Economics

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. The 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 that there is 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; Hazard 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 that have a capital adequacy ratio below 9%, or non-performing assets (NPA) above 10%. Acharya (2018) argued that PCA is an essential and important step by RBI to restore financial stability in the Indian banking system. A bank's capital is a critical indicator of loss absorption adequacy, and therefore, it becomes imperative for bank supervisors to intervene in weak banks much before the capital is completely eroded. Importantly, 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, which is a seven-part plan, mostly suggested 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).

[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.

In R.K. Talwar Memorial Lecture (2017), Dr. Viral V Acharya (Deputy Governor, RBI) raised concerns about the unfinished agenda of restoring PSBs' health in India.[2] He pointed out that India's banks' credit growth and transmission are weak. Moreover, their gross NPA ratios have been increasing at one end, while growth in advances (%YoY) has been decreasing especially in 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 (CRILC, 2014), Asset Quality Review in 2015, Enactment of Insolvency and Bankruptcy Code (IBC) for referring large, aged NPA. Additionally, it has asked GOI to infuse more capital to meet the recapitalization needs of PSBs.

Based on RBI's recommendation, the GOI has 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 to be raised from market funding by March 2019. The Indian banking system is highly concentrated by PSBs and private sector banks; 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). Furthermore, some of the PSBs include large banks like the SBI group, while there are some smaller banks based on total assets under management (AUM).

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

	%	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)

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 function to estimate the survival rate of Indian banks both ownership and size-wise. The study is organized as follows: Section-2 covers the literature review and develops hypotheses in accordance. Section-3 covers the methodology, section-4 contains data description and descriptive statistics, section-5 presents the empirical results, and finally section-6 covers conclusions and implications of the study.

2. Literature Review and Hypothesis Development

To carry out our 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.

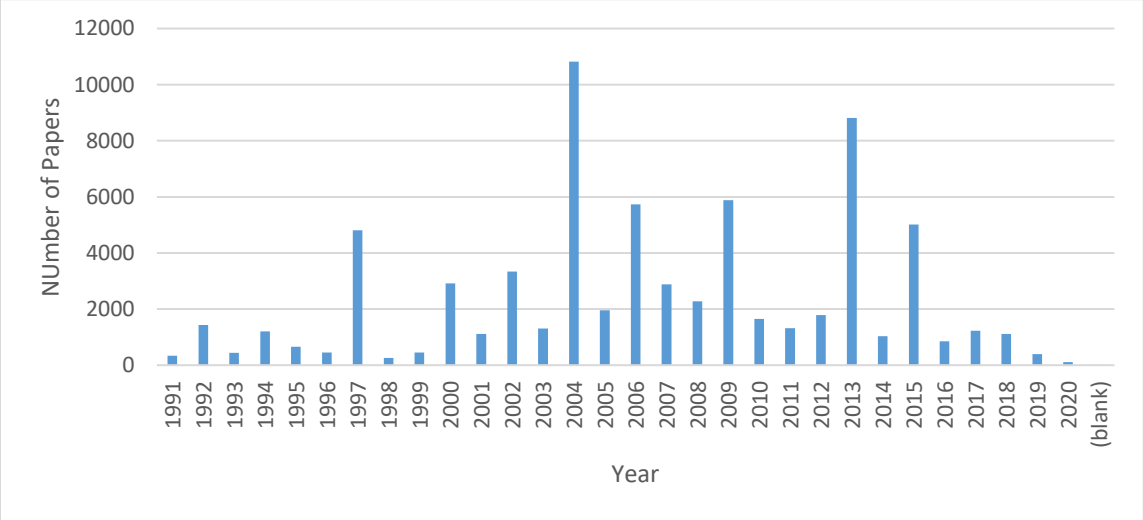
[2] Acharya, V.V., 2017. The Unfinished Agenda: Restoring Public Sector Bank Health in India. Speech delivered at the 8th RK Talwar Memorial Lecture organized by the Indian Institute of Banking and Finance at Hotel Trident, Mumbai (Available at URL https://rbi. org. in/Scripts/BS_SpeechesView. aspx).

Notably, only research and review articles in journals have been considered for bibliometric and content analysis. First, in our bibliometric analysis, we have identified total 998 articles from 1991 to 2020 based on the survival or failure of firms and these research articles are gathered from the Science Direct, Emerald, and ProQuest databases. Table-2 gives a summary of the data set and figure-1 gives the number of articles published by year on the survival of firms.

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

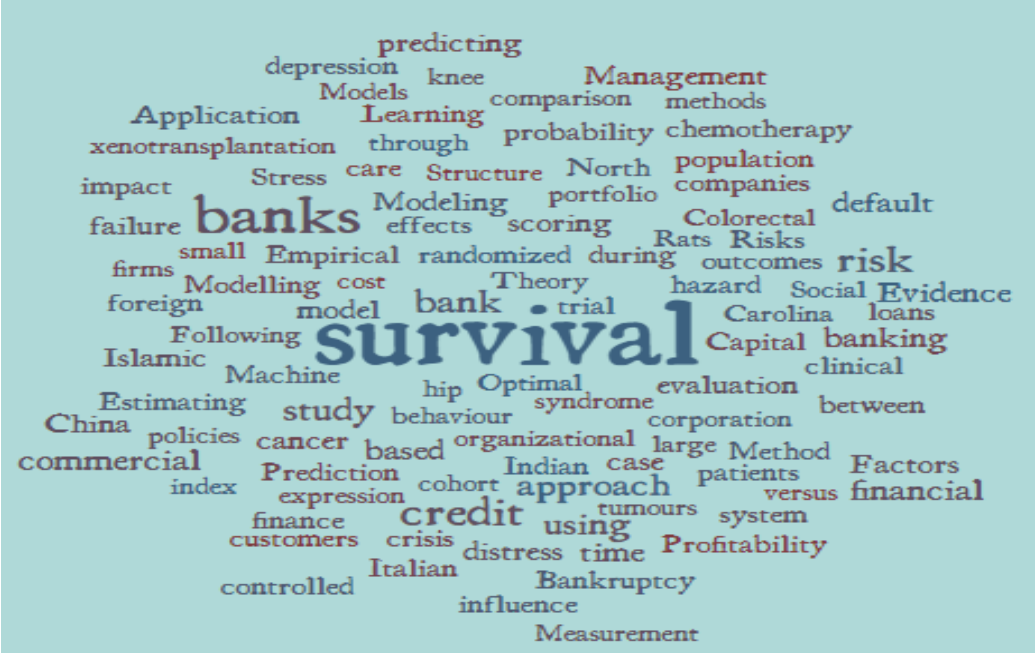
Publication years	1991–2020
Citation years	29 (1991–2020)
Papers	998
Citations	71578
Citations/year	2468.21
Citations/paper	71.72
Authors/paper	2.80
h-index	120
G-index	256

Figure 1: Number of articles published each year



As it is obvious from figure-2 that the between 2014-2013, maximum articles were published on the survival of firms. Prorably this was the time when the market was more uncertain and risk was high for firms. The authors have formulated a word cloud for the title of the research articles using text mining and given below:

Figure-2 Word cloud of abstract



The word cloud of the abstract extracted from all 998 articles shows that most of the 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.

Table-3 represents top-12 papers based on citation

Number of citation	Authors	Title
851	DC Wheelock, PW Wilson (Wheelock & Wilson, 2000)	Why do banks disappear? The determinants of US bank failures and acquisitions
254	T Bellotti, J Crook (Bellotti & Crook, 2009).)	Credit scoring with macroeconomic variables using survival analysis
154	G Giovannetti, G Ricchiuti, M Velucchi (Giovannetti et al., 2011)	Size, innovation and internationalization: a survival analysis of Italian firms
134	D Glennon, P Nigro (Glennon & Nigro, 2005)	Measuring the default risk of small business loans: A survival analysis approach
98	AY Evrensel (Evrensel,2008)	Banking crisis and financial structure: A survival-time analysis
96	M Carlson (Carlson, 2004)	Are branch banks better survivors? Evidence from the depression era
94	MK Leung, D Rigby, T Young (Leung et al. 2003)	Entry of foreign banks in the People's Republic of China: a survival analysis

88	MJ LeClere (LeClere, 2000)	The occurrence and timing of events: Survival analysis applied to the study of financial distress
86	M Halling, E Hayden (Halling & Hayden, 2006)	Bank failure prediction: a two-step survival time approach
81	V Pappas, S Ongena, M Izzeldin (Pappas et al. 2017)	A survival analysis of Islamic and conventional banks

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

2.1 Ownership and bank stability

Indian banks till 1990 were dominated by PSBs. 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, post the financial crises during that period, 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. La Porta et al.,(2002) based on cross-country data found that higher government ownership of banks in the 1970s was associated with slower subsequent financial development and lower growth of per capita income and productivity supporting thereby 'political' theories of the effects of government ownership of firms. Dewenter and Malatesta (2001) found that state-owned firms do display inferior profitability.

Altunbas, Evans, and Molyneux (2001), based on the German banking market for the period 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, namely, Bulgaria, the 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 post-deregulation 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 et al., (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 all obligations of PSBs would be fulfilled by the government in the event of a failure (Acharya and Kulkarni, 2010). This leads to our first hypothesis of the study.

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

2.2 Size and bank stability

With respect to size, there are arguments both in favor and against whether size increases or decreases financial fragility. Uhde and Heimeshoff (2009) found that larger banks in concentrated banking sectors decrease financial fragility through five channels that include

1. Large banks that 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 et al., 2013).

Arguments claiming that the banking sector increases financial fragility (Uhde and Heimeshoff, 2009) are as follows:

1. Moral hazard problem, 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 be able 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 US from 1995 to 2010, found that a bank's size typically reduces volatility with a non-linear effect. In other words, when a bank's size exceeds a particular threshold, it is positively related to earnings volatility. Laeven et al. (2014), based on data from 52 countries, found that larger banks, on average, create more risks than smaller banks. Based on data from the EU banking sector for the period 2002–2011, Köhler (2015) reported that bank size does have a significant negative effect on bank stability, indicating thereby that larger banks are generally less stable than smaller banks.

However, Altaee et al. (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. Based on the ownership and size, Kaur and Kaur (2019) found that PSBs and larger private/international banks are more aggressive in substituting their non-interest income if there is a change in that front. However, Das and Ghosh (2006), based on banks' 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 does not seem to be any 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 of 3 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

3. Methodology

3.1 Survival analysis, censoring, and types of survival analysis

Cox proportional hazards technique has been used in this study. Interestingly, however, previous studies were based on discriminate 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 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 tend to exploit information on survival time, effectively defined as the actual number of years, especially in case, a bank has been in business, wherein 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 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 the analysis of survival times in different categories and inspecting, by how much some predictors affect the risk of events.

Chart 1: Types of survival analysis

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 Hazard regression model
	Non Parametric:- **Fewest assumption:** Distribution of survival times & hazard is not known. **Relevant Model:** Kaplan Meier Model plus Log-rank test

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

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

The second relies on a parametric survival model (Evrensel, 2008; Männasoo and Mayes, 2009; Sales and Tannuri-Pianto, 2007), which imposes several distributional assumptions (e.g. exponential, Weibull, etc.) over the hazard functions. Each of these studies accepts a different distribution for the baseline hazard that illustrates the potential problem of misspecification.
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 (PDF), $f(t)$, and the Cumulative Density Function (CDF); F(t)is given as below:

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

$$F(t) = \mathrm{P_r}(T \le t) \qquad (2)$$

The survival function $S(t)$ gives the probability of surviving for banks beyond year t under the condition that banks have survived until time t. Hazard 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 below:

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

$$h(t) = \lim it_{dt \to 0} \frac{\Pr(t \le T < t + dt)}{dt \times S(t)} = \frac{f(t)}{S(t)} \qquad (4)$$

Furthermore, the hazard rate that is always non-negative 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 hazard 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:

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

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

The term h_0 is called baseline hazard. It gives the value of the hazard when all the predictors are zero. The exponent of coefficients $(a_1, a_2, ..., a_p)$ are called hazard ratios (HRs). A value of an estimated coefficient $(a_1, a_2, ..., a_p)$ greater than zero, or an HR greater than 1, shows that as the value of the j^{th} predictor variables increases, the hazard increases, and thus the length of survival time decreases. The assumption on the Cox proportional hazard model is that the hazard 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, we have used an advanced form of Cox proportional hazard model that deals with both, and its mathematical formulation is given as

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

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

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

3.2 Why survival analysis?

The first reason to use survival analysis is that it uses the actual time-to-failure as the main observable variable. Herein, the survival functions give the probability of survival beyond a certain number of years which could also help in identifying 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, all of which could have started operating at different points in time, eliminating thereby any unaccounted for survivorship bias that earlier statistical methods like discriminant analysis or logit model suffer from the same. The third reason is that it does not impose any distributional condition concerning the baseline hazard function.

4. Data Description and Descriptive Statistics

Considering that approximately 94% of total assets are covered by public[3] and private[4] sector banks in India (Table-1), this study focuses on data collected from 2000 to 2018 for both public and private sector banks in India from the Reserve Bank of India's website (RBI 2019). 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 of these conditions such as bankruptcy, dissolution, negative assets, merger, or acquisition occurs.

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

Bank-specific variables		**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 ± other incomes	8268	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	4371	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

[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] India are banks where the majority of the shares or equity are not held by the government but by private shareholders.

Gross tier-I capital	Shareholder's fund plus perpetual, non-cumulative 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 which 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

Table-4 gives descriptive statistics for the variables considered for the study. The study is based on 56 Indian banks (i.e. both public and private) and covers the period from 2000 to 2018. All quantitative variables except ratios are in million. As it is clear from Table-4, the standard deviation of variables and ratios are high, indicating the large 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 as 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 are characterized by a stronger financial profile than the failed banks.

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	7684	9297	2250	11,984***	10017.56	2066***
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***	4325	44,010***	35391.59	6797***
Loans	1,003,488	484,460***	172,875	1,149,979***	935,094	246,853***
Net interest revenue	34,236	21,662***	6605	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

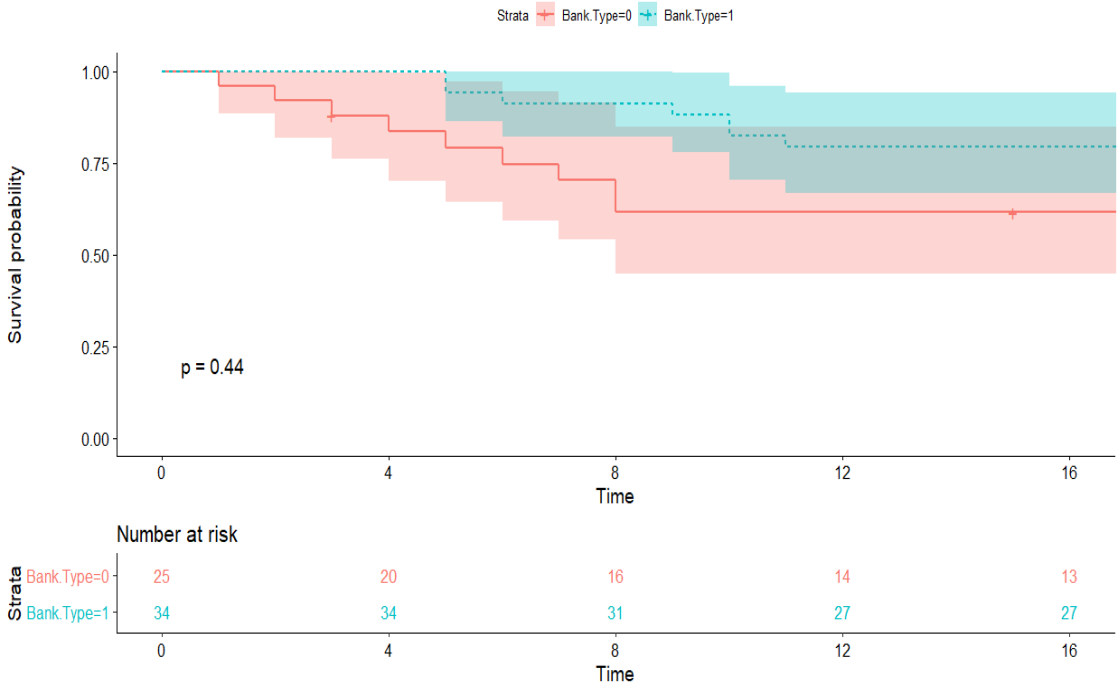
***, **, and * imply significance at 1%, 5%, and 10%, respectively

5. Empirical Results

5.1 Survival function estimates (unconditional)

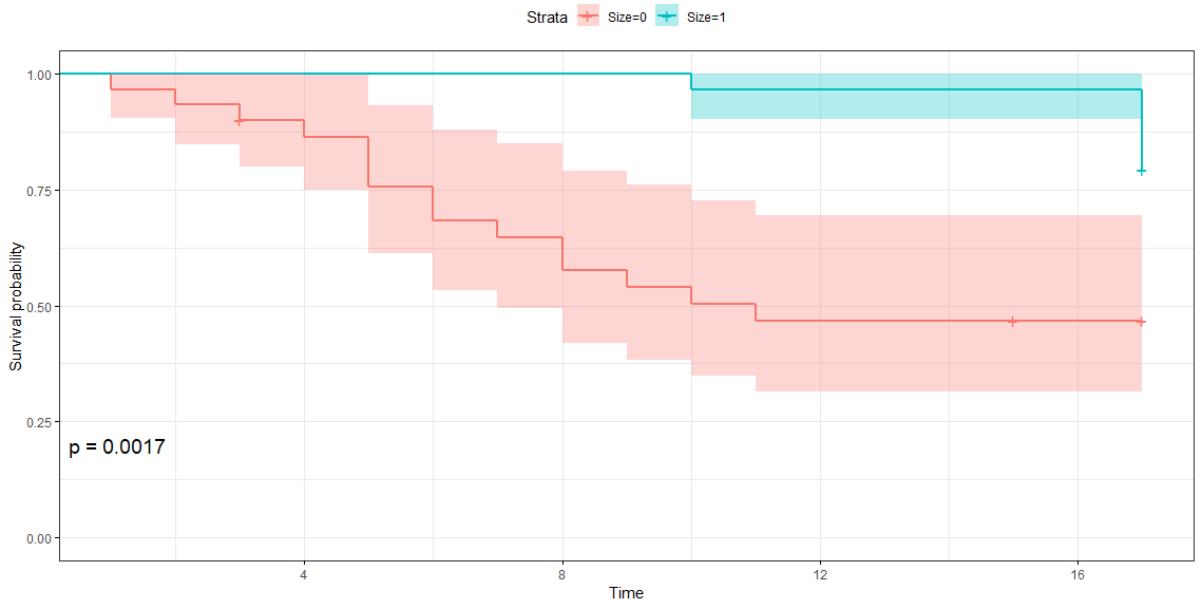
Figure-3 represents the unconditional survival function to test the hypothesis of equal survival rates for public sector and private sector banks using Kaplan–Meier estimator. Figure-3 also shows 95% confidence interval bands of banks survival for 18 years. The survival rates are 70% for private banks, and 63% for public sector banks beyond 18 years. Importantly, the 95% confidence interval for survival overlaps, and a log-rank p-value of 0.44 shows that there is 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 as to why we have not found any statistically significant difference in the failure risk of both public and private banks.

Figure-3: Unconditional survivor function estimates for public and private sector banks



Bank_type = 0 indicates private bank and Bank_type = 1 government banks. From figure-3, it is clear that there is no statistically significant difference in the survival of private and government banks as the p-value is .44.

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



Size = 0 indicates smaller bank and size = 1 is bigger bank. From figure-4, it clear that there is a statistically significant difference in the survival of smaller and bigger banks as the p-value is .0017. 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 small and bigger bank both. Figure-4 shows the unconditional survival function $S(t)$, t = 1 ... 18 years estimated using 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. The survival probabilities, therefore, are approximately 50% for smaller banks, and 90% for bigger banks beyond 18 years.

5.2 Survivor function estimates (conditional)

The output of the Cox survival model based on the income statement, balance sheet variables, financial ratios, and country-specific variables for larger versus smaller banks are given in Table-6. In this analysis, the selection of conditioning factors is based on the forward and backward approach and comparing the individual significance (likelihood-ratio test) and overall goodness of fit according to the Akaike information criterion (AIC). The Wald test is used for the joint significance of all variables in this analysis.

Table-6: Conditional survivor function estimates

Parameter	Parameter estimate	Standard error	Pr > Chi-sq.
Size	–1.89**	0.74	0.0103
Cost/income ratio	–0.53	0.13	0.7098
Profit after tax	–0.52**	0.43	0.028
Equity/assets 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	
–2λογΛ	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

The R^2 is the McFadden goodness-of-fit criterion. The output gives p-values for three alternative tests – the likelihood-ratio test, the Wald test, and score log-rank test for the overall significance

of the 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 has better behavior for small sample sizes, so it is generally preferred. The p-value of all these three tests is less than 0.05, which in turn indicates 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 Z-score, net interest margin, and profit after tax are statistically significant in the model, as p-values are less than 0.05. However, the other remaining covariates are not as significant, as the p-value is greater than 0.05. The negative coefficient of the size indicates that the survival of smaller banks is less in comparison to 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 p-value is 0.0103. The HR of size is exponential (−1.89) or 0.17. The hazard rate (HR) of predictive variables is interpretable as the multiplicative effects of the hazard. The expected hazard is 0.17 times higher in bigger banks as opposed to smaller banks, holding other predictive variables constant. If all the predictor variables are constant except size, bigger banks do reduce the hazard by a factor of 0.17, or 83%. 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 an HR (exponential (–0.64)) or 0.53. Holding the other covariates constant, increasing one unit of Z-score decreases the hazard by a factor of 0.53, or 47%. The assumption of the Cox model is proportionality and we have tested the proportionality of the model as a whole and is given in Table-7 below:

Table-7: 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

From Table-7, 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 satisfies the assumption of the proportional hazards for cox model.

6. Conclusions and Implication of the study

The unconditional survival functions based on the nonparametric 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 sector banks and PSBs. Hence, this study rejects the first hypothesis that PSBs have a higher probability of survival, and rather accept the second hypothesis that large banks do have a higher probability of survival than smaller banks. The conditional survival function estimated using the advanced Cox model, which includes size as a predictor variable, also shows that smaller banks do have higher hazards than bigger banks. From table-7 and above discussion it is obvious 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 useful to quantify the financial distress of banks as shown in Table-7.

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 cautious management. It was a surprise for the bank management to see the high deposit in some of the banks, especially towards the public sector banks in India. Later it was realized that the people have shifted their money into the large public sector banks for security reasons and 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 in bigger banks from smaller banks and probably the fear of depositors was right during the global crisis (Subbarao, 2009). The financial crisis has not only affected the USA but also the European Union and Asia. The Indian Economy system has also been impacted by the crisis to some extend. 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 financial firms and has significant implications for their decisions of various stakeholders such as shareholders, management of the banks, analysts, and policymakers. This study also indicates that the design and implementation of early warning systems for bank failure should distinguish the various distinct risk profiles of the banks based on size and ownership.

References

1. Acharya, V. V. (2018), "Prompt Corrective Action: An Essential Element of Financial Stability Framework", *Current Statistics*, Vol. *67*, pp.1.

2. Acharya, V.V. and Kulkarni, N., (2010), "State Ownership and Systemic Risk: Evidence from the Indian financial sector during 2007–09", *Unpublished paper, NYU–Stern, New York.*

3. Altaee, H.H.A., Talo, I.M.A. and Adam, M.H.M., (2013), "Testing the financial stability of banks in GCC countries: Pre and post-financial crisis", *International Journal of Business and Social Research*, Vol. *3 No.* 4, pp. 93-105.

4. Altunbas, Y., Evans, L. and Molyneux, P., (2001), "Bank ownership and efficiency", *Journal of Money, Credit and Banking*, pp. 926-954.

5. Beck, T., Demirgüç-Kunt, A. and Maksimovic, V., (2004), "Bank competition and access to finance: International evidence", *Journal of Money, Credit and Banking*, pp. 627-648.

6. Bellotti, T., & Crook, J. (2009). Credit scoring with macroeconomic variables using survival analysis. *Journal of the Operational Research Society*, *60*(12), 1699-1707.

7. Bonin, J.P., Hasan, I. and Wachtel, P., (2005), "Privatization matters: Bank efficiency in transition countries", *Journal of Banking & Finance,* Vol *29 No.* (8-9), pp. 2155-2178.

8. Caporale, G.M., Pittis, N. and Spagnolo, N., 2006. Volatility transmission and financial crises. *Journal of economics and finance*, *30*(3), pp.376-390.

9. Caprio, G. and Peria, M.S.M., (2002), "Avoiding disaster: policies to reduce the risk of banking crises", *Monetary policy and exchange rate regimes: Options for the Middle East,* pp. 193-230.

10. Carlson, M. (2004). Are branch banks better survivors? Evidence from the depression era. *Economic Inquiry*, *42*(1), 111-126.

11. Cole, R.A. and Wu, Q., (2009), April. "Predicting bank failures using a simple dynamic hazard model", In *22nd Australasian Finance and Banking Conference,* pp. 16-18.

12. Cox, D. R. (1972), "Regression models and life-tables", *Journal of the Royal Statistical Society: Series B (Methodological),* Vol *34* No. 2, pp.187-202.

13. Dabos, M., & Sosa-Escudero, W. (2004), "Explaining and predicting bank failure using duration models: The case of Argentina after the Mexican crisis", *Revista de Análisis Económico,* Vol *19 No.* 1.

14. Das, A., & Ghosh, S. (2006), "Financial deregulation and efficiency: An empirical analysis of Indian banks during the post reform period", *Review of Financial Economics,* Vol *15 No.* 3, pp. 193-221.

15. De Haan, J., & Poghosyan, T. (2012), "Size and earnings volatility of US bank holding companies", *Journal of Banking & Finance,* Vol *36 No.* 11, pp. 3008-3016.

16. Dewenter, K. L., & Malatesta, P. H. (2001), "State-owned and privately owned firms: An empirical analysis of profitability, leverage, and labor intensity", *American Economic Review,* Vol *91 No.* 1, pp. 320-334.

17. Evrensel, A. Y. (2008), "Banking crisis and financial structure: A survival-time analysis", *International Review of Economics & Finance,* Vol *17 No.* 4, pp. 589-602.

18. Giovannetti, G., Ricchiuti, G., & Velucchi, M. (2011). Size, innovation and internationalization: a survival analysis of Italian firms. *Applied Economics*, *43*(12), 1511-1520.

19. Glennon, D., & Nigro, P. (2005). Measuring the default risk of small business loans: A survival analysis approach. *Journal of Money, Credit and Banking*, 923-947.

20. Gomez-Gonzalez, J. E., & Kiefer, N. M. (2009), "Bank failure: Evidence from the Colombian financial crisis", *The international journal of business and finance research*, Vol *3* No.2, pp.15-31.

21. Halling, M., & Hayden, E. (2006). Bank failure prediction: a two-step survival time approach. *Available at SSRN 904255*.

22. Kaplan, E.L. and Meier, P., (1958), "Nonparametric estimation from incomplete observations", *Journal of the American statistical association*, Vol *53* No.282, pp. 457-481.

23. Kaur N, Kaur P. (2020), "Ownership structure, size, and interest income substitution by banks: An exploratory study in the Indian context", Australian Economic Paper, Vol 59 No.3, pp. 279–301.

24. Klein, J.P., Van Houwelingen, H.C., Ibrahim, J.G. and Scheike, T.H. eds., (2016), *Handbook of survival analysis*. CRC Press.

25. Köhler, M., (2015), "Which banks are more risky? The impact of business models on bank stability", *Journal of Financial Stability*, Vol *16*, pp. 195-212.

26. Kumbhakar, S. C., & Sarkar, S. (2003), "Deregulation, ownership, and productivity growth in the banking industry: evidence from India", *Journal of Money, Credit and Banking*, pp. 403-424.

27. La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2002), "Government ownership of banks", *The Journal of Finance*, Vol *57* No. 1, pp. 265-301.

28. Laeven, M. L., Ratnovski, L., & Tong, H. (2014), "*Bank size and systemic risk* (No. 14)", International Monetary Fund.

29. Lane, W. R., Looney, S. W., & Wansley, J. W. (1986), "An application of the Cox proportional hazards model to bank failure", *Journal of Banking & Finance*, Vol. *10 No.* 4, pp. 511-531.

30. LeClere, M. J. (2000). The occurrence and timing of events: Survival analysis applied to the study of financial distress. *Journal of Accounting Literature*, *19*, 158.

31. Leung, M. K., Rigby, D., & Young, T. (2003). Entry of foreign banks in the People's Republic of China: a survival analysis. *Applied Economics*, *35*(1), 21-31.

32. Männasoo, K., & Mayes, D. G. (2009), "Explaining bank distress in Eastern European transition economies", *Journal of Banking & Finance*, Vol. *33* No 2, pp. 244-253.

33. Mirzaei, A., Moore, T., & Liu, G. (2013), "Does market structure matter on banks' profitability and stability? Emerging vs. advanced economies", *Journal of Banking & Finance*, Vol *37* No 8, pp. 2920-2937.

34. Mishkin, F. S. (1999), "Financial consolidation: Dangers and opportunities", *Journal of Banking & Finance*, Vol *23*(2-4), pp. 675-691.

35. Mohan, R. (2008). Global financial crisis and key risks: impact on India and Asia. *RBI Bulletin*, 2003-2022.

36. Molina, C. A. (2002), "Predicting bank failures using a hazard model: the Venezuelan banking crisis", *Emerging markets review*, Vol *3 No* 1, pp. 31-50.

37. Narasimham, M. (1998). Report of the committee on banking sector reforms. *Government of India*.

38. Pappas, V., Ongena, S., Izzeldin, M., & Fuertes, A. M. (2017), "A survival analysis of Islamic and conventional banks", *Journal of Financial Services Research*, Vol *51* No. 2, pp. 221-256.

39. Platt, H.D. and Platt, M.B., 2002. Predicting corporate financial distress: reflections on choice-based sample bias. *Journal of economics and finance*, *26*(2), pp.184-199.

40. RBI (2018), Statistical Tables relating to Banks in India, available at https://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications

41. Sales, A. S., & Tannuri-Pianto, M. (2007), "Identification of monetary policy shocks in the Brazilian market for bank reserves", *Banco Central do Brasil WPS*, pp. *154*.

42. Sathye, M. (2003), "The efficiency of banks in a developing economy: The case of India", *European journal of operational research*, Vol *148 No.* 3, pp. 662-671.

43. Subbarao, D. (2009, February). Impact of the global financial crisis on India: Collateral damage and response. In *Speech delivered at the Symposium on The Global Economic Crisis and Challenges for the Asian Economy in a Changing World. Organized by the Institute for International Monetary Affairs, Tokyo* (Vol. 18).

44. Uhde, A., & Heimeshoff, U. (2009), "Consolidation in banking and financial stability in Europe: Empirical evidence", *Journal of Banking & Finance*, Vol *3 No* 7, pp. 1299-1311.

45. Whalen, G. (1991), "A proportional hazards model of bank failure: an examination of its usefulness as an early warning tool", *Economic Review*, Vol *2 No.*1, pp. 21-31.

46. Wheelock, D. C., & Wilson, P. W. (2000), "Why do banks disappear? The determinants of US bank failures and acquisitions", *Review of Economics and Statistics*, Vol *82 No.*1, pp. 127-138.

47. Whitaker, R.B., 1999. The early stages of financial distress. *Journal of Economics and Finance*, *23*(2), pp.123-132.