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ORIGINAL ARTICLE

Credit Risk Capital Estimation Under IRB Approach for Banks in India

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Abstract In this paper, an attempt is made to estimate credit risk capital charge for public sector and private sector banks in India for the period from 2007–2008 to 2013–2014 under advanced internal rating based (AIRB) approach using Basel risk weight formula. The analysis brings out that credit risk capital charges would be higher for the banks with high default risk and recovery risk and vice-versa. The inter-sector comparison indicates that a substantial proportion of the overall additional capital requirement for credit risk would falls on the public sector banks. Hence, banks in this sector requires improvement in appraisal system and loan recovery mechanism to reduce burden of additional credit risk capital charges and for better-quality performance on risk adjusted basis.

Keywords Basel II · Credit loss estimation · Systematic risk · Credit portfolio risk · Risk based capital

JEL Classification G21 · G31 · G32 · O16

Introduction

Risk-taking is intrinsic to banking business. The management of each back, on one hand, is concerned with the sufficient return for the risk that it assumes (i.e. risk adjusted return on capital—RAROC) and the regulator world-wide, on the other hand, focuses on extent of risk-taking by the banks, in such a way, that it should not jeopardize their safety and soundness. To address these concerns about the effect of risk taking

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on bank's soundness, the Basel Committee on Banking Supervision (BCBS) released guidelines on New Capital Framework (also referred as Basel II) in June 1999. Basel II provides a range of options for determining the capital requirements for credit risk, market risk and operational risk. This paper focuses particularly on "Credit risk".

Credit risk is in existence from the day banks and financial institutions were involved in lending business. It is nothing but default risk, resulting from the borrower's failure to repay the bank dues consisting, principal, interest, etc. in accordance with the agreed terms. The risk of non-repayment by the borrower is either due to his inability or unwillingness to pay. It is possible for a banker to judge the borrowers' ***willingness to pay*** through his past repayment history and same would be very difficult for a new account. The ***ability of a borrower*** to pay is judged on the basis of the information available in his (company's) annual reports. This information is then inputted into the rating assessment sheet on which the bankers/lenders decision to lend or not to lend is based. The risk in a credit transaction, normally, results from unexpected changes in this assessment, which turns an account into NPAs or deterioration is observed in credit quality of an account. Similar phenomenon in many accounts lead to credit risk in the bank's credit portfolio. Thus, it is important for each bank to maintain capital against these unexpected changes.

Basel committee (Basel II) proposes two approaches for estimating credit risk capital charges, viz., Standardized approach, which is an improved version of 1988 Basel I accord, and internal rating based (IRB) approach, with two variants- foundation IRB (FIRB) and advanced IRB (AIRB).

Under the **standardized approach,** the capital computation is based on the external rating agency's assessment of risk and risk weights are given by regulators. It is important to note here that foreign Banks operating in India and Indian Banks having operational presence outside India were Basel II compliant in March 2008 with the implementation of Standardized Approach of credit risk and all other scheduled commercial banks (except local area banks and regional rural banks) in March 2009.

On the other hand, the capital computation under **IRB approach** is a function of various risk elements. These would be: probabilities of default (PD), loss given default (LGD), exposure at default (EAD) and Maturity. Under this approach, the borrower assessment is based upon bank's internal rating system. Traditionally, the rating assessment was done considering 5 C's of credit and these 5 C's are factored into banks internal rating model under five heads (as given in Table 1). This is called as one dimensional rating model, as collateral is a part of obligor's rating model.

Today for the banks, who plans to migrate to advanced approaches of credit risk capital estimation, it is important for them to have in place two dimensional internal rating based system for credit assessment, which focuses on separate assessment of obligor and facility. Thus, decision to lend or not to lend would depend on composite rating as shown below in Table 2 and accordingly pricing/interest rate charges varies.

The reserve bank of India (RBI) released guidelines on internal rating based approach for calculation of credit risk capital charges as on December 22, 2011. The RBI/Basel guidelines state that banks' using FIRB approach should provide their own estimates of borrowers' PD and rely on supervisory estimates of exposures' LGD and EAD. Under the AIRB approach, banks should provide their own estimates of all credit risk elements. Implementation of these approaches, nowhere asking banks to

Table 1 One dimensional rating model

	Traditional rating methodology: 5 C's of credit	Bank's rating models/ obligor rating model
Idiosyncratic/borrower specific/ internal/controllable factors	Character	Management
	Capital	financial/operational efficiency
	Capacity	Business of the obligor
	Collateral	Collateral
Systematic/external/uncontrollable factors	Condition	Industry

Table 2 Two dimensional rating model

Obligor Rating is Good **Facility Rating is Strong** **Obligor with good credit quality**	**Obligor Rating is Good** **Facility Rating is Weak** **Banks back upon obligors' repayment capacity**
Obligor Rating is Poor **Facility Rating is Strong** **Banks back upon facility for loan repayment**	**Obligor Rating is Poor** **Facility Rating is Weak** **Obligor with Poor credit quality:** **- Bank can opt for exit option for existing accounts** **- Bank can avoid entering a new account with this rating**

change the lending practices, but expecting from them to understand implication of these practices. In simple words, these guidelines are trying to establish the consensus between the perspectives of credit officers (who focuses on business) and risk officer (who focuses on capital) for risk adjusted performance measurement of the bank. Broadly, the credit risk management framework (Fig. 1) in a bank looks like following, which makes us clear that, if the risk is not identified properly at branch level, it can have huge implications at the bank's risk adjusted performance and capital adequacy.

The credit risk elements or drivers mentioned in Fig. 1 are converted into risk weights and regulatory capital requirements by means of risk weight formula specified by Basel Committee, which was developed considering a special credit portfolio model, the so-called asymptotic single risk factor (ASRF) model. It is believed that Gordy (2003) was the pioneer of this formula. The paper by Thomas and Wang (2005) describes in detail the theoretical and institutional background to the formula spec-

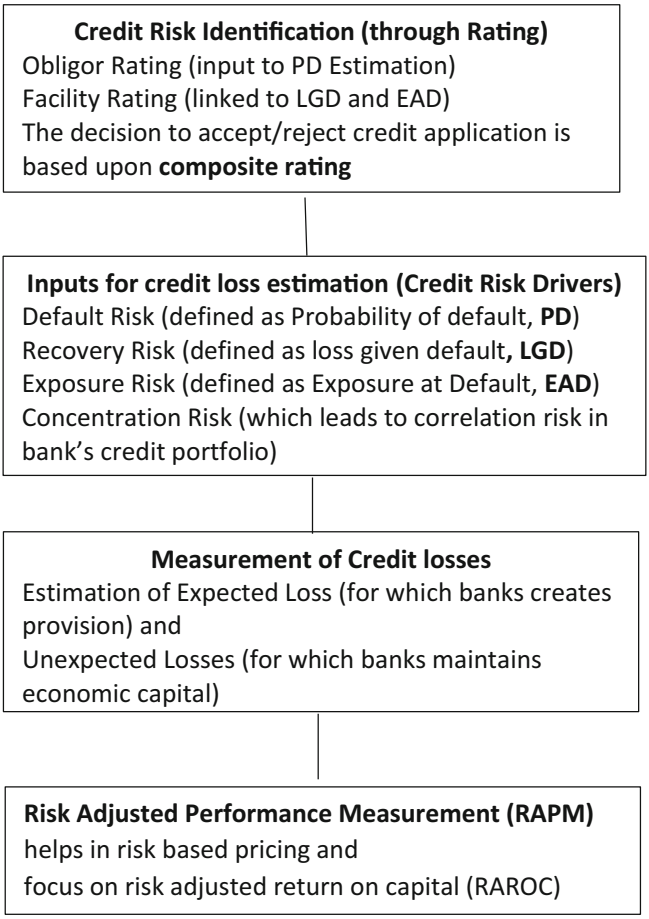

Fig. 1 Credit risk management framework

ified by the Basel Committee. The authors discuss the assumptions of the Vasicek (1984) formula in their paper and the adjustments made to it in the IRB formula. The paper by Munniksma (2006) also focuses on IRB capital requirements function. The paper viewed that the Basel Committee had an important requirement that the capital requirements function should be portfolio invariant and Gordy (2003) has shown that only ASRF models are portfolio invariant and, therefore, the Basel Committee has chosen for an ASRF model. The ASRF model assumes that the bank credit portfolio consists of a large number of relatively small exposures, therefore, idiosyncratic risk associated with individual exposures tends to be cancelled out and only systematic risks that affect all borrowers to a certain degree, like industry or regional risk, have a material effect on portfolio losses (Samba 2005) and similar results were documented by Bluhm and Overbeck (2003).

Given this background, an attempt is made to estimate the credit risk capital charges for public sector and private sector banks in India for the period from 2007–2008

to 2013–2014, i.e. 7 years, under advanced internal rating based (AIRB) approach of credit risk using ASRF model as given by the Basel committee. This selection of study period is in line with RBI guidelines (1999), which states that a bank can manage credit risk by quantifying it correctly by tracking portfolio behavior over five or more years.

This paper is divided into five sections. After an introduction to credit risk and Basel II in first section, a review of literature is given in "Literature Review" section. While, "Database, Methodology and Variables Definition" section addresses the data and methodology used for this study, results are discussed in "Empirical Results" section. Finally, "Conclusion" section presents the conclusion.

Literature Review

According to Gordy (2000) and Carey (2000), capital requirements under IRB approach are highly sensitive of the accuracy of estimates of LGD and granularity in PD. In other words, credit losses in a bank varies depending upon borrower's default and loss severity. Credit losses are affected by economic conditions and models parameters (credit risk drivers) should be adjusted to reflect these expected levels of economic activity. Fama (1986) and Wilson (1997a, b) find cyclical PDs, especially in the case of economic downturns when PDs increase dramatically. Similar results were reported by Bangia et al. (2000) and Figlewski et al. (2006). They find evidence of macroeconomic and industry effects on rating transitions. Bajaj (2010a, b) studied the distribution of rating transitions conditional on rating of the issuers, economic activity of the issuer and macroeconomic factors. It is found from the analysis that the least stable retention rates were found in low rating grades issuer and default rates, in contrast, were observed high. The study documented that the ratings transition is cyclical in nature and so the default probability. Araten et al. (2004) conducted a study at J.P. Morgan Chase (JPMC) covering 3761 defaulted loans for a period of 18 years (1982–1999) and documented 39.8% average economic LGD and 27% of average accounting LGDs. There is an empirical evidence that LGDs are positively correlated with economic cycle and default data. That is during the periods of high defaults, one might expect lower recovery value. This evidence is supported by Altman et al. (2006) and Hu and Perraudin (2002).

The approach implicit in the Basel II framework does recognize the importance of correlations for determining appropriate capital. Lucas (1995) in his paper highlighted the credit issues related to default correlation. The observable fact is that the likelihood of one company defaulting on its credit obligations is affected by the default of the other company. Nagpal and Bahar (2001) in their study on various sectors in US from 1981 to 1999, found that default events exhibit correlations due to economic and/or industry specific factors. Servigny and Renault (2002) provided empirical evidences on default correlation using Standard & Poor's rating database. They found that default correlations are higher for low credit quality firms than for highly rated ones. Bajaj (2010a, b) estimated default correlation within and across different rating grades and sectors for corporate in India. It is found from the analysis that default probabilities and correlation estimates vary with time, rating of the issuer and economic activity of the issuer. It is also found that the correlation is the highest between companies within

the same rating grade and industry, because of borrower and industry specific factors. Similar results were documented by Bandyopadhyay et al. (2007). The author used Bluhm and Overbeck (2003) model to calculate the implied asset correlation from default correlation for corporate bonds.

On making review of the previously conducted studies as above, it is clear that although, many studies have been conducted on each credit risk driver separately, but there is a need to assess the impact of all credit risk drivers collectively on capital charges for banks in India. That is why, the present study entitled, "***Credit risk capital estimation under IRB approach for banks in India*** ", is an initiative in this direction. The objective of this study is to estimate credit risk capital charges for all public sector and private sector banks (list is given in annexure) in India for the period from 2007–2008 to 2013–2014 under internal rating based (IRB) approach of credit risk. Credit risk capital charge depends on credit management practices (covering appraisal, monitoring, recovery etc.) of the banks. This study is important for banks to understand the implications of these practices on their credit risk capital. The study reflects on the impact of deficiencies in credit appraisal and recovery strategies on banks' probability of default (PD) and loss given default (LGD) number, which have reflection upon credit risk capital. An attempt is also made to study how risk weights vary depending on the sector and size of the bank? In the end, the paper examines the risk adjusted performance of the banks under study.

Database, Methodology and Variables Definition

The present study is an endeavor to estimate credit risk capital charges under advanced IRB approach for public sector banks and private sector banks for the period from 2007–2008 to 2013–2014 i.e. 7 years. For the study period, the secondary data has been collected from RBI website, Indian Banks Association's Performance Highlights and annual reports of the banks included in the study. The data of NPAs and recovery forms the basis of analysis, which is collected from Basel III disclosures and Assets Quality data available in "Notes to Accounts" in Annual Reports of the banks included in study (annexure). As mentioned above, the credit risk capital estimation is based on credit risk drivers i.e. probability of default (PD), loss given default (LGD), exposure at default (EAD) and maturity under IRB approach. Each parameter is detailed as below:

Probability of Default (PD)

To start with PD, Basel committee defines it as a measure which gives the average percentage of obligors that default in a rating grade in the course of 1 year. As borrower-wise rating is not available in the annual report of the banks. The paper attempt to estimate rupee weighted average PDs for the bank and it is a more conservative measure than frequency based measure of PDs (Davis and Williams 2004). This computation is possible for the Bank as a whole by tracking the historical NPA movements and gross advances data (yearly movements from the year 2007–2008 to 2013–2014). The yearly marginal PD is estimated by using a moving average method as shown in the

following equation (Bandyopadhyay 2011):

$$\text{Marginal PD} = \frac{\textit{Fresh NPAs Accretions}}{\textit{Three Years Average Gross Advances}}$$

Next, the long run average PD is estimated. Long run average PD is nothing but weighted average of yearly marginal PDs from the year 2009–2010 to 2013–2014 (here T is 5 years).

$$\text{Long run average Probability of Default} = \frac{\textit{Marginal PDs}}{T}$$

This bank-reported average PD reflects expected default rate under normal business condition and it is an important parameter in IRB formula. Another PD which enters into IRB formula is conditional PDs. The bank can derive this conditional PD from bank-reported average PD, using following supervisory mapping function:

$$N\left[\frac{1}{\sqrt{1-R}} * G\left(PD\right) + \sqrt{\frac{R}{1-R}} * G\left(0.999\right)\right]$$

Here, N is the standard normal distribution, G is the inverse of the standard normal distribution.

Loss Given Default (LGD)

The second credit risk driver is LGD. *Basel committee defines LGD as the percentage of exposure (EAD) the bank might lose in case the borrower defaults.* The LGD depends on the type and amount of collateral as well as the type of borrower and the expected proceeds from the work-out of the assets. Here, exposure at default (EAD) is the third credit risk driver, which gives an estimate of the amount outstanding in case the borrower defaults.

Loss Given Defaults (LGD, in percent) = 1 minus Recovery Rate

Here, Recovery Rate (in percent) = $\frac{\textit{Total Amount of Cash Recovered in a Year}}{\textit{Three Years Average Gross NPAs Amount}}$ (Bandyopadhyay 2011)

Long Run Recovery Rate (in percent) = $\frac{\textit{Recovery Rates}}{T}$

Here, T is 5 years

Basel committee expects banks to compute economic LGD. In the annual reports of the banks, the data on aggregate recoveries is available to compute bank's level accounting or historical LGD. Accounting LGD differs from economic LGD as it does not take into account the length of workout period and certain costs and payments and discounting of net cash flows. In addition, under Advanced IRB, the banks are expected to report downturn LGDs that reflect economic-downturn conditions in circumstances where loss severities are expected to be higher than average economic conditions. To comment on this, recovery data is available in annual reports of the banks from the year 2009–2010 only, under the head "Movement of NPAs". Despite this data limitation,

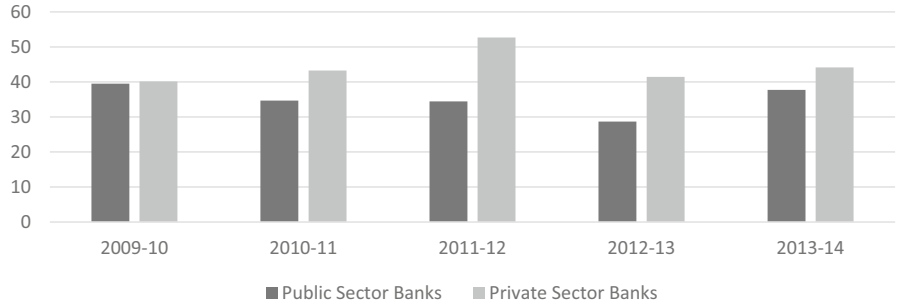

Fig. 2 Recovery to reduction ratio

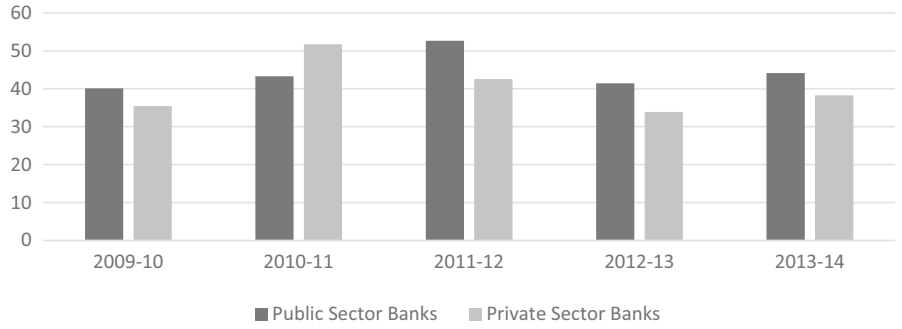

Fig. 3 Recovery to slippage ratio

the bank-wise recoveries in the year 2012–2013 is considered for computation of Downturn LGD. The major reasons behind this are presented in Figs. 2 and 3. Figure 2 presents the ratio of recovery to total NPAs reduction. The Fig. 2 present that the reference ratio has declined marginally in both sectors (public sector/private sector) in the year 2012–2013.

Figure 3 shows trend relating to Recovery to Slippage (fresh accretion of NPAs during the year) Ratio. The figure depicts the decline in ratio of recovery to slippage in the year 2012–2013. This decline reflects that slippages are more than recovery in this year.

Figures 4 and 5, shows that downturn LGD is higher than accounting LGD, as documented by by Altman et al. (2006) and Hu and Perraudin (2002).

This Downturn LGD, enters into Basel risk weight function in two ways (Basel 2005):

Firstly multiplied by the conditional PD to produce an estimate of the conditional expected loss (unexpected loss, i.e. conditional PD * downturn LGD) and

Secondly, multiplied by the average PD to produce an estimate of the expected loss (i.e. average PD * downturn LGD) associated with the exposure.

Both, Expected loss and Conditional Expected Loss or Unexpected loss, are explained below.

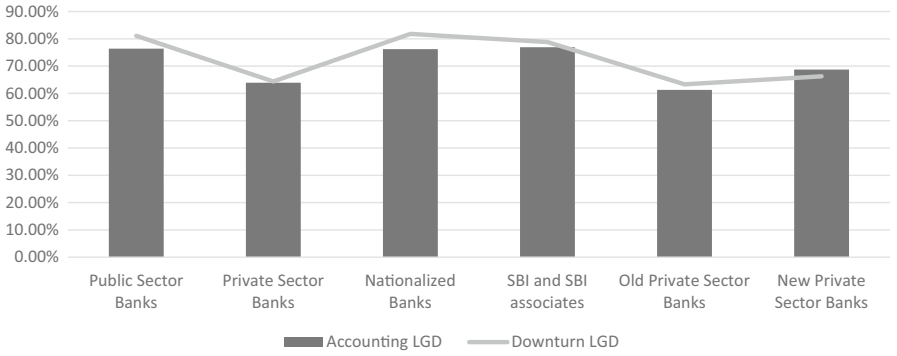

Fig. 4 Estimates of LGD (sector-wise)

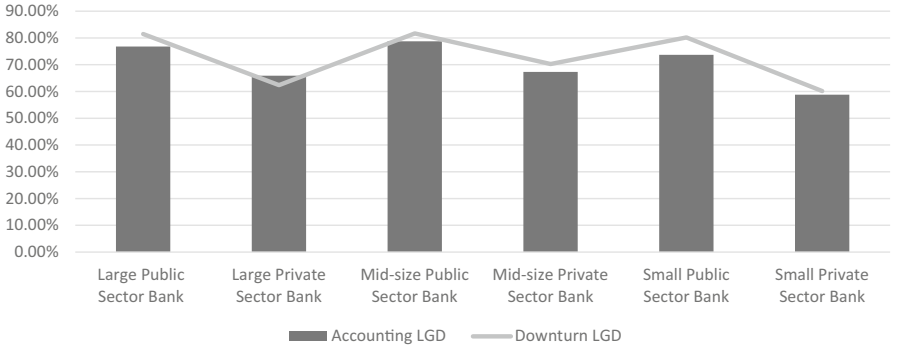

Fig. 5 Estimates of LGD (size-wise)

Estimation of Credit Losses

Credit losses are of two types: expected loss (EL) and unexpected loss (UL) or conditional expected loss. RBI guidelines clearly state that a bank can manage credit risk by quantifying it correctly through estimation of expected loan losses and unexpected loan losses by tracking portfolio behavior over 5 or more years (RBI 1999).

Expected loss (EL) is the amount the bank can expect to lose, on an average, over the period of time, it extends credit. It is anticipated cost of doing business and should, therefore, be incorporated in loan pricing and ex-ante provisioning (Ong 2000). The expected loss rate for a borrower is the probability of default times the loss given default (EL (percent) = PD*LGD). The expected loss can also be mentioned in absolute amount as: EAD*Expected Loss Rate.

Interestingly, **unexpected loss (UL)** depends on the same variables as the EL and it represents volatility of average loss. It equals the LGD times the square root of the product of the PD times one minus PD (LGD*$\sqrt{PD\,(1-PD)}$) (Ong 2000). It is important to note that unexpected loss can significantly exceed the expected loss and, therefore, should be a cause of concern for credit portfolio management. That is why; it is important for banks to keep aside capital for unexpected losses, i.e. economic capital

or risk based capital or credit value at risk (CVaR), which is nothing but (multiple of loss volatility)-EL. Here, this multiple is the confidence level (99.9%), given by Basel committee. Basel document (2005) clearly states that confidence level in the IRB risk weight formula have to be determined by supervisor and loss volatility is unexpected losses. Thus, economic capital is the required capital which acts as a buffer against insolvency for the bank in the event of default by obligors. In other words, it can be expressed as, protection against unexpected future losses at a selected confidence level.

Correlation

The magnitude of unexpected loss critically depends on correlation between all the loans in the portfolio. Correlations are of two types, namely default correlation and assets correlation.

Default correlations is the likelihood of simultaneous default by the borrower because of dependence on same industry specific fundamentals and same macroeconomic environment. As a rule of thumb, higher the correlation of default, greater is the concentration risk of the portfolio and vice-versa. In other words, concentration based on the correlated risk factors between borrowers may lead to simultaneous default. This paper uses methodology as suggested by Bandyopadhyay (2011) and Bandyopadhyay and Ganguly (2011) to compute default correlation in credit portfolio of the banks based on the NPAs data. If we consider banks all loans under a pool, the unexpected loss of the portfolio is:

$$UL^2P = \sum_{i=1}^{N}\sum_{j=1}^{N} r_{i,\,j} UL_i UL_j$$

Here, $r_{i,j}$ is pair-wise correlation of default between loans i and j. A Bank can estimate this correlation if they assume that the correlation between each loan is identical (i.e. ri $= rj$), and each loan has same UL (ULi $=$ ULj), then correlation (r) is: $r = \frac{UL_P^2}{UL_T^2}$. Here, ULP is Standard deviation of marginal PDs and ULT is $\text{LGD} * \sqrt{PD(1-PD)}$.

Assets correlation, on the other hand, is an important input in IRB risk weight formula. This correlation parameter links the default risk of a borrower with the macroeconomic environment. High correlation shows that borrowers default is strongly linked to status of overall economy and, vice versa. These correlations are not to be estimated by the banks, instead they should be determined by formulas given by the Basel committee. This paper considers formula given by Basel committee for computation of assets correlations for wholesale (Corporates, Banks and Sovereigns) exposure as:

$$\textit{Asset Correlation (R)} = 0.12 \times \frac{\left(1 - e^{(-50 \times PD)}\right)}{\left(1 - e^{-50}\right)}$$

$$+0.24 \times \left(1 - \frac{\left(1\text{-e}^{(-50\times \mathrm{PD})}\right)}{\left(1\text{-e}^{-50}\right)}\right)$$

This assets correlation formula have been derived by analyses of data from the G10 countries and shows two systematic dependencies: First, '*Asset correlations decrease with increase in PD*'. The intuition states that higher the PD, the higher the idiosyncratic risk of a borrower. Second, '*Asset correlations increase with firm size*.' Large firms will have more systematic risk and less idiosyncratic risk as they will be more dependent on economy and vice-versa, BCBS (2005, 2006).

Maturity Adjustment Function

Another input in IRB formula is a maturity adjustment function. The maturity adjustment is introduced in IRB formula to reflect the potential credit quality deterioration of loans with longer maturity (Munniksma 2006). Thus, the longer the term to maturity, more variation is expected in obligors' credit quality, which may result in larger unexpected losses. Maturity adjustment depends on both, maturity (M) (which is assumed 2.5 years here, as given by regulator under FIRB) and probability of default. It can be interpreted as anticipation of additional capital requirements due to downgrades. It is higher for low PDs, as the bank with low PD has more potential and more room for downgrading (IRB, Basel 2005).

IRB Formula by Basel/RBI

Credit risk drivers, detailed above, plays a crucial role in computing capital charges under IRB approach. These credit risk estimates enter into following IRB risk weight formula, produces credit risk capital requirements for a Bank. Here, k is minimum capital per unit exposure.

$$\mathrm{k} = \left[\mathrm{LGD} \times \mathrm{N}\left[\frac{1}{\sqrt{1-R}} \times G(PD) + \sqrt{\frac{R}{1-R}} \times G(0.999)\right] - PD \times LGD\right] \times \left(\frac{1 + (M - 2.5) \times b(PD)}{1 - 1.5 \times b(PD)}\right)$$

Here, b is smoothed (regression) maturity adjustment (smoothed over PDs). As, PDs increases, b and accordingly, maturity adjustment factor decreases.

Risk Adjusted Return on Capital (RAROC)

After estimating credit losses (both EL and UL) and capital, it is important for each bank to know their risk adjusted return (Fig. 1), that is studied through a performance measurement tool called RAROC (risk adjusted return on capital). In this paper, an

attempt is made to compute RAROC for all public sector and private sector banks in India for the period from 2007–2008 to 2013–2014. Under RAROC framework, lender begins by charging an interest mark-up to cover the expected loss – expected default rate of the rating category of the borrower. The lender then allocates enough capital to the prospective loan to cover some amount of unexpected loss- variability of default rates (RBI 1999). Thus, RAROC helps banks in allocating capital to a transaction, portfolio, business lines or region/zone according to their respective risk profile. It is computed as:

$$\frac{Spread + Fee - Operating\ Expenses - Provision\ against\ Expected\ Losses}{Economic\ Capital\ for\ Unexpected\ Credit\ Losses}$$

Empirical Results

The Tables 3 and 4 presents sector-wise and size-wise estimates of credit risk elements, k factor and risk weights under IRB approach.

To start with **probability of default (PD),** inter-sector comparison (Table 3) shows that PD is found at 2.81 and 1.82%, in public sector and private sector banks, respectively. This high PD percentage for public sector banks is clearly pointing towards assets quality concerns in this sector. Because, banks with high PD requires more capital in IRB regime. Further look at the table indicates that SBI and its associate banks and old private sector banks have high PDs. This sector specific PD percentages calls for improvement in bank's appraisal system or inclusion of more stressed parameters into borrower's assessment to avoid migration of accounts into NPAs category.

The size-wise analysis regarding PD in Table 4 indicates that small banks in public sector and private sector have more defaults, whereas defaults in large banks are low. Is this mean that large banks have low defaults on the strength of their better quality appraisal systems?

The bank-wise analysis (Table 5) reveals that the default probability in many public sector banks is between 2 to 4%. The PD is above 4% only in the case of United Bank of India and State Bank of Travancore. In contrast, the default probability in many private sector banks is between 1 to 3%. It is important to note here that three banks (Karur Vyasa, Ratnakar Bank and Yes bank) have PD of less than one percent. On the whole, these comparatively low PD percentages in private sector banks clearly indicate strength of their appraisal systems.

The trend relating to **loss given default (LGD)**, which is 1 minus recovery rate, for public sector and private sector banks in India is further presented through Tables 3, 4 and 6. Table 3 shows that on an average, LGD is found higher for public sector banks at 76.39% in comparison to their counterpart private sector banks (63.91%). This comparatively low LGD among private sector banks reflect quick recovery strategy in this sector. On inter-sector comparison, slight difference is observed in the recovery experience of nationalized banks and SBI and its associate banks, but the new private sector banks have high LGD of 68.73% than old private sector banks. Size-wise analysis in Table 4 indicates that recovery (1-LGD) experience of small banks is better in comparison to their counterpart's large and mid-size banks. Inter-bank LGD analysis

Table 3 Estimates of Credit Risk elements, k factor and risk weights under Basel II: sector-wise analysis (in percent)

	Probability of default	Loss given default	Expected loss	Unexpected loss	Assets correlation	Maturity adjustment	k	Risk weight
Public sector banks	2.81	76.39	2.13	12.46	15.15	117.72	18.03	200.31
Nationalised banks	2.65	76.23	2.00	12.06	15.41	118.18	17.88	198.68
SBI and its associates	3.36	76.93	2.58	13.81	14.28	116.21	18.52	205.74
Private sector banks	1.82	63.91	1.17	8.39	17.21	121.83	12.49	138.79
Old private sector banks	1.97	61.31	1.17	8.15	16.94	121.23	12.27	136.36
New private sector banks	1.55	68.73	1.18	8.86	17.71	122.94	12.90	143.32

Table 4 Estimates of Credit Risk elements, k factor and risk weights under Basel II: size-wise analysis (in percent)

	Probability of Default	Loss given default	Expected loss	Unexpected loss	Assets correlation	Maturity adjustment	k	Risk weight
Public sector banks								
Large	2.60	76.80	1.98	12.10	15.39	118.15	17.77	197.38
Mid-size	2.69	78.74	2.10	12.58	15.29	117.98	17.98	199.72
Small	3.12	73.68	2.31	12.67	14.80	117.08	18.32	203.49
Private sector banks								
Large	1.35	65.89	0.99	7.96	18.28	124.15	11.63	129.20
Mid-size	1.65	67.32	1.12	8.49	17.46	122.20	13.34	148.18
Small	2.40	58.79	1.37	8.68	16.06	119.47	12.39	137.63

Table 5 Estimates of probability of default among public sector and private sector banks (in percent)

	Below 1	1–2	2–3	3–4	Above 4
Public sector banks		Bank of Baroda (BOB), Corporation Bank (Co.B), IDBI Bank (IDBI), Punjab and Sind Bank (PSB) (4)	Andhra Bank (AB), Bank of Maharashtra (BOM), Canara bank (CB), Dena Bank (DB), Indian Bank (IB), Oriental Bank of Commerce (OBC), Punjab National Bank (PNB), Syndicate Bank (SB), Union bank of India (UBI), State Bank of Bikaner and Jaipur (SBB&J) (10)	Allahabad Bank (Al.B), Bank of India (BOI), Central Bank of India (CBI), Indian Overseas Bank (IOB), UCO Bank (UCOB), Vijaya Bank (VB), State Bank of Hyderabad (SBH), State bank of India (SBI), State Bank of Mysore (SBM), State Bank of Patiala (SBP) (10)	United Bank of India (UBOI), State Bank of Travancore (SBT) (2)
Private sector banks	Karur Vysya Bank Ltd. (KV), Ratnakar Bank Ltd. (RB), Yes Bank Ltd (YES) (3)	City Union Bank Ltd. (CU), ING Vysya Bank Ltd (INGV), Jammu & Kashmir Bank Ltd (J&K), Nainital Bank Ltd (NB), South Indian bank Ltd (SIB), Tamilnad Mercantile Bank Ltd (TMB), HDFC Bank Ltd (HDFC), ICICI Bank Ltd (ICICI), Indus Ind Bank Ltd (INDUS), Kotak Mahindra Bank Ltd (KMB), Axis Bank Ltd. (Axis) (11)	Catholic Syrian Bank Ltd. (CS), Federal Bank Ltd. (FB), Karnataka Bank Ltd (KB), Development Credit Bank Ltd. (DC) (4)	Dhanalakshmi Bank Ltd (DH.B) (1)	Lakshmi Vilas Bank Ltd (LV) (1)

in Table 6 reveals that many public sector banks have LGD of more than 70%. It is important to mention that LGD is above 90% in the case of Co.B and IDBI bank. Among private sector banks, CU, DH.B, INGV and Yes bank have LGD of less than 50%. In contrast, DC, ICICI and Axis Bank have LGD of above 80%. High LGD percentages or low recovery in banks among public sector and private sector demands management attention to reduce levels of credit losses at portfolio level.

These PD and LGD estimates are then entered into IRB formula to compute **credit losses**. Inter-sector comparison (Table 3) indicates high expected losses percentage against gross exposure, thus, provision of 2.13% for public sector banks, in comparison to private sector banks (1.17%). This trend reflects poor management of credit in public sector banks, thus, need of more provisions and reduction in bank's profitability. Within public sector banks, SBI and its associates (2.58%) needs to maintain more provisions against expected losses in comparison to nationalized banks (2.00%). Not much difference is observed in provisioning requirement for old and new private sector banks. The major reason behind this is that old private sector banks have high PDs and low LGDs and vice-versa is true for new private sector banks. That is why, sector specific impact is negligible. Size-wise analysis in Table 4 indicate that small banks among public sector and private sector needs to maintain more provision against expected losses because of high probability of default. At bank-level (Table 7), United Bank of India and Lakshmi Vilas Bank needs to maintain more provision against expected losses, as they experienced higher PD during the study period.

It is further observed from the Tables 3 and 4 that **unexpected losses (conditional expected loss)** are significantly higher than expected losses for all public sector and private sector banks in India. Inter-sector comparison indicates that high defaults, thus, low recovery (high LGDs) lead to high unexpected losses of 12.46% in public sector banks and 8.39% in private sector banks. Within these sectors, SBI and its associate banks and new private sector banks have experienced high unexpected losses. The size-wise analysis (Table 4) indicates high unexpected loss percentage in small banks in public sector and private sector under study. This clearly indicates that more the variation in estimates of default and recovery, more will be the unexpected losses of banks and vice-versa. Thus, the banks with highest unexpected losses (United bank of India and Development Credit bank) need more economic capital (or risk based capital) (Table 7).

Further perusal of the Tables 3 and 4 presents **estimates of assets correlations**, which have significant impact on unexpected loss estimation. Higher the correlation, more will be the banks' losses. The following Figs. 6 and 7 present that asset correlation (AC) for banks (in public sector as well as in private sector) is higher than the default correlations (DC). This confirms the finding of Zhou (1997).

The analysis also present that assets correlation decreases with increasing PD for banks in India. The Table 3 shows that assets correlations are found at 17.21 and 15.15% in private sector and public sector banks, respectively, in India. Higher assets correlation among private sector banks indicates sensitivity of the bank's loans to the systematic factors. Inter-sector analysis reveals that nationalized banks among public sector and new private sector banks would be with high assets correlation because of their size or PD, as documented by Basel (2005), Basel (2006). The size-wise analysis in Table 4 indicates that the assets correlation for large banks like SBI, PNB, BoB,

Table 6 Estimates of loss given default (LGD) among public sector and private sector banks (in percent)

	Below 50	50–60	60–70	70–80	Above 80
Public sector banks		Canara bank (CB) (1)	Punjab and Sind Bank (PSB), Vijaya Bank (VB), State Bank of Travancore (SBT) (3)	Allahabad Bank (Al.B), Bank of India (BOI), Bank of Maharashtra (BOM), Central Bank of India (CBI), Dena Bank (DB), Indian Bank (IB), Indian Overseas Bank (IOB), Oriental Bank of Commerce (OBC), Punjab National Bank (PNB), Syndicate Bank (SB), UCO Bank (UCOB), United Bank of India (UBOI), State Bank of Bikaner and Jaipur (SBB&J), State Bank of Hyderabad (SBH), State Bank of Mysore (SBM), State Bank of Patiala (SBP) (16)	Andhra Bank (AB), Bank of Baroda (BOB), Corporation Bank (Co.B), IDBI Bank (IDBI), Union bank of India (UBI), State bank of India (SBI) (6)
Private sector banks	City Union Bank Ltd. (CU), Dhanalakshmi Bank Ltd (DH.B), ING Vysya Bank Ltd (INGV), Yes Bank Ltd (YES) (4)	Catholic Syrian Bank Ltd. (CS), Lakshmi Vilas Bank Ltd (LV), Ratnakar Bank Ltd. (RB), Tamilnad Mercantile Bank Ltd (TMB) (4)	Nainital Bank Ltd (NB), South Indian bank Ltd (SIB), Indus Ind Bank Ltd (INDUS) (3)	Federal Bank Ltd. (FB), Jammu & Kashmir Bank Ltd (J&K), Karnataka Bank Ltd (KB), Karur Vysya Bank Ltd. (KV), HDFC Bank Ltd (HDFC), Kotak Mahindra Bank Ltd (KMB) (6)	Development Credit Bank Ltd. (DC), ICICI Bank Ltd (ICICI), Axis Bank Ltd. (Axis) (3)

Table 7 Estimates of Credit Losses, Assets Correlation, M, k, and Risk weights under Basel II: Bank-wise Analysis (in percent)

Public sector banks	EL	UL	AC	MAF	k	RW	Private sector banks	EL	UL	AC	MAF	k	RW
Al.B	2.71	14.47	14.19	116.06	19.72	219.06	CS	1.42	9.05	15.61	118.53	15.71	174.49
AB	1.73	12.05	16.35	119.81	17.27	191.81	CU	0.89	6.20	16.42	119.93	13.13	145.90
BOB	1.61	11.51	16.57	120.21	17.78	197.58	DH.B	1.41	7.97	14.63	116.84	3.64	40.49
BOI	2.22	12.56	14.65	116.87	18.49	205.46	FB	1.68	10.81	15.70	118.69	15.22	169.09
BOM	1.72	11.56	16.07	119.32	17.42	193.52	INGV	0.52	4.69	18.50	124.08	11.22	124.65
CB	1.35	8.39	15.37	118.10	15.95	177.20	J&K	0.84	7.89	18.84	124.87	12.94	143.75
CBI	2.30	12.85	14.53	116.66	17.03	189.23	KB	1.78	11.78	15.90	119.03	15.11	167.87
Co.B	1.50	11.54	17.22	121.41	17.62	195.73	KV	0.57	6.54	20.27	128.96	9.77	108.55
DB	1.67	10.95	15.85	118.94	16.71	185.69	LV	2.38	10.92	13.25	114.22	11.00	122.17
IDBI	1.64	12.15	16.89	120.79	18.72	207.97	NB	1.16	8.62	16.94	120.88	15.19	168.80
IB	1.70	11.23	15.91	119.04	17.53	194.78	RB	0.57	5.78	19.47	126.50	9.60	106.66
IOB	2.83	14.29	13.82	115.38	20.99	233.18	SIB	0.95	8.09	18.10	123.18	13.92	154.67
OBC	2.08	12.49	15.13	117.69	16.98	188.68	TMB	1.05	7.56	16.64	120.34	13.10	145.56
PSB	1.12	8.42	17.00	120.98	17.13	190.33	DC	1.81	12.20	16.11	119.38	18.44	204.87
PNB	1.94	11.68	15.15	117.73	17.27	191.92	HDFC	1.26	9.69	17.22	121.40	12.45	138.29
SB	1.67	10.95	15.86	118.95	15.86	176.19	ICICI	1.66	11.67	16.47	120.03	17.94	199.27
UCOB	2.34	13.15	14.60	116.78	18.99	211.03	INDUS	0.82	7.36	18.48	124.02	8.44	93.77
UBI	1.88	12.22	15.76	118.78	16.11	178.96	KMB	1.32	9.94	17.07	121.13	15.02	166.90
UBOI	3.80	16.72	13.03	113.72	21.89	243.21	Axis	1.31	10.32	17.45	121.86	16.56	183.98
VB	2.21	12.02	14.33	116.30	18.19	202.05	YES	0.06	0.83	21.21	132.75	1.45	16.13
SBB&J	2.13	12.52	14.94	117.38	18.84	209.27							
SBH	2.32	13.02	14.57	116.73	16.84	187.06							
SBI	2.91	15.46	14.18	116.04	20.77	230.73							

Table 7 continued

Public sector banks	EL	UL	AC	MAF	k	RW	Private sector banks	EL	UL	AC	MAF	k	RW
SBM	2.61	14.15	14.31	116.27	19.64	218.18							
SBP	2.62	14.12	14.27	116.21	18.76	208.47							
SBT	2.86	13.58	13.44	114.62	16.27	180.72							

Expected loss (EL), unexpected loss (UL), assets correlation (AC), maturity adjustment factor (MAF), capital requirement (k), risk weight (RW)

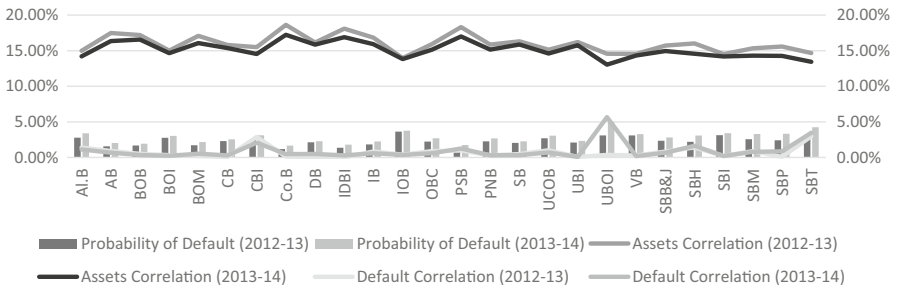

Fig. 6 Proability of default and correlations for public sector banks in India

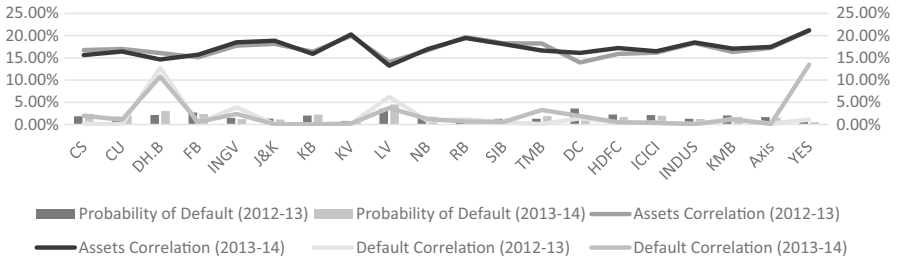

Fig. 7 Proability of default and correlations for private sector banks in India

BOI, CB, UBI, HDFC, ICICI, INDUS, Axis, J&K and Yes etc. would be higher, which clearly show that borrowers' defaults in large sized banks is strongly linked to status of overall economy. Similar results were documented by Lopez (2004) who finds that there is relatively high asset correlation between high rated large size firms since they are more affected by common macroeconomic conditions. Thus, when the fundamentals turns bad, the large size banks are expected to experience more unexpected losses and thus, need to maintain sufficient economic capital against these losses. Inter-bank analysis shows that among public sector banks, United Bank of India with high PD have highest default correlation and lowest assets correlation. Same is true for Lakshmi Vilas Bank in private sector, as presented in Table 7.

The Tables 3 and 4 further presents the size of **maturity adjustment factor** for banks under study. It is empirically verified (Basel 2005) that banks with low PD have high maturity adjustment factor, as they have more room for down-gradation or default. The private sector banks with low PD of 1.82% have high maturity adjustment factor of 121.83%, in comparison to public sector banks (117.72%). Similar phenomenon is observed on sector-wise analysis (Table 3). The size-wise analysis (Table 4) indicates that maturity adjustment factor is highest among large public sector and private sector banks, as large banks have low PD on the basis of strength of their credit appraisal system. Though, this high percentage of maturity adjustment factor indicate that the large banks needs to control or monitor the migration of borrowers to low rating grade or default grade, to avoid capital burden. Inter-bank analysis (Table 7) indicates that among public sector banks, for Corporation Bank with the lowest PD, the maturity adjustment is 121.41% and for United Bank of India, on the other hand, the adjustment

factor drops to 113.72%. Among private sector banks, the maturity adjustment would be the highest for Yes Bank at 132.75% and the lowest for Lakshmi Vilas Bank at 114.22%.

k (percent) is capital requirement as per IRB formula, which is further presented in Tables 3, 4 and 7. Inter-sector comparison in Table 3 indicates that the capital requirements under IRB approach would be higher for public sector banks in comparison to their counterpart private sector banks. The k factor is found at 18.03 and 12.49% in public sector and private sector banks, respectively. Thus, it is clear that public sector banks have high credit risk, thus, needs more capital in comparison to private sector banks in India. Sector-wise analysis reveals high capital requirement in IRB regime for SBI and its associate banks (18.52%), because of high PD and LGD percentages and in new private sector banks (12.90%), because of higher LGD. The size-wise analysis in Table 4 indicates that small banks with higher 'k' factor of 18.32% among public sector need to improve quality of their credit appraisal system to avoid capital burden. Whereas, among private sector banks, the mid-size banks, needs to maintain more capital with 'k' factor of 13.34%, because of poor recovery experience or high LGD. On bank-wise analysis (Table 7), it is found that the capital requirement under IRB would be the highest for United Bank of India at 21.89% amongst public sector banks, while capital requirements would be the lowest for Syndicate Bank. Among private sector banks, the capital requirements would be higher for Development Credit Bank at 18.44% and the lowest for Yes Bank.

As mentioned in introduction section of this paper that in standardized approach, risk weights are given by regulator, whereas, in IRB approach, same would be computed by the bank from various risk elements. Thus, in the end, Tables 3, 4 and 7, presents that risk weight for the banks under study with the implementation of IRB approach of credit risk.

Inter-sector comparison (Table 3) clearly indicates that risk weights would be higher in the case of public sector banks, indicating high credit risk (i.e. high PD and LGD) and need of more capital with Basel implementation, in comparison to private sector banks, in India. The risk weights in nationalized banks and SBI and its associates banks are found at 198.68 and 205.74%, respectively. Within private sector banks, new private sector banks on an average have high risk weight than old private sector banks of 143.32 and 136.36%, respectively. This is mainly because of high assets correlation and maturity adjustment factor. The size-wise analysis (Table 4) indicates that among public sector banks, risk weights of small banks would be highest at 203.49, because they have high defaults and thus, high unexpected losses. Among private sector banks, risk weight of 148.18% for mid-size banks is high, because of high loss given default. Inter-bank comparison indicates high risk weight of 243.21% for United Bank of India and 204.87% for Development Credit Bank, in public sector and private sector, respectively.

In the end, Risk Adjusted Performance of the banks through RAROC is studied. It is revealed from the Table 8 that approximately 27% of public sector banks have negative RAROC. This indicate that many public sector banks in India are not earning sufficient return on capital. Similar results were reported by Thampy and Baheti (2000). As many as, fifteen public sector banks have returns to the extent of 40% on economic capital. CB, PNB and UBI are the only public sector banks who are generating highest risk

Table 8 RAROC of public sector and private sector banks (in percent)

	Negative	Less than 20	20–40	40–60	Above 60
Public sector banks	Bank of India (BOI), Central Bank of India (CBI), Indian Overseas Bank (IOB), United Bank of India (UBOI), Vijaya Bank (VB), State Bank of Patiala (SBP), State Bank of Travancore (SBT) (7)	Allahabad Bank (Al.B), Dena Bank (DB), Punjab and Sind Bank (PSB), State Bank of Hyderabad (SBH), State bank of India (SBI), State Bank of Mysore (SBM) (6)	Andhra Bank (AB), Bank of Baroda (BOB), Bank of Maharashtra (BOM), Corporation Bank (Co.B), Indian Bank (IB), Oriental Bank of Commerce (OBC), Syndicate Bank (SB), UCO Bank (UCOB), State Bank of Bikaner and Jaipur (SBB&J) (9)	IDBI Bank (IDBI) (1)	Canara bank (CB), Punjab National Bank (PNB), Union bank of India (UBI) (3)
Private sector banks	Catholic Syrian Bank Ltd. (CS), Dhanalakshmi Bank Ltd (DH.B), Karnataka Bank Ltd (KB) (3)	Lakshmi Vilas Bank Ltd (LV), Development Credit Bank Ltd. (DC) (2)	Tamilnad Mercantile Bank Ltd (TMB) (1)	Federal Bank Ltd. (FB), South Indian bank Ltd (SIB) (2)	City Union Bank Ltd. (CU), Jammu & Kashmir Bank Ltd (J&K), Karur Vysya Bank Ltd. (KV), Nainital Bank Ltd (NB), Ratnakar Bank Ltd. (RB), HDFC Bank Ltd (HDFC), ICICI Bank Ltd (ICICI), Indus Ind Bank Ltd (INDUS), Kotak Mahindra Bank Ltd (KMB), Axis Bank Ltd. (Axis), Yes Bank Ltd (YES) (11)

adjusted returns. In contrast, all private sector banks have positive RAROC other than CS, DH.B and KB. All new private sector banks, other than DC banks are among the best performing banks. Old privates sector Banks, like, CU, J&K, KV, NB and RB bank are also part of this list.

Conclusion

Under Basel II, the amount of capital that a bank should hold against a credit exposure will depends upon risk weight of that exposure. These risk weights are, thus, an indicator of risk (unexpected loss) involved in a particular credit. In standardized approach, these risk weights are given by the regulator, whereas, under AIRB approach, the bank have to compute these risk weights on the basis of its own data relating to probabilities of default (PD), loss given default (LGD), exposure at default (EAD) and maturity. In this paper, an attempt is made to estimate the risk weights for public sector and private sector banks in India for the period from 2007–2008 to 2013–2014 under IRB approach of credit risk using Basel risk weight formula. The analysis brings out that changes in default and recovery experience of the banks have reflection upon their credit losses and, thus, credit risk capital charges. Therefore, the bank with high defaults and low recovery (i.e. high LGD) needs to maintain more capital in IRB regime and vice-versa. Inter-sector comparison presents that a substantial proportion of the overall additional capital requirement for credit risk would fall on the public sector banks and at the same time, they are not earning sufficient returns on risk adjusted basis. The capital computation using IRB proves onerous for SBI and its associate banks, and new private sector banks. Inter-bank comparison indicates high capital requirement for United Bank of India, and Development Credit Bank. Thus, it is important for banks to improve credit appraisal system and have in place quick recovery mechanism to reduce burden of additional credit risk capital and to earn sufficient risk adjusted returns. To conclude, the overall quality of credit portfolio management is important for smooth functioning of the banking system.

Annexure

List of public sector and private sector banks in India

Public sector banks	Private sector banks
Nationalised banks	Old private sector banks
Allahabad Bank (Al.B)	Catholic Syrian Bank Ltd. (CS)
Andhra Bank (AB)	City Union Bank Ltd. (CU)
Bank of Baroda (BOB)	Dhanalakshmi Bank Ltd (DH.B)
Bank of India (BOI)	Federal Bank Ltd. (FB)
Bank of Maharashtra (BOM)	ING Vysya Bank Ltd (INGV)
Canara bank (CB)	Jammu & Kashmir Bank Ltd (J&K)
Central Bank of India (CBI)	Karnataka Bank Ltd (KB)
Corporation Bank (Co.B)	Karur Vysya Bank Ltd. (KV)
Dena Bank (DB)	Lakshmi Vilas Bank Ltd (LV)
IDBI Bank (IDBI)	Nainital Bank Ltd (NB)
Indian Bank (IB)	Ratnakar Bank Ltd. (RB)

Public sector banks	Private sector banks
Indian Overseas Bank (IOB)	South Indian bank Ltd (SIB)
Oriental Bank of Commerce (OBC)	Tamilnad Mercantile Bank Ltd (TMB)
Punjab and Sind Bank (PSB)	New private sector banks
Punjab National Bank (PNB)	Development Credit Bank Ltd. (DC)
Syndicate Bank (SB)	HDFC Bank Ltd (HDFC)
UCO Bank (UCOB)	ICICI Bank Ltd (ICICI)
Union bank of India (UBI)	IndusInd Bank Ltd (INDUS)
United Bank of India (UBOI)	Kotak Mahindra Bank Ltd (KMB)
Vijaya Bank (VB)	Axis Bank Ltd. (Axis)
SBI and Its Associates	Yes Bank Ltd (YES)
State Bank of Bikaner and Jaipur (SBB&J)	
State Bank of Hyderabad (SBH)	
State bank of India (SBI)	
State Bank of Mysore (SBM)	
State Bank of Patiala (SBP)	
State Bank of Travancore (SBT)	

List of public sector and private sector banks in India (size-wise)*

Public sector banks	Private sector banks
Large banks	Large banks
State bank of India	HDFC Bank Ltd
Bank of Baroda	ICICI Bank Ltd
Bank of India	Axis Bank Ltd
Punjab National Bank	Yes Bank Ltd
Canara bank	Jammu & Kashmir Bank Ltd
Union bank of India	IndusInd Bank Ltd
IDBI Bank	
Central Bank of India	
Mid Size Banks	Mid Size Banks
Allahabad Bank	Tamilnad Mercantile Bank Ltd
Andhra Bank	Karnataka Bank Ltd
Corporation Bank	ING Vysya Bank Ltd
Indian Bank	Karur Vysya Bank Ltd
Indian Overseas Bank	South Indian bank Ltd
Oriental Bank of Commerce	Federal Bank Ltd.
Syndicate Bank	Kotak Mahindra Bank Ltd
UCO Bank	
State Bank of Hyderabad	
Small Size Banks	Small Size Banks
State Bank of Mysore	Catholic Syrian Bank Ltd.
State Bank of Bikaner and Jaipur	City Union Bank Ltd.
Punjab and Sind Bank	Dhanalakshmi Bank Ltd
State Bank of Patiala	Lakshmi Vilas Bank Ltd
State Bank of Travancore	Nainital Bank Ltd
United Bank of India	Development Credit Bank Ltd
Dena Bank	Ratnakar Bank Ltd
Bank of Maharashtra	
Vijaya Bank	

* On the basis of the business (deposits + advances) of the year 2014 of the banks

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