

Research Article

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Ownership Structure, Size, and Banking System Fragility in India: An Application of Survival Analysis

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Abstract: The Reserve Bank of India has put 11 public sector banks under prompt corrective action and is planning to put three more where public sector banks constitute 68.9% of the total asset of the Indian banking industry based on 2018 figures; this raises a genuine concern for the financial health of the Indian banking sector as a whole. Under these considerations, this study is conducted to estimate the survival of banks based on ownership and size and uses the Cox proportional hazards model. This study has not found any significant difference in the failure risk of both public and private sector banks based on ownership. However, the study found a significant difference in the failure risk of banks based on size. The smaller banks are indeed at a higher risk of failure than larger banks. The findings of this study can be used to create an early warning system for smaller banks in India.

Keywords: ownership, size, survival analysis, financial indicators, hazards function

1 Introduction

The Reserve Bank of India (RBI)¹ has put 11 banks under prompt corrective action (PCA) out of 27 public sector banks (PSBs). Notably, Indian PSBs constitute 68.9% of

the total assets of the Indian banking industry as a whole, based on figures obtained from 2018. Further, it is indeed worrisome that RBI is planning to put three more PSBs under PCA. Generally, RBI initiates PCA proceedings for banks with a capital adequacy ratio below 9% or nonperforming assets (NPAs) above 10%. Acharya (2018) argued that PCA is an essential and important step taken by RBI to restore financial stability in the Indian banking system. A bank's capital is a critical indicator of loss absorption adequacy. Therefore, it becomes imperative for bank supervisors to intervene in weak banks before the capital is completely eroded. Notably, banks under PCA are restricted on dividend distribution, branch expansion, and management compensation.

Further, they are asked to infuse more capital by their owners/promoters in addition to higher provisioning requirements. In 2015, the Government of India (GOI), Ministry of Finance, announced the “Indradhanush” plan for revamping PSBs, a seven-part plan, suggested mainly by the “P J Nayak” committee. The seven-part plan includes appointments, bank board bureau, capitalization, de-stressing, empowerment, framework of accountability, and governance reforms (ABCDEFG).

In R. K. Talwar Memorial Lecture (2017), Dr Viral V. Acharya (Deputy Governor of RBI) had raised concerns about the unfinished agenda of restoring PSBs' health in India.² He pointed out that Indian banks' credit growth and transmission are weak. Moreover, their gross NPA ratios have been increasing at one end, while the growth in advances (% YoY) has been decreasing significantly in

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1 The Reserve Bank of India is India's central bank which controls the issue and supply of the Indian rupee. RBI is the regulator of the entire Banking in India. RBI plays an important part in the Development Strategy of the Government of India.

2 Acharya V. V., 2017. The Unfinished Agenda: Restoring Public Sector Bank Health in India. Speech delivered at the 8th RK Talwar Memorial Lecture organized by the Indian Institute of Banking and Finance (Available at URL https://rbi.org.in/Scripts/BS_SpeechesView.aspx).

the case of Indian PSBs from 2008 to 2018. The RBI has been taking constant steps to address the stressed assets problem of Indian banks by creating a Central Repository of Information on Large Credits, Asset Quality Review in 2015, Enactment of Insolvency, and Bankruptcy Code (IBC) for referring large aged NPA. In addition, it has asked the Government of India to infuse more capital to meet the recapitalization needs of PSBs. Based on RBI's recommendation, the Government of India announced a recapitalization package for PSBs in October 2018 of Rs. 2.11 trillion, comprising Rs. 1.53 trillion of government capital infusions and the balance raised from market funding by March 2019.

2 Indian Banking Structure

Indian financial system has scheduled commercial banks and cooperative banks. Scheduled commercial banks are further 27 in number for PSBs, 21 for private sector banks, 49 foreign banks, and 56 regional rural banks as per the financial year 2017 data. PSBs dominated Indian banks till 1990. Beginning from much-controlled environments such as restrictive entry, regulated interest rate, credit dispersal, and high reserve requirement, the Indian banking system has come a long way through various reforms that were introduced through recommendations of various expert committees formed at different periods. The most prominent reforms were the Narsimham Committee (1991) reforms that deregulated the interest rates and other issues like income recognition and disclosures transparency. These reforms have increased the competition of nationalized banks from private and foreign banks (Aßmuth, 2020; Kaur & Kaur, 2020). PSBs and private sector banks highly concentrate the Indian banking system; even though the number of private (foreign) banks is large, still foreign banks comprise only 5.7% of the total asset of the banking industry as per the estimates of 2007 (Table 1).

Considering the present state of the Indian banking industry, it would be useful to know the probability of bank failure or survival. This study proposes to use Cox proportional hazards model to estimate the survival of Indian banks, both ownership and size-wise. The study is organized as follows: Section 1 presents the introduction, Section 2 describes the Indian banking structure, Section 3 presents the literature review and develops hypotheses in accordance, Section 4 includes the methodology, Section 5 presents data description and descriptive statistics, Section 6 presents the empirical results, and finally, Section 7 presents conclusions and implications of the study.

Table 1: Ownership wise total assets of banks for the year 2017–2018 (amount in millions)

Banks	%	2017	%	2018
Foreign banks	6.2	8,144,577	5.7	8,095,272
Nationalized banks	47.3	62,064,503	45.3	64,124,272
Private sector banks	24.0	31,467,338	25.4	36,015,123
State Bank of India and its associates	22.6	29,616,465	23.5	33,231,911
Small finance banks	0.0		0.1	119,662
All scheduled commercial banks	100.0	131,292,882	100.0	141,586,239

Source: Statistical tables relating to banks in India (RBI website).

3 Literature Review and Hypothesis Development

To carry out the literature review, we followed step-wise filtering of literature search in three major reputed databases (ABI/INFORM, Science Direct, and Emerald) using keywords “Survival Analysis of firms” OR “Survival Analysis of Banks,” restricting the date range to 1991–2020. Notably, only research and review articles in journals have been considered for bibliometric and content analyses. First, in our bibliometric analysis, we have identified 998 articles from 1991 to 2020 based on the survival or failure of firms. These research articles are gathered from the Science Direct, Emerald, and ProQuest databases. Table 2 summarizes published articles, and Figure 1 shows the pattern of articles published by year on the survival of firms.

As it is evident from Figure 2, between 2004 and 2013, maximum articles were published on the survival of firms. Probably, this was the time when the market was more uncertain, and the risk was high for firms. The authors have formulated a word cloud for the title of the research articles using text mining as shown in Figure 2.

Table 2: Descriptive information about the research articles data collected from different sources

Publication years	1991–2020
Citation years	29 (1991–2020)
Papers	998
Citations	71,578
Citations/year	2468.21
Citations/paper	71.72
Authors/paper	2.80
h-index	120
G-index	256

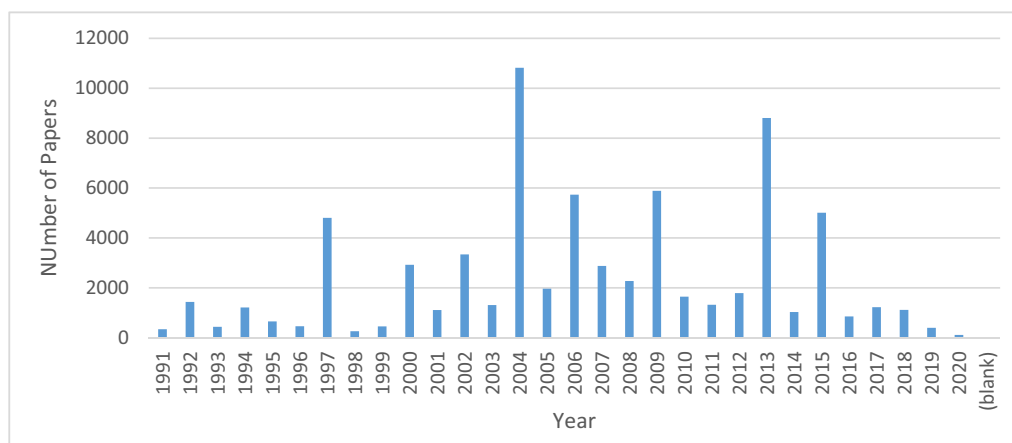


Figure 1: Number of articles published each year.

The word cloud of the abstract extracted from all 998 articles shows that most research articles represent the survival of either financial firms or banks globally. The top-12 most cited research papers based on search are listed in Table 3.

The literature section is classified into two parts: ownership versus bank stability and size versus bank stability.

3.1 Ownership and Bank Stability

PSBs dominated Indian banks till 1990. Acharya and Kulkarni (2010) found that performance-wise, profitability (net profit/assets) of private sector banks surpassed that of PSBs from 2005 to 2006, wherein the quality of assets (NPA/total assets) was lower for PSBs. However, after the financial crisis, PSBs outperformed private sector banks. The argument in favor of PSBs can be both implicit and explicit, whereby the government has been backing the

PSBs. Based on cross-country data, La Porta, Lopez-de-Silanes, and Shleifer (2002) found that higher government ownership of banks in the 1970s was associated with slower subsequent financial development and lower per capita income and productivity growth, thereby supporting “political” theories of the effects of government ownership of firms. Dewenter and Malatesta (2001) found that state-owned firms do display low profitability. Altunbas, Evans, and Molyneux (2001), based on the German banking market for 1989–1996, found that PSBs and mutual banks have a slight cost and profit advantage over their private-sector competitors. Bonin, Hasan, and Wachtel (2005), based on transition countries Bulgaria, Czech Republic, Croatia, Hungary, Poland, and Romania, found that government-owned banks are less efficient than privatized banks and foreign-owned banks. Sathye (2003), based on data from 1997 to 1998, found that PSBs were more efficient than the private sector and foreign commercial banks in India. Das and Ghosh (2006), based on data from 1992 to 2002, found that PSBs were more efficient than their private counterparts.

Cross-country findings of Caprio and Peria (2002) reported that nationalized banks are generally less efficient because of the requirement of pursuing multiple goals at the same time; for instance, in addition to profit maximization, it needs to encourage the employment of low-skilled workers, open branches in rural areas to promote job opportunities, and also focus on priority sector lending (i.e., being lent at below-market rates, yield a low return on advances). Kumbhakar and Sarkar (2003), based on data from 1985 to 1996, found that postderegulation of the Indian financial markets, private sector banks have improved their performance in terms of total factor productivity, but PSBs have not responded well to the deregulation measures. Beck, Demirgüç-Kunt, and

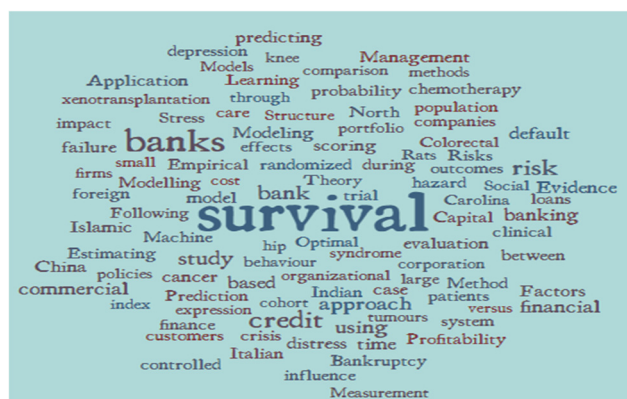


Figure 2: Word cloud of the abstract.

Table 3: Represents top-12 papers based on citation

Number of citation	Authors	Title
851	Wheelock and Wilson (2000)	Why do banks disappear? The determinants of US bank failures and acquisitions
254	Bellotti and Crook (2009)	Credit scoring with macroeconomic variables using survival analysis
154	Giovannetti, Ricchiuti, and Velucchi (2011)	Size, innovation, and internationalization: a survival analysis of Italian firms
134	Glennon and Nigro (2005)	Measuring the default risk of small business loans: a survival analysis approach
98	Evrensel (2008)	Banking crisis and financial structure: a survival-time analysis
96	Carlson (2004)	Are branch banks better survivors? Evidence from the depression era
94	Leung, Rigby, and Young (2003)	Entry of foreign banks in the People's Republic of China: a survival analysis
88	LeClere (2000)	The occurrence and timing of events: survival analysis applied to the study of financial distress
86	Halling and Hayden (2006)	Bank failure prediction: a two-step survival time approach
81	Pappas, Ongena, Izzeldin, and Fuertes (2017)	A survival analysis of Islamic and conventional banks

Maksimovic (2004), based on a dataset from 74 countries, found that restrictions on a bank's activities, including more government interference in the banking sector as a whole, coupled with a large share of government-owned banks in themselves, do increase the obstacles further for obtaining financing especially if the banks are largely more concentrated.

The Indian Bank Nationalization Act provides an explicit guarantee that the government would fulfill all obligations of PSBs in the event of a failure (Acharya & Kulkarni, 2010), which leads to our first hypothesis of the study.

H1. Public sector banks have a higher probability of survival than private sector banks

Even though the Indian banking sector has scheduled commercial banks consisting of public sector banks, private sector banks, and foreign banks, public sector banks and private sector banks contribute 94.4% of total assets under the banking industry (Bandick, 2020; Kaur & Bapat, 2021). Considering the percentage of assets represented by public and private sector banks, this study only focuses on these banks.

3.2 Size and Bank Stability

There are arguments both in favor and against whether the size increases or decreases financial fragility. Uhde and Heimeshoff (2009) found that larger banks in concentrated banking sectors reduce financial fragility through five channels that include

1. Large banks may increase profits, building up high "capital buffers," thereby making them more secure from liquidity and macroeconomic shocks.
2. Supervisory authorities find it easier to monitor large and fewer banks.
3. Large banks provide credit monitoring services.
4. Large banks have higher economies of both scale and scope, along with the potential to diversify loan portfolio risks efficiently and geographically through cross-border activities (Mirzaei, Moore, & Liu, 2013).

Arguments claiming that the banking sector increases financial fragility (Gavilá Alcalá, Maldonado García-Verdugo, & Marcelo Antuña, 2020; Giovannelli, Iannamorelli, Levy, & Orlandi, 2020; Uhde & Heimeshoff, 2009) are as follows:

1. Moral hazards because large banks are too big to fail (Mishkin, 1999).
2. Larger banks charge higher loan interests because of their market power; the borrower may be compelled to undertake risky projects to pay off the loans, which may, in turn, increase the risks of defaults.
3. Risk diversification in assets and liabilities may deteriorate in a concentrated banking market, causing high operational risk (Mirzaei et al., 2013).

De Haan and Poghosyan (2012), based on banks in the United States from 1995 to 2010 found that a bank's size typically reduces volatility with a nonlinear effect. In other words, when a bank's size exceeds a particular threshold, it is positively related to earnings volatility. Laeven, Ratnovski, and Tong (2014), based on data from 52 countries, found that larger banks, on average, create

more risks than smaller banks. On the basis of data from the EU banking sector for 2002–2011, Köhler (2015) reported that the bank size has a significant negative effect on bank stability, indicating that larger banks are generally less stable than smaller banks.

However, Altaee, Talo, and Adam (2013) have tested the stability of banks in the Gulf Cooperation Council (GCC) countries and found that the size (represented by total assets) has no statistically significant effect on a bank's stability. On the basis of ownership and size, Kaur and Kaur (2020) found that PSBs and larger private/international banks are more aggressive in substituting their noninterest income if there is a change in that front. However, Das and Ghosh (2006), based on the bank size, found that both small (assets up to Rs. 50 billion) and large banks (assets exceeding Rs. 200 billion) do witness the highest efficiency. Hence, there is no conclusive evidence on the effect of size on the stability of banks, especially in the context of developing markets like India, where one of the recommendations of the Narasimham Committee (1998) was to set up a three-tier banking structure. This comprises three large banks of international size, 8–10 national banks, and a large number of regional banks. This study looks to explore the impact of size (based on total asset) on bank stability with the following premise:

H2. Large banks have a higher probability of survival than smaller banks

4 Methodology

4.1 Survival Analysis and Censoring

Cox proportional hazards model has been used in this study to measure the survival of the banks. Interestingly, however, previous studies were based on discriminant analysis, binary logit model, or some conventional classification techniques. The survival analysis estimates the expected time-to-failure for an event, whereby the parameters are estimated using the partial maximum likelihood. The survival method deals with censored and complete lifetime data easily. The complete lifetime data, in turn, are very interesting because they imply that the survival analysis naturally controls for the fact that the observation period may not necessarily represent an entire lifetime. Further, because the models effectively exploit information on survival time, defined as the actual number of years, especially when a bank has been in business, left censoring is naturally

avoided. However, on the other hand, a bank could remain in business beyond the end time, known otherwise as “right censoring,” whereby the survival models are formulated to deal with the right-censored data explicitly.

Censoring generally is of two types, i.e., right and left. If an individual is followed up from a time of origin T_0 up to some later time point T_C and has not observed the event of interest, this is known as right censoring. This may occur due to an individual dropping out of a study even before the event of interest occurs. Left censoring is a situation in which an individual is known to have had the event before a specific time or a starting time, but that could be any time before the censoring time. The survival method aims to estimate survival times in different categories and inspect how much predictors affect the risk of events (Chart 1).

Banking failure studies through the survival analysis follow two strands; the first is a semi-parametric Cox proportional hazards model (Cox, 1972; Lane, Looney, & Wansley, 1986) that does not require any distributional assumption on the hazards function. Lane et al. (1986) applied this method to investigate the prediction of failure for US-based banks. Whalen (1991) and Wheelock and Wilson (2000) extended the study by Lane et al. (1986) in terms of the sample size. Yet, in another setting, Dabos and Sosa-Escudero (2004) examined the failure of Argentinean banks using the banks' accounting information. Caporale, Pittis, and Spagnolo (2006), Cole and Wu (2009, April), Gomez-Gonzalez and Kiefer (2009), Molina (2002), Platt and Platt (2002), and Whitaker (1999) also used the Cox model to assess conventional bank and corporate failures.

The second relies on a parametric survival model (Evrensel, 2008; Männasoo & Mayes, 2009; Sales & Tanuri-Pianto, 2007), which imposes several distributional assumptions (e.g., exponential, Weibull) over the hazards functions. Each of these studies accepts a different distribution for the baseline hazards that illustrate the potential misspecification problem. We use a Cox proportional hazards model, where $T \in [0, \infty)$ denotes the time-to-failure, which in itself is a random variable with the probability density function $f(t)$ and the cumulative density function $F(t)$ as follows:

$$f(t) = -dF(t)/dt, \quad (1)$$

$$F(t) = \Pr(T \leq t). \quad (2)$$

The survival function $S(t)$ gives the probability of survival for banks beyond year t under the condition that banks have survived until time t . Hazards rate $h(t)$ is an immediate risk of the disappearance in year t under the condition that banks have survived till time t . These two functions mathematically can be formalized as follows:

Types of survival analysis

Parametric:-

Many Assumptions:

Distribution of survival times follows a known probability distribution

Relevant Model: Maximum likelihood function

Semi-Parametric:-

Fewer Assumptions:

Survival times distribution is unknown but hazards follow some known distribution

Relevant Model: Cox Proportional Hazards regression model

Non Parametric:-

Fewest assumption:

Distribution of survival times and hazards are unknown.

Relevant Model: Kaplan Meier Model plus Log-rank test

Source: Klein et al., Eds. Handbook of survival analysis. CRC Press, 2016

Chart 1: Types of survival analysis. Source: Klein, Van Houwelingen, Ibrahim, and Scheike (2016).

$$S(t) = 1 - F(t) = \Pr(T > t), \quad (3)$$

$$h(t) = \lim_{dt \rightarrow 0} \frac{\Pr(t \leq T < t + dt)}{dt \times S(t)} = \frac{f(t)}{S(t)}. \quad (4)$$

Furthermore, the hazards rate that is always nonnegative gives a time-varying risk of a bank's failure. This study uses the unconditional Kaplan and Meier (1958) methods to estimate the survival function using data containing information on whether a bank has failed over the observation window, vis a vis the time when the bank's failure effectively occurred. The null hypothesis in the unconditional Kaplan and Meier (1958) estimator is the equality of the unconditional survival rates for the two bank types, whereby the significance is checked using a log-rank test statistic.

The Cox model is expressed by the hazards function $h(t)$ and can be interpreted as the risk of failure at time t . The mathematical form of Cox model can be written as follows:

$$h(t) = h_0(t) \exp \sum_{j=1}^p a_j y_j. \quad (5)$$

Here, t is the survival time, $h(t)$ is the hazards function estimated by p predictors $(y_1, y_2, \dots, y_p)$, and the coefficients $(a_1, a_2, \dots, a_p)$ measure the impact of predictors.

The term h_0 is called baseline hazards. It gives the value of the hazards when all the predictors are zero. The exponent of coefficients $(a_1, a_2, \dots, a_p)$ are called hazards ratios (HRs). A value of an estimated coefficient $(a_1, a_2, \dots, a_p)$ greater than zero or an HR greater than 1 shows that as the value of the j th predictor variable increases, the hazards increases, and thus, the length of survival time decreases. The Cox proportional hazards model assumes that the hazards curve for the groups of records should be proportional and

cannot cross. In this study, due to two types of predictors, time-dependent and time-independent predictors, we have used an advanced form of Cox proportional hazards model that deals with both, and its mathematical formulation is given as follows:

$$h(t, y, z(t)) = h_0(t) \exp \left(\left[\sum_{j=1}^p \beta_j y_j + \sum_{k=1}^q \delta_k z_k(t) \right] \right), \quad (6)$$

where $h(t|y, z(t))$ is the hazards rate.

The coefficients $\beta_1, \dots, \beta_{p1}$ and $\delta_1, \dots, \delta_q$ are estimated using the partial maximum likelihood. A value $\beta_j > 0$ indicates that by increasing the j th predictor variable, failure risk increases and survival time decreases. e^{β_j} is the hazards rate, and $100 \times (e^{\beta_j} - 1)$ gives the expected percentage increase in failure risk for one unit increase in the j th predictor variable.

4.2 Why Survival Analysis?

The first reason to use survival analysis is that it uses the actual time-to-failure as the primary observable variable. Herein, the survival functions give the probability of survival beyond a certain number of years, which could also help identify the determinants of the differential failure risk profiles associated with the two bank groups. The second reason is the presence of censoring data. In survival techniques, the inferences are based on surviving and failed banks, which could have started operating at different times, thereby eliminating any unaccounted for survivorship bias that earlier statistical methods like discriminant analysis or logit model suffer from. The third

Table 4: Descriptive statistics for private and public sector Indian banks over the period 2000–2018

Bank-specific variables	Definitions	Mean	Max	Min	Std. Dev.	N
Status	Survived (0) or failed (1)	0.03	1	0	0.16	838
Size	Total assets	0.62	1	0	0.49	825
Bank type	Public sector banks as 1 and private sector banks as 0	0.64	1	0	0.48	838
Profit after tax	Operating profits $\pm$ other incomes	8,268	145,496	-60,892	19,077	823
Total assets	Current assets + advances + investment + fixed assets + others	1,185,955	27,059,663	0.5	2,239,587	823
Total capital	Equity + reserves and surplus	4,371	45,739	0.5	5646.94	822
Deposits	Demand + saving + term deposits	952,140	20,447,514	866	1,725,551	814
Loans and advances	Loans and advances	705,731	15,710,784	763	1,381,711	821
Return on assets	Net profit/total assets	0.85	4.46	-6.5	0.81	794
Gross tier-I capital	Shareholder's fund plus perpetual, noncumulative preference shares as a percentage of risk-weighted assets and off-balance sheet risks	79710.38	434042.7	0	87351.47	190
Return on net worth	Net profit/net worth	12.37	64.18	-392.33	24.93	814
Net interest revenue	Gross interest and dividend income minus total interest expense	29703.24	625,481	-14063.9	58665.92	821
Other operating income	Any other sustainable income that is related to the company's core business	103652.6	2075392.8	79.5	187286.5	822
Overheads	Personnel expenses and other operating expenses	61682.34	1139568.9	34.3	105937.9	821
LLR/loans ratio	Loan loss reserve/loan ratio	0.04	0.52	0	0.04	670
Total capital/asset ratio	Total capital/asset ratio	0.01	0.95	-50.6	1.77	823
Total capital/net loans	Total capital/net loans	0.15	11.43	-0.12	0.45	821
Total capital/deposits	Total capital/deposits	0.1	11.68	-0.06	0.43	814
Total capital/liability ratio	Total capital/liability ratio	0.11	19.86	-0.98	0.77	823
Net loan/asset ratio	Net loan/asset ratio	0.54	0.74	0	0.11	823
Net interest margin	Net interest income expressed as a percentage of earning assets	0.03	0.68	0	0.04	814
Cost/income ratio	Cost/income ratio	1.64	22.75	0.92	0.78	821
Z-score	(Return on assets (ROA) + equity/asset)/ σ (return on assets)	2.29	11.46	-3.27	2.05	792
Microeconomics variables						
Inflation CPI	Inflation at the consumer price index	6.92	14.97	2.23	3.24	675
GDP at market prices	Gross domestic product at market price	71,389	151,837	25,363	39,582	675
GDP growth	GDP growth	0.13	0.2	0	0.04	675
Market structure variables						
C3 all	Percentage of total assets held by the big three banks of total assets of the banking industry	0.25	0.32	0	0.11	675
C5 all	Percentage of total assets held by the big five banks of total assets of the banking industry	0.33	0.41	0	0.14	675

reason is that it does not impose any distributional condition concerning the baseline hazards function.

5 Data Description and Descriptive Statistics

Considering that approximately 94% of total assets are covered by public³ and private⁴ sector banks in India (Table 1), this study focuses on data collected from 2000 to 2018 for public and private sector banks in India from the Reserve Bank of India's website (RBI, 2018). The target variable in the Cox model is the time a bank takes to fail after its inception. Herein, the variable equals zero for the surviving banks in all the sample years. A bank generally fails (Pappas *et al.*, 2017) when any conditions such as bankruptcy, dissolution, negative assets, merger, or acquisition occur.

Table 4 provides descriptive statistics for the variables considered for this study. The study is based on 56 Indian banks (i.e., both public and private) and covers 2000–2018. All quantitative variables except ratios are in a million. As it is clear from Table 4, the standard deviation of variables and ratios are high, indicating the significant difference in bank profiles. For a basic comparison of the banks, we summarize the descriptive statistics of their accounting profile in Table 5, from columns I–VI. The statistics shown in columns I and II indicate that PSBs are bigger than private sector banks in terms of total assets (1,448,182 million against 723,978 million), equity (82,287 million against 71,079 million), and net interest revenue (34,236 million against 21,662 million). Importantly, in a country like India, PSBs capture 70% of the banking assets compared to private banks, which comprise only 25% of banking assets as of 2018 (Table 1).

In columns III and IV, we have compared the accounting profiles of both small and big banks. The difference between both is noticeable from the total assets (236,517 million against 1,768,470 million), equity (19,007 million against 114,769), and loans (172,875 million against 1,149,979 million). In columns V and VI of Table 5, the comparison is made between surviving and failed banks. In terms of size and turnover, the failed banks are significantly smaller than the surviving banks. The equity and net income for failed banks are 15,946 and 2066, while for surviving banks, the equity and net income are 95,788 and 1,435,595, respectively.

Moreover, the financial position of failed banks is significantly worse when compared to the surviving banks (−0.01 against 0.06). Hence, the critical conditions for the failed banks show up in their accounting information. Overall, this table indicates that the surviving banks have a stronger financial profile than the failed banks.

Table 6 represents the correlation between various features used in the survival model, and it is evident that some of them have a statistically significant correlation, while some have insignificant. We have classified banks into smaller and bigger banks using the medians of their asset distributions and denoted by size (0, 1), where 1 represents bigger banks, and 0 represents smaller banks. The explanation of all the above features are presented in Table 4.

6 Empirical Results

6.1 Survival Function Estimates (Unconditional)

The dependent variable in the first survival estimate (Figure 3) is the observed failure event: the failure indicator is a binary dummy variable that takes the value one in the year immediately before the actual failure and zero else. This variable equals zero for the surviving banks in all of the sample years. The independent variable in the first unconditional survival model (baseline of the model) is the *Bank_Type* that is equal to one in the case of public sector banks and zero in the case of private banks.

Figure 3 represents the unconditional survival function to test the hypothesis of equal survival rates for public and private sector banks using the Kaplan–Meier estimator. Figure 3 also shows 95% confidence interval bands of banks' survival for 18 years. The survival rate is 70% for private banks and 63% for public sector banks beyond 18 years. Notably, the 95% confidence interval for survival overlaps, and a log-rank *p*-value of 0.44 shows no statistically significant difference in the survival of private sector banks versus public sector banks. Furthermore, since the Indian regulatory system is proactive, it may be a primary reason why we have not found any statistically significant difference in the failure risk of both public and private banks owner-wise.

The dependent variable in the second unconditional survival estimate (Figure 4) is the observed failure event as in the first case, but the independent variable is the bank size (bigger and smaller) equal to one in the case of bigger banks and zero in the case of smaller banks. Later, we have used bank-specific variables, macroeconomic variables, and market structure variables to estimate the banks' survival guided by the literature.

³ Public Sector Banks (PSBs) is a major type of bank in India, where a majority stake (i.e. more than 50%) is held by a government.

⁴ Private Sector banks are those where the majority of the shares or equity are not held by the government but by private shareholders.

Table 5: Descriptive statistics of accounting profiles of public versus private banks, smaller versus bigger banks, and survived versus failed banks

	I	II	III	IV	V	VI
Variables	Public	Private	Smaller	Bigger	Survive	Fail
Number of banks	33	24	25	32	36	21
Profit after tax	7,684	9,297	2,250	11,984***	10017.56	2,066***
Total assets	1,448,182	723,978***	236,517	1,768,470***	1,435,595	300,492**
Return on net worth	13	11	7.9	15***	0.92	0.58***
Equity	82,287	71,079**	19,007	114,769***	95,788	15,946***
Liabilities	1,365,895	652,898***	217,509	1,656,742***	1339806.8	284545.6***
Total provision	40,188	13,710***	4,325	44,010***	35391.59	6,797***
Loans	1,003,488	484,460***	172,875	1,149,979***	935,094	246,853***
Net interest revenue	34,236	21,662***	6,605	43,855***	35,929	7686.814 ***
Other operating income	123,634	68,330***	22,893	153,304***	125,046	27,887***
Growth overheads	0.31	0.20***	0.25	0.30***	74,247	17,252***
LLR/loans ratio	0.04	0.03**	0.04	0.04***	0.03	0.04
Equity/asset ratio	0.06	-0.08	-0.09	0.06	-0.01	0.06
Equity/net loans	0.14	0.16	0.21	0.10***	0.13	0.21
Equity/deposits	0.09	0.12	0.16	0.07**	0.09	0.14
Equity/liability ratio	0.08	0.15	0.18	0.06**	0.1	0.12
Net loan/asset ratio	0.54	0.53	0.52	0.55***	0.55	0.49
Net interest margin	0.03	0.04***	0.04	0.04***	0.03	0.03
Cost/income ratio	1.62	1.67**	1.7	1.6	1.61	1.72
Z-score	1.75	3.25***	2.49	2.2**	2.34	2.13**
Inflation CPI	6.98	6.79	6.74	7	6.98	6.6
C3 all	0.25	0.25	0.24	0.26	0.26	0.22***
GDP growth	0.13	0.13	0.123	0.13	0.13	0.12

***, **, and * imply significance at 1, 5, and 10%, respectively.

Here, size = 0 indicates a smaller bank, and size = 1 is a bigger bank. To check whether the bank size matters in the survival of banks, we classify all banks into small and large using the medians of their asset distributions. We check the hypothesis of equal survival rates for both small and bigger banks. Figure 4 shows the unconditional survival function $S(t)$, $t = 1 \dots 18$ years estimated using the Kaplan–Meier model. The 95% confidence interval band shows that the survival of larger banks is significantly different from smaller banks, as indicated from the non-overlap of confidence intervals. The same conclusion may also be supported by the log-rank p -value of 0.0017. Therefore, the survival probabilities are approximately 50% for smaller banks and 90% for bigger banks beyond 18 years.

6.2 Survivor Function Estimates (Conditional)

As discussed in Section 6.1, the dependent variable in the survival model is the time, a bank takes to fail after its inception. The main independent variable of interest is size, a dummy variable that takes the value one in the

case of bigger banks and zero for smaller banks. Further, we have also considered bank-specific, macroeconomic, and market structure variables based on previous studies as follows.

Bank-specific variables: The study conducted by Lane et al. (1986) provides evidence that accounting information such as capital ratios, earnings, and liquidity is an essential feature in predicting the banks' failure. Another study conducted by Männasoo and Mayes (2009) shows that high leverage levels and operating costs are significantly connected with a higher threat of bank failure. We have included information from the balance sheet and the income statement in also the survival model. Overall, the set of variables included in the survival model is broader than those used in the previous studies, allowing us to capture the failure risk more precisely. We have shown a list of bank-specific variables in Table 4, the profile comparison in Table 5, and the correlation between them in Table 6.

Macroeconomic variables: Demirgüç-Kunt and Detragiache (1998) and Männasoo and Mayes (2009) have shown that economic downturns affect banks' financial stability. Motivated by the outcome of these two studies, we have included real GDP growth and inflation as

Table 6: The Correlation coefficients of various features listed in Table 4

Variables	Size	Profit after tax	Return on assets	Gross Tier I capital	Return on net worth	Net interest revenue	Overheads	LLR loans ratio	Equity asset ratio	Equity net loans	Equity liab ratio	Netloanasset ratio	Net interest margin	Costincome ratio	Z score
Size	1	0.21**	0.073	0.013	0.10*	0.21**	0.32**	0.037	0.34**	0.31**	0.34***	0.05	0.058	0.149	0.077
Profit after tax	0.21**	1	0.25**	0.68**	0.13*	0.81***	0.7**	0.19*	0.02	-0.02	-0.01	0.23**	0.04	0.05	0.12*
Return on assets	0.073	0.25**	1	0.03	0.67**	0.02	-0.1	-0.36**	0.25**	0.06	0.05	0.08	0.27**	0.15**	0.64***
Gross Tier I capital	0.013	0.68**	0.03	1	-0.03	0.95***	0.88***	0.23**	-0.01	-0.05	-0.02	0.09	0.24**	0.36**	-0.06
Return on net worth	0.10*	0.13*	0.67**	-0.03	1	-0.01	-0.1	-0.27**	0.03	0.01	0	0.01	0.06	0.2**	0.39***
Net interest revenue	0.21**	0.81***	0.02	0.95***	-0.01	1	0.96***	-0.01	0.02	-0.03	-0.01	0.27**	0.01	0.01	0.1
Overheads	0.32**	0.7**	-0.07	0.88***	-0.05	0.96***	1	0.01	-0.01	-0.05	-0.02	0.32**	-0.04	-0.04	-0.01
Total capital asset ratio	0.08**	-0.24**	-0.014	0.01	0.10**	0.20**	-0.01	0.012*	0.01	0.03	0.02	0.023	0.09	0.12**	0.17**
Total capital liability ratio	0.023	0.012	0.014	-0.01	-0.23**	0.01	0.043	-0.17**	0.021	0.23**	-0.09*	0.011	0.01	0.09	0.12**
LLR loans ratio	0.037	0.19*	-0.36**	0.23**	-0.27**	-0.01	0.01	1	-0.03	0.13**	-0.02	-0.42**	-0.04	-0.02	-0.27**
Equityasset ratio	0.34**	0.02	0.25**	-0.01	0.03	0.02	0	-0.03	1	0.8**	0.07	0.17**	0.61**	0.65**	0.08
Equitynet loans	0.31**	-0.02	0.06	-0.05	0.01	-0.03	-0.1	0.13**	0.8**	1	0.94***	-0.27**	0.5**	0.86***	0.01
Equity liab ratio	0.34***	-0.01	0.05	-0.02	0	-0.01	0	-0.02	0.07	0.94***	1	-0.22**	0.51**	0.95***	-0.03
Net loan asset ratio	0.05	0.23**	0.08	0.09	0.01	0.27**	0.32**	-0.42**	0.17**	-0.27**	-0.22**	1	-0.05	-0.18**	0.07
Net interest margin	0.058	0.04	0.27**	0.24**	0.06	0.01	0	-0.04	0.61**	0.5**	0.51**	-0.05	1	0.56**	0.13*
Cost income ratio	0.1	0.05	0.15**	0.36**	0.2**	0.01	0	-0.02	0.65**	0.86***	0.95***	-0.18**	0.56**	1	0.09
Z score	0.077	0.12*	0.64***	-0.06	0.39***	0.1	0	-0.27**	0.08	0.01	-0.03	0.07	0.13*	0.09	1

***, **, and * imply significance at 1, 5, and 10%, respectively.

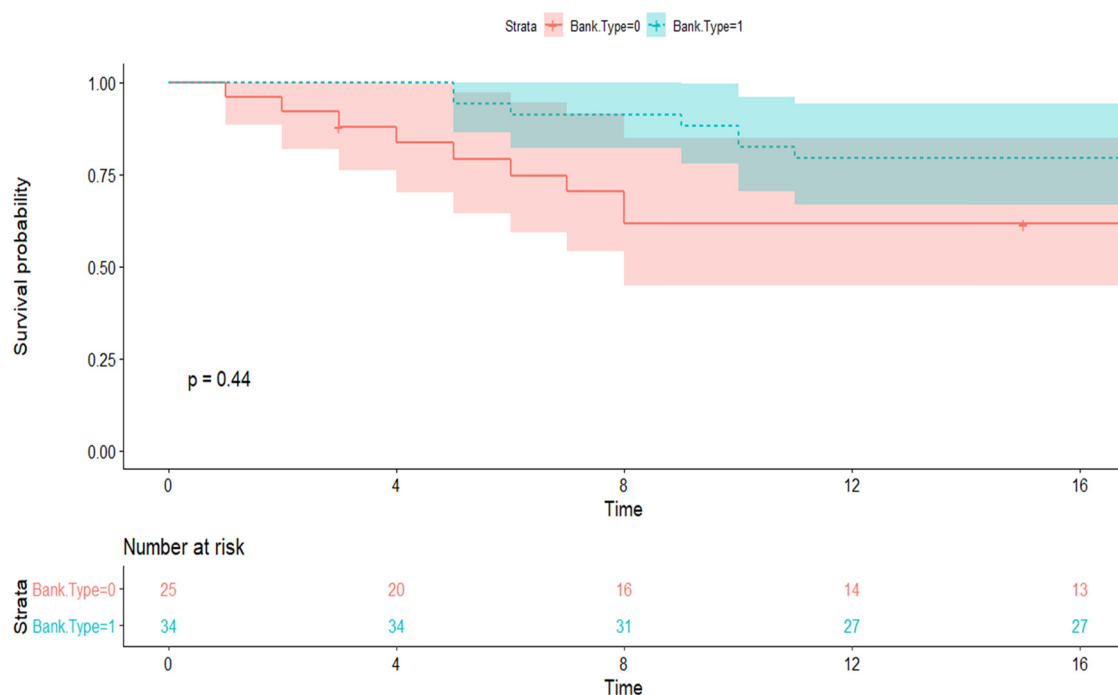


Figure 3: Unconditional survivor function estimates for Bank_Type (public and private sector banks) (Bank_type = 0 indicates private bank and Bank_type = 1 public sector banks.).

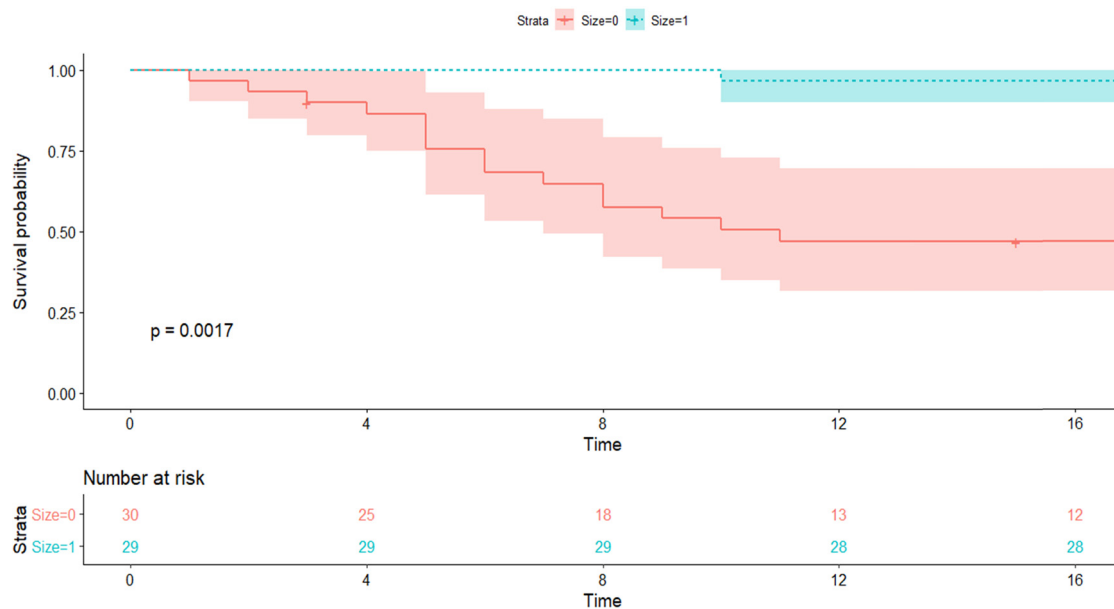


Figure 4: Unconditional survivor function estimates for bigger and smaller banks.

macroeconomic variables in the survival model. The descriptive statistics of macroeconomic variable is given in Table 4 and profile comparison in Table 5.

Market structure variables: A study conducted by Mishkin (1999) shows that a more concentrated banking

atmosphere increases the chance of failure risk. Allen and Gale (2004) resist that larger profits in more concentrated banking sectors moderate the banks' risk-taking behavior. Matutes and Vives (2000) and Beck et al. (2006) show that intense banking competition increases

the chance of bank failure. This study has taken C3_All (percentage of total assets held by the big three banks of the total banking industry assets) as an independent market structure feature in the survival model.

The dependent variable and the complete set of independent variables considered for the survival model are listed in Table 4.

The survival model is presented as follows:

$$\begin{aligned} \log(h(t, a_i, b_i)) = & \log(h_0(t)) + a_0 * \text{Size} \\ & + a_1 * \text{Profit after tax} + a_2 * \text{Return on assests} \\ & + a_3 * \text{Return on net worth} \\ & + a_4 * \text{Net interest revenue} \\ & + a_5 * \frac{\text{LLR}}{\text{Loan ratio}} + a_6 * \frac{\text{Total capital}}{\text{Asset ratio}} \\ & + a_7 * \frac{\text{Total Capital}}{\text{Net loans}} + a_8 * \frac{\text{Total capital}}{\text{Deposits}} \\ & + a_9 * \frac{\text{Total capital}}{\text{Liability ratio}} + a_{10} * \frac{\text{Net loans}}{\text{Asset ratio}} \\ & + a_{11} * \text{Net interest margin} \\ & + a_{12} * \frac{\text{Cost}}{\text{Income ratio}} \\ & + a_{13} * \text{Z score} + b_1 * \text{Inflation CPI} \\ & + b_2 * \text{GDP growth} + b_3 * \text{C3 all.} \end{aligned} \quad (7)$$

Here, the coefficient “ a_i ” variables are time dependent and take the different values for different banks in the same year. The coefficients “ b_i ” variables are time independent, and the values are the same for all banks in the same year. We have used the iterative process to formulate the statistically significant model. The likelihood-ratio test, Wald test, and score log-rank statistics are the three methods to check the significance of the survival model. These three methods are asymptotically equivalent. For large enough N , they will give similar results. For small N , they may differ somewhat. The likelihood-ratio test shows better behavior for small sample sizes, so it is generally preferred. The highly correlated features (Table 6) may inflate the value of coefficients, and to avoid this, this analysis applies the selection of conditioning factors based on a backward approach. After including all combinations of independent features given in equation 7, we have selected only those that offer the model’s global statistical significance. (The p -value of the likelihood-ratio test is less than 0.5) (Cox, 1972; Shrivastav, 2019; Shrivastav & Ramudu, 2020.) The final output of the survival model is given in Table 7. The p -value of all these three tests is less than 0.05, indicating that the overall model is statistically significant.

The value of R^2 without covariates is 0.38 and with covariates is 0.36. In the multivariate Cox analysis, the covariates size (bigger or smaller), Z-score, net interest margin, and

Table 7: Conditional survivor function estimates

Parameter	Parameter estimate	Standard error	Pr > Chi-sq.
Size	−1.89**	0.74	0.0103
Cost income ratio (cost/income ratio)	−0.53	0.13	0.7098
Profit after tax	−0.52**	0.43	0.028
Equity assets ratio (equity/asset ratio)	5.29	4.94	0.2844
Net interest margin	−3.26**	0.14	0.028
Z-score	−0.64**	0.22	0.0038

Testing the global null hypothesis: alpha = 0

Test	Chi-sq.	Pr > chi-sq.
Likelihood-ratio	26.19	0.005
Score	54.05	<0.0001
Wald	27.92	0.0002
PH test (chi-square)	1.37	—

Criterion	Without covariates	With covariates
−2logΛ	136.008	109.818
AIC	136.008	123.818
SBC	136.008	130.051
R^2	0.38	0.36

***, **, and * imply significance at 1, 5, and 10%, respectively.

profit after tax are statistically significant in the model, as p -values are less than 0.05. However, the other remaining covariates are not significant, as the p -value is greater than 0.05. The negative coefficient of the size indicates that smaller banks’ survival is less than bigger banks, and the same result is obtained with the Kaplan–Meier method (Figure 4).

The coefficient estimate of the size variable is −1.89, and the hazards rate of size is exponential (−1.89) or 0.17. The expected hazards rate is 0.17 times lower in bigger banks as opposed to smaller banks or bigger bank reduces the hazards by a factor of 0.17 or 83%, holding other predictive variables constant, and so, the bigger banks have a survival probability higher than the smaller ones, a result that confirms our hypothesis 2. The negative sign of the Z-score indicates that as the Z-score increases, the survival probability of the bank increases. The coefficient estimate of the Z-score is −0.64, with a hazards rate of 0.53. Holding the other covariates constant, increasing one unit of Z-score decreases the hazards by a factor of 0.53 or 47%. The cox survival model has a proportionality assumption, and it is tested and depicted in Table 8.

From Table 8, it can be seen that the proportionality test is not statistically significant for each of the covariates (p -value is greater than 0.05) and the global test is also not statistically significant. Therefore, the model

Table 8: Results for the test of proportionality

Variables	Rho	Chi-sq.	p
Size	0.716	0.5811	0.59
Z-score	0.415	0.803	0.6
Net interest margin	−0.397	0.973	0.324
Profit after tax	0.605	0.4301	0.381
Global	NA	2.84	0.45

satisfies the assumption of the proportional hazards for the cox model.

7 Conclusions and Implication of the Study

The unconditional survival functions based on the non-parametric Kaplan–Meier model indicate that the failure risk of smaller banks is significantly higher than the bigger banks. We have not observed any statistically significant difference in survival between private and public sector banks. Hence, this study rejects the first hypothesis that public sector banks have a higher probability of survival and accepts the second hypothesis that large banks have a higher probability of survival than smaller banks. The conditional survival function, estimated using the advanced Cox model, which includes the size as a predictor variable, shows that smaller banks have higher hazards than bigger ones. From Table 7 and based on the aforementioned discussion, it is evident that if all the predictor variables are constant except size, bigger banks reduce the chance of failure by 83% with respect to smaller banks. Furthermore, our study found a statistically significant relationship between the failure of banks and their accounting information such as the Z-score, net interest margin, and profit after tax, which in turn may prove helpful to quantify the financial stress of banks.

It has been found that overall bank credit growth and transmissions are weak in Indian Banks. In R. K. Talwar Memorial Lecture (2017), Dr. Viral V Acharya (Deputy Governor, Reserve Bank of India) raised concerns about the unfinished agenda of restoring Public Sector banks' health in India.⁵ He pointed out that gross NPA ratios are increasing on the one side, and the growth in advances

(% YoY) is decreasing for public sector banks in India for 2008–2017. The study conducted by Kaur and Kaur (2019) based on data from 2005 to 2018 found no significant difference in essential parameters of public sector banks with or without PCA. This study highlights the concern that the overall health of public sector banks needs attention rather than a few, and there is a problem of “Too-many-to-fail” rather than “Too-big-to-Fail” in the Indian Banking Industry. During the 2008 financial crisis, it was thought that the Indian banking system was shielded from the global financial crisis owing to heavy public ownership and conservative management. It was a surprise for the bank management to see the high deposit in some banks, especially toward the public sector banks in India. Later, it was realized that the people had shifted their money into the large public sector banks for security reasons. They were under the impression that the smaller and private banks may face a financial crisis in the future (Mohan, 2008). This study also verifies the reason for shifting the money to bigger banks from smaller banks, and probably, the fear of depositors was right during the global crisis (Subbarao, 2009). The financial crisis has affected not only the United States but also the European Union and Asia. The crisis has also impacted the Indian economic system to some extent. It is difficult to quantify the impact of the crisis on India. It is felt that certain sectors of the economy would be affected by the spillover effects of the financial crisis.

The study helps to carry out comparative analyses of the survival of banks. It has significant implications for the decisions of various stakeholders such as shareholders, management of the banks, analysts, and policy-makers. This study also indicates that the design and implementation of early warning systems for bank failure should distinguish the different risk profiles of the banks based on the size and ownership.

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⁵ Acharya V. V., 2017. The Unfinished Agenda: Restoring Public Sector Bank Health in India. speech delivered at the 8th RK Talwar Memorial Lecture organized by the Indian Institute of

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