in good times) is controlled using time effect dummies.

The level of capital is expected to be positively related to the profitability of the banking firm, owing to the plough back of earnings into reserves. This suggests the Return on Assets (RoA) as a plausible explanatory variable to explain CRAR. In addition, we control for the effect of bank size on capital, by including the natural logarithm of total assets (SIZE). In order to capture the effects of capital regulation, we include *regulatory pressure* variables, denoted by RPH and RPL. In particular, the focus is on the response of the PSBs to the 8 per cent risk-based capital standards. In other words, RPH and RPL signal the degree of regulatory pressure brought about by the risk-based capital standards on bank risk level and capital ratio. Specifically, the regulatory pressure variable equals the difference between the inverse of the bank's total risk-based capital ratio (CRAR) and the inverse of the regulatory minimum risk-based ratio of 8 per cent. Because banks with total risk-based capital ratios above and below the 8 per cent regulatory minimum may react differently, this study partitioned regulatory pressure into two variables: RPH and RPL. RPL equals (1/CRAR-1/8) for all banks with a total risk-based capital ratio less than 8 per cent, and zero otherwise. These banks are under considerable pressure to increase capital ratios. Therefore, RPL is expected have a positive effect on capital ratios, because one of the options available to banks to meet the prescribed capital standards is simply by raising capital[11].

A second regulatory pressure variable, RPH equals (1/8-1/CRAR) for all banks with total risk-based ratio greater than or equal to 8 per cent, zero otherwise. Although banks with risk-based capital ratios in excess of 8 per cent are not explicitly constrained by the prescribed capital standards, it might well happen that the risk-based standards induce them to reduce their ratios (the opportunity cost of holding additional capital might be high). Alternately, since banks must meet the minimum prescribed standards on a continuous basis, the risk-based capital standards may cause banks to increase their capital ratios (additional capital might act as a cushion for some loans migrating into non-performance). More importantly, higher capital ratios might act as a signaling device, both to the market and bank regulators, that these banks are in compliance and in the process, lead to a reduction in regulatory costs.

Finally, in the INEFFICIENCY equation, we control for the effect of loan growth on efficiency by introducing two loan growth variables, ADVGR and ADVGRSQ. To the extent that a low to moderate growth rate captures managerial quality, while a high growth rate reflects

[11]*For banks with risk based capital ratios less than 8 per cent, (1/CRAR-1/8) was positive. Therefore, a positive value implies that greater regulatory pressure, as measured by RPL, correspond to larger increases in the capital ratio. A similar argument can be applied for RPH.*

managerial entrenchment, the relation between growth and efficiency might be U-shaped. Finally, to control for the dominance of Government ownership of the state-owned banking system in India, we define a variable, DIVEST, which takes the value one for that year (and for all subsequent years), if a bank has made an equity issue in the particular year and zero, otherwise. In other words, DIVEST intends to ascertain whether the divestment of Government ownership in PSBs has had any influence on INEFFICIENCY. If, for example, the relationship is negative, then one might surmise that Government ownership tends to improve the efficiency of the banking sector. Reverse would be the case if the relationship is found to be positive.

Based on the aforesaid discussion, one can postulate a simultaneous equation system comprising of three linear equations, representing the empirical model to be estimated in the study. These equations are as under:

$$GNPA = f_1(CRAR, INEFF, PRIOL, ADVGR \quad ADVGRSQ, TIME\ EFFECT\ DUMMIES) \tag{1}$$

$$CAPITAL = f_2(GNPA, INEFF, RoA, RPL, RPH, \quad SIZE, TIME\ EFFECT\ DUMMIES) \tag{2}$$

$$INEFFICIENCY = f_3(GNPA, CRAR, ADVGR, ADVGRSQ, GOVT) \tag{3}$$

where,

GNPA=gross non-performing loan to gross advances;
CRAR=capital to risk-weighted asset ratio;
INEFF=estimate of firm-specific efficiency from the stochastic cost frontier;
PRIOL= ratio of loans given to priority sector to total loans;
ADVGR=annual growth rate of total loans;
ADVGRSQ=square of ADVGR;
RoA=return on asset (defined as net profit *to* total asset);
SIZE=natural logarithm of total assets;
DIEVST=Government ownership, defined as a dummy variable which equals 1 in the particular year (and all subsequent years) in which the bank has made an equity offering and zero, otherwise;
T=time effect dummy=one for year *t*, zero otherwise.

In equations (1) and (2), INEFFICIENCY tests the effects of operating performance on risk-taking. Under moral hazard hypothesis, inefficient firms run by entrenched management are postulated to be more prone to risk-taking due to the lower value of their charters. Hence, INEFFICIENCY is expected to have a positive effect on the amount of bad loans and a negative effect on the level of capital. However, under the hypothesis that inefficient firms are subject to stricter regulatory scrutiny and consequently, have less flexibility to pursue riskier activities,

INEFFICIENCY is expected to have a negative effect on GNPA and a positive effect on CAPITAL.

Equation (3) examines the effect of risk-taking on operating efficiency. Credit risk management involves controlling adverse selection problems by screening loan applicants as well as tackling moral hazard problems through closer and continuous loan monitoring. Depending on the efficacy of utilization of resources to manage the risk, the costs of controlling credit risk may increase with the level of risk exposure due to monitoring and hedging costs, implying a positive relation between GNPA and efficiency. On the contrary, if costs of credit risk management decrease with the level of risk exposure (for example, due to credit screening), the relationship between GNPA and INEFFICIENCY might well turn out to be positive.

3. Institutional Structure of the Indian Banking System

The commercial banking system comprises of the foreign banks operating in India, in addition to PSBs and those in the private sector. The two rounds of nationalization-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 - led to the creation of 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 state-owned, private or foreign, are regulated by the central bank, the Reserve Bank of India (RBI). A process of liberalization 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 market conditions 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 also sought to improve bank profitability by lowering pre-emptions (through reductions in the cash reserve and statutory liquidity ratios) 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. The reforms also sought to promote competition 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 different for different category of banks. While state-owned 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 was fixed at 32 per cent. These amounts, for both the state-owned/private and the foreign banks were inclusive of several sub-targets, the former comprising a sub-target of 18 per cent for agriculture, while the latter comprised a sub-target of 10 per cent for export and 10 per cent for small-scale industries.

Until 1991-92, all PSBs were fully owned by the Government. 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 11 PSBs accessed to capital market and raised an amount aggregating Rs.63 billion. The management of nationalized banks is under the purview of the Ministry of Finance of the Government, which has its representatives on the Board of Directors. The management of SBI, on the other hand, is under the Reserve Bank of India (RBI), the country's central bank, which has its representative on its Board of Directors. As observed in the Narasimham Committee Report (1991), such a move has seriously abridged the functional autonomy of these banks and constrained their free and fair functioning.

Evidence of competitive pressures on the Indian banking industry is evidenced from the decline in the five bank asset concentration ratio 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 2). 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-reforms era.

Table 2: Summary of the Banking Industry: 1990-91 to 1999-2000

Year /	1990-91			1995-96			2000-01		
Bank Group	PSB	Pvt.	Forgn.	PSB	Pvt.	Forgn.	PSB	Pvt.	Forgn.
No. of Banks	28	25	23	27	35	29	27	32	41
Total Deposits (D)	2087.3	94.3	84.5	3908.2	361.7	306.1	8593.8	1349.2	591.9
Total credit (C)	1305.7	49.5	50.6	2075.4	219.3	225.0	4146.3	672.1	429.9
C/D	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	240.4	10.4	15.3	536.7	71.8	74.99	1034.9	163.9	119.8

Amounts in Rs. billion; shares in percent
PSB. Public sector banks; Pvt. Private Sector banks; Forgn: Foreign banks

4. The Data Set and Variables

Yearly data on PSBs from 1992-93 through 1999-2000 is obtained from the various issues of *Statistical Tables Relating to Banks in India* and the *Report of Trend and Progress of Banking in India.* The reason for the choice of PSBs can be stated as follows. First, these banks

comprised between 85-90 per cent of the total assets of Scheduled Commercial Banks during this period. Second, the PSBs group is sufficiently heterogeneous in terms of geographical location of branches, product sophistication, technological orientation as well as their clientele base, so that a study of these banks suffices to extract broad inferences about the interrelation between risk and operating inefficiency for the banking sector in India. As it stands, there are 27 PSBs, comprising of the State Bank of India (SBI), in which the RBI is the majority shareholder, 7 associates of SBI (the majority holding being with SBI) and 19 nationalised banks (the majority holding being with RBI). The final sample therefore comprises of 27 PSBs for the period 1993-94 to 2000-2001. The choice of period is dictated by two facts. First, it roughly coincides with the onset of liberalization in 1991-92, wherein major changes were ushered in the financial sector as mentioned earlier. Secondly, owing to the construction of the one-year loan growth rate, the estimation period covers the years 1993-94 through 2000-01.

Summary statistics of the sample banking firms in each of the four size classes for the estimation period is reported in Table 3. In order to account for the heterogeneity *within* PSBs, the sample is broken down into three size classes, based on their total assets as at end-March 1993 (the first year of the sample period). The three size classes are defined as 'small', i.e., those with total assets less than or equal to Rs.100 billion; 'medium', i.e., those with assets exceeding Rs.100 billion, but less than or equal to Rs.150 billion; and finally, 'large', i.e., those with assets exceeding Rs.150 billion. This classification leaves us with an equal number of banks within each of the three categories. In addition, separating the sample firms into different size classes is also warranted by the exclusive focus on X-efficiency as a measure of operating efficiency. The size grouping enables to control variation in scale, technology and scope efficiencies across firms.[12]

On average, banks in the medium category tend to have relatively higher non-performing loans than those in the other two size classes, whereas capitalization, on average, tends to be highest in the small category. In contrast to findings in prior efficiency literature, there is a general trend that smaller firms, on average, have lower inefficiencies than larger firms. Of greater interest is the fact that small banks tend to have more priority sector loans than large/medium ones, with the latter making up the shortfall through other loans. Return on assets tend to be larger for smaller firms, attesting a negative relation between size and return on assets;

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[12] *The banks within each size class in alphabetical order are: 'Large' (Bank of Baroda, Bank of India, Canara Bank, Central Bank of India, Indian Overseas Bank, Punjab National Bank, State Bank of India, Syndicate Bank and Union Bank of India,); 'Medium' (Allahabad Bank, Andhra Bank, Bank of Maharashtra, Dena Bank, Indian Bank, State Bank of Hyderabad, State Bank of Patiala, United Bank of India and United Commercial Bank,) and 'Small' (Corporation Bank, Oriental Bank of Commerce, Punjab and Sind Bank, State Bank of Bikaner and Jaipur, State Bank of Indore, State Bank of Mysore, State Bank of Saurashtra, State Bank of Travancore and Vijaya Bank.*

the same is however negative for medium-sized firms. Interestingly, of the regulatory pressure variables, RPH tends to be higher for the smaller banks, whereas RPL is the highest for the medium sized banks. Since RPH is high for relatively undercapitalised banks, this would seem to suggest that a greater concentration of such banks in the 'small' category. A similar logic applies to the RPL variable.

Table 3: Summary Statistics: Mean Values of the Variables

Variable	Large	Medium	Small	All
ADVGR	13.595	12.79	18.427	14.937
PRIOL	34.943	36.259	38.845	36.682
TOTAL ASSET	10.443	9.382	8.832	9.552
ROA	0.029	-0.0507	0.326	-0.050
CRAR	8.571	6.850	9.556	8.326
GNPA	17.703	21.851	15.128	18.227
INEFF	53.619	31.941	18.644	34.735
RPL	0.111	0.179	0.039	0.109
RPH	0.019	0.015	0.023	0.019
N	81	81	81	243

5. Results and Discussion

The simultaneous equation system is fitted by pooled time-series, cross-Section observations using the two-stage least squares procedure separately for each size class using *STATA* software. The estimation[13] results for (1) to (3) are presented in Tables 4 through 6, respectively.

GNPA. The explanatory power for the GNPA equation in reasonably high, ranging from 28 to 67 per cent (Table 4). CRAR is uniformly found to have a significant and negative effect on asset quality, irrespective of bank size, with the absolute magnitude of the coefficient being highest for medium-sized banks. This implies that banks with relatively more capital (lower leverage) are less prone to credit risk. To the extent that greater financial leverage tends to have a positive effect on credit risk, the findings lend credence to the fact that the two types of risks tend to reinforce each other. Second, contrary to widely held belief, loans to priority sector do not seem to affect GNPA. Although the sign on the coefficient is consistently negative (except for small banks), the coefficient is not significant in any case. As observed earlier, loans to priority sector are subject to regulatory stipulation: banks have to advance of 40 per cent of their net demand and time liabilities to this sector; the shortfall having to be dovetailed to bonds of select financial institutions. Banks often end up holding back loans to priority sector (with high credit risk) and instead, invest the same in bonds of select financial institutions, with implicit

[13] *Instead of using traditional standard errors, the Huber/White/Sandwich robust standard errors have been reported.*

government guarantee (thereby minimizing the credit risk). Not surprisingly, therefore, priority sector loans do not necessarily lead to higher GNPA. The coefficient on ADVGR is negative and statistically significant for large as well as small banks, pointing to the fact that for these banks, loan growth has a negative effect on bad loans, possibly because of their superior credit risk management techniques. Juxtaposed with the fact that the coefficient on ADVGRSQ being negative for the small banks, this finding suggests that the relationship between non-performing loans and loan growth is U-shaped for this class of banks. While not statistically significant, for the entire gamut of PSBs, the coefficient on ADVGRSQ is negative. In other words, at a high loan growth rate, the amount of non-performing loans diminishes with loan growth. Higher loan growth rate is typically reflective of boom conditions in the economy. Under such circumstances, firms are able to repay their loans without default, so that the relationship between loan growth and GNPA is negative.

Table 4: Two-stage least-squares regression estimates of equation:
Dependent Variable-GNPA

Variable	Large	Medium	Small	All
INTERCEPT	33.316*	53.473	28.152*	29.525*
	(5.205)	(0.938)	(3.353)	(1.589)
CRAR	-1.014*	-1.657*	-0.841*	-1.144*
	(0.217)	(0.533)	(0.177)	(0.115)
INEFF	0.021	-0.244	-0.012	0.017
	(0.045)	(0.583)	(0.096)	(0.018)
PRIOL	-0.117	-0.315	0.017	-0.012
	(0.101)	(0.435)	(0.011)	(0.021)
ADVGR	-0.152*	0.212	-0.495*	-0.115***
	(0.097)	(0.235)	(0.199)	(0.071)
ADVGRSQ	-0.0004	-0.010*	0.007***	-0.002
	(0.003)	(0.006)	(0.004)	(0.001)
T	-0.452	-0.258	0.106	0.062
	(0.333)	(0.938)	(0.243)	(0.170)
R^2	0.672	0.284	0.480	0.554

Figures in brackets indicate robust standard errors.
*, ** and *** indicate significance at 1, 5 and 10 per cent.

CRAR. The explanatory power on capital equation is the highest among the three equations, with R^2 ranging from a low of 62 per cent for medium-sized banks to a high of 91 per cent for small banks. While the coefficient on GNPA is negative in the medium and small size classes, it is not statistically significant. For the PSBs as a whole, the coefficient is negative and statistically significant, reiterating the mutually reinforcing relation between credit risk and financial leverage. Bank size (SIZE) and CRAR tend to be negatively related for the PSBs as a

whole, attesting to the fact that there might be limited scale effects in bank operations. Finally, while capitalization is driven positively by RoA, it is significant at conventional levels only for medium-sized banks, attesting to the fact that these banks have been pro-active in transferring part of their profits into reserves to shore up their capital levels.[14]

Table 5: Two-stage least-squares regression estimates of equation:
Dependent Variable-CRAR

Variable	Large	Medium	Small	All
INTERCEPT	-23.668	7.340	21.176	39.049
	(32.732)	(22.503)	(20.509)	(30.429)
GNPA	0.008	-0.121	-0.147	-0.450***
	(0.252)	(0.154)	(0.186)	(0.265)
INEFF	-0.289	-0.181	0.094	0.214
	(0.348)	(0.215)	(0.139)	(0.217)
RoA	0.909	1.175**	0.574	0.256
	(0.716)	(0.598)	(0.422)	(0.639)
RPL	-1.692*	0.057	0.216	0.112
	(0.687)	(0.143)	(2.729)	(0.253)
RPH	97.046**	98.954*	158.712*	125.005*
	(42.968)	(29.790)	(15.059)	(14.762)
SIZE	4.998	0.947	-2.068	-3.935
	(5.733)	(3.341)	(2.602)	(4.14)
T	-1.245	-0.363	0.639	1.051
	(1.840)	(0.876)	(0.455)	(0.936)
Adjusted R^2	0.698	0.622	0.915	0.629

Figures in brackets indicate robust standard errors.
*, ** and *** indicate significance at 1, 5 and 10 per cent.

Of particular interest are the regulatory pressure variables, RPH and RPL. Since RPH captures banks with low capital adequacy, which does not meet the regulatory minimum risk-based standards, they should have a positive effect on capital ratios. In Table 5, the parameter estimate on RPH is positive and significant across all classes of banks. This would suggest that banks in the inadequately capitalized in all size-classes are under considerable regulatory pressure to increase their capital ratios. At the other end, as regards RPL, the coefficient is statistically significant only for the 'large' category banks, the magnitude of the coefficient being equal to –1.692. This would attest to the fact that the large, adequately capitalized banks tend to lower their capital ratios in response to regulatory pressure, possibly because of the high opportunity cost of holding excess capital.

[14] *The Banking Regulation Act, 1949, which is the bedrock of bank regulation in India, stipulates, vide Section 17 that every banking company incorporated in India transfer a sum equivalent to not less than 20 per cent of its disclosed profits to reserves created for the said purpose.*

INEFFICIENCY. The explanatory power of the INEFFICIENCY equation is the lowest among the three equations, with the R^2 ranging from a low of 9 per cent for large banks to a high of 47 per cent for medium banks. The coefficient on GNPA is positive and significant for the large banks as well as the PSBs as a whole. This tends to suggest that for the PSBs, in general, and the large banks in particular, operating inefficiency stems from managing additional bad assets, perhaps due to inadequate monitoring activities. Second, the coefficient on CRAR is positive and significant for large banks, whereas it is significant, but negative, for the small banks. This would testify that for the category of small banks, those with more capital operate more efficiently than those with less capital. The result is however, just the reverse for the large banks: more capital does not necessarily imply higher operating efficiency. There exists negative but insignificant relationship between loan growth and operating efficiency for any bank group whatsoever. Thus the growth in loan portfolio may not exert any significance influence on bank efficiency. Finally, coming to the critical issue of Government ownership, the results unambiguously support that, except for the medium sized banks, operating efficiency tends to improve with lower Government ownership. These results run contrary to the findings of Sarkar *et al.* (1998), who find that neither traded not non-traded private sector banks in India seem to have any comparative advantage in respect of operational efficiency *vis-à-vis* their state-owned counterparts, but supports more recent work by Caprio and Martinez Peria (2000) who find increased government ownership a deterrent to the development of the banking system.

Table 6: Two-stage least-squares regression estimates of equation:
Dependent Variable-INEFFICIENCY

Variable	Large	Medium	Small	All
INTERCEPT	-3.137	18.616	26.778 *	-15.679
	(21.773)	(25.207)	(10.689)	(23.995)
GNPA	2.177 *	0.712	0.168	2.125 *
	(0.755)	(0.783)	(0.335)	(0.792)
CRAR	1.795 ***	-0.158	-0.898 *	1.164
	(0.982)	(1.221)	(0.360)	(0.949)
ADVGR	-0.133	-0.221	-0.348	-0.073
	(0.479)	(0.268)	(0.295)	(0.318)
ADVGRSQ	0.009	0.007	0.008	0.004
	(0.012)	(0.009)	(0.005)	(0.007)
DIVEST	8.550 ***	-6.982 **	3.272 ***	9.582 **
	(3.843)	(3.351)	(1.976)	(3.954)
Adjusted R^2	0.096	0.475	0.254	0.122

Figures in brackets indicate robust standard errors.
*, ** and *** indicate significance at 1, 5 and 10 per cent.

6. Concluding remarks

In terms of policy implications, while efficiency is found to have a positive effect on credit risk in most cases, it also has a positive effect on bank capitalization. This supports the fact that poor performers are more prone to risk taking than high performing banking organizations, supporting the 'gamble for resurrection' argument (Dewartipont and Tirole, 1993). The positive effect of efficiency on capital is attributable to regulatory pressure, especially for banks which fall short of the prescribed minimum capital adequacy standards.

The purpose of the present article has been to understand the interrelationships among capital, risk-taking and operating efficiency in the state-owned banking system in India. Towards this end, the study utilized several periods of cross-Section data on PSBs in India to ascertain the interrelationships among risk, capital and efficiency. Finally, the analysis supports the fact that efficiency, capital and risk taking tend to be jointly determined, reinforcing and compensating each other.

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