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Integrated & Individual Approach of Measuring Market & Credit Risk

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All financial institutions have diversified portfolio which are exposed to various kind of risks, such as market risk, credit risk and operational risk. Today, precision in calculation of risk is a herculean task and almost all organization is spearheading in the same direction to have a better success & growth rate at all levels. Conventionally, the mechanism of risk (market & credit) calculation was based on integrated approach. While today, with the introduction of various norms, guidelines and policy, the mechanism look forward for a disintegrated approach to calculate risk as the pool of risk basket has increased and therefore calculating risk separately would call for a more accurate risk measurement. The paper attempts to calculate the credit & market risk constituting the important risk component both in integrated and disintegrated manner focused on Indian banks in public sector. Regression based models have also been illustrated for determining the relation between risk and respective affecting factors in a separate and an integrated manner. Further, the paper highlights the comparison of both the approach and suggests feasibility of approach for calculation in different situations.

Keywords: Market risk, Credit risk, GDP, Loan loss provision, T-bill, Integrated approach

Introduction

Risk in simple terms can be defined as probability of having an output against expectations completely or partially. Each organization has a portfolio with a set of assets. These portfolios are exposed to three basic risks, namely, market risk, credit risk, and operational risk. Market risk is the extent of decrease in investment due to changes in various market factors. Credit risk is the probability of default i.e. inability of meet financial obligation within a stipulated time by any person or organization.

In historical perspective risk has been measured as a single entity. Though lately for better risk management, separate measurement of risk has been considered as a better approach. In the separate calculation the total risk was determined by summation of the individually calculated credit risk and market risk. Combined calculation of the credit and the market risk was traditionally supposed to be the optimum method for calculating risk as it has been observed that both the market & credit risk are significantly related to each other.

This paper tends to calculate risks as individual entity as well as a single combined entity to determine the better method for calculation of risk based on certain factors. The study considers 16 public sectors over a period from 2003-2010. The models for determining risk have a regression based approach. Each model draws a regression equation based on various factors, as below

For Market Risk - Foreign exchange rate of US Dollar & Euro, Gross Domestic Product(GDP) , T-bill rate , Investment portfolio of the banks based on 4 categories namely, Government Securities, Equity, Debentures & bonds & other investments

For Credit Risk – GDP, Net Non-Performing Assets to Net Advance of the banks, tier1capital/tier 2 capital to measure leverage of the bank.

For Integrated measurement- Foreign exchange rate of US Dollar & Euro, Gross Domestic Product(GDP) , T- bill rate , Investment portfolio of the banks based on 4 categories namely, Government Securities, Equity, Debentures & bonds & other investments, Net Non-Performing Assets to Net Advance of the banks, tier1capital/tier 2 capital to measure leverage of the bank.

Based on the above factors models have been designed in the regression equation form:

$RV = a_0 + a_1 * f_1 + a_2 * f_2 + ... + a_n * f_n$,

Where,

RV = Risk value

a_0 = Constant in the model

a_1, ..., an = Coefficients of the model

f_1, f_2, ...f_n = Independent factors determining risk

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The paper further discusses the various literatures available in the subject & supporting the study. The literature review is followed by methodology which discusses the data collection, model development & analysis. The models are discussed in details with factors involved, its significance is also been studied.

Literature Review

The Basel Committee had started with the calculation of risk capital as a whole and identified credit risk, market risk and operational risk as its three basic components.

Models had been developed by Breuer et al (2007) doing a situational analysis thus comparing where an integrated and an individual analysis is better for a portfolio. Emmanuel E and Samuel O (2009) stated various risks which a banking institution is exposed to and emphasized on proper management of these so as to determine the future of the bank. Liquidity, gross domestic product, business operations, and international and domestic market have been identified by Voon-Chang, Yap et al (2010) as factors affecting bank risk exposure. Nor Hayati and Nizan (2004) considered factors like loan loss provision, regulatory capital, risk-weighted assets that affect the credit risk. Barnhill and Maxwell (2002) have taken factors like foreign exchange risk for finding the overall assessment of portfolio risk by using an integrated approach. Gibson (2000) developed a model using the loan loss provision of the banks so as to determine the credit quality of their portfolios. Gorvett writes about the issue of how the companies are exposed to market risk due to the changes in the foreign exchange rates. Considering the variation in the market risk with changes in the share price is very well given in the Capital Asset Pricing Model (CAPM) which talks about asset's sensitivity to the market risk in the financial industry.

Thus, taking factors like GDP, leverage, foreign exchange rate, provision for doubtful debts, portfolio investment ratio into considerations for the analysis of credit risk and market risk, in our paper we will try to derive results through regression analysis to figure out which among the separate or integrated approach is a better method for the risk assessment.

Methodology & Analysis

As the paper intends to determine the better method for measuring risk whether separate or combined based on certain factors therefore Regression based approach is used. The regression equations are used for modeling the separate & combined risk measurement. The data is collected for a period from 2003-2010 for 16 public sector banks in India. The data related to the values of various factors that impact the risk & are being used to model it. The models are defined by the equations. The 16 public sector banks were selected based on availability of factor related data from a set of all public sector banks. Pre data analysis brought all data in common scale through log conversion to increase the accuracy of the results. Due to conversion of factor values to log we have applied the linear regression to generate the model.

The data so collected & processed is analyzed in the SPSS tool wherein we carry out the ANNOVA test to verifying the null hypothesis at a significance level of 1%, R2 & adjusted R2 value to get the level of behavioral impact of these factors on the risk.

Model-Market Risk

Model Hypothesis are:

Null Hypothesis H_o: states that GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate does not have an impact on the market risk.

Alternative Hypothesis H_a: states that the GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate have an impact on the market risk.

The proposed model for market risk has been given as follows:

$$\log\beta = a_{m0} + a_{m1} * \log\$ + a_{m2} * \log€ + a_{m3} * \log GDP + a_{m4} * loggsec + a_{m5} * logequity + a_{m6} * logdebon + a_{m7} * logothers + a_{m8} * logtbill$$

where,

a_{m0} = constant

$a_{m1}, a_{m2}, a_{m3}, a_{m4}, a_{m5}, a_{m6}, a_{m7}, a_{m8}$ = coefficients of factors used

log β	=	Market Risk
log$	=	The exchange rate as Rs/$
log €	=	The exchange rate as Rs/€
logGDP	=	Gross Domestic Product of India
loggsec	=	Investment Ratio of a bank in Government Securities = Inv estment in Government Securities by a bank in a year 'n' Total investment by a bank in a year 'n'

logequity	=	Investment Ratio of a bank in Equity = Investment in Equity by a bank in a year 'n' Total investment by a bank in a year 'n'
logdebon	=	Investment Ratio of a bank in Debentures & Bonds = Investment in Debentures & Bonds by a bank in a year 'n' Total investment by a bank in a year 'n'\
logothers	=	Investment Ratio of a bank in other investments = Investment in other investments by a bank in a year 'n' Total investment by a bank in a year 'n'
logtbill	=	Treasury bill rate

Market Risk Model Variable

Table 1: Summary of regression result for market risk

Variables	Coefficient	Coefficient Value
(Constant)	a_{m0}	0.064
log$	a_{m1}	0.245
log€	a_{m2}	0.110
logGDP	a_{m3}	0.072
loggsec	a_{m4}	0.009
logequity	a_{m5}	0.020
logdebon	a_{m6}	-0.006
logothers	a_{m7}	0.029
logtbill	a_{m8}	-0.008

Using the coefficients calculated using SPSS tool in Table 1 as above, the proposed model can be written as below:

logβ = 0.064 + 0.245 * log$ + 0.110 * log€ + 0.072 * logGDP + 0.009 * loggsec + 0.02 * logequity - 0.006 * logdebon + 0.029 * logothers - 0.008 * logtbill

This equation with Adjusted R2 0.366 or 36.6% demonstrates and signifies that the GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate define 36.6% of the behavioral aspect of market risk for Indian public sector bank for the considered time frame.

Table 2: Table defining F-test for market risk b

	Sum of Squares	Degree of Freedom	Mean Square	F value	Sig.
Regression	.055	8	.007	10.182	.000(a)
Residual	.080	119	.001		
Total	.135	127			

a predictors: (Constant), LN_TBILL, LN_OTHER, LN_DEBON, LN_EQUIT, LN_GSEC, LN_GDP, LN_EURO, LN_USD

b Dependent Variable: LN_BETA

At 1% significance level F_{cal}=10.182, standard $F_{tab(8,119)}$= 2.66

As $F_{cal} > F_{tab}$ so the null hypothesis is rejected. Hence GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate have an impact on the market risk.

Model-Credit Risk

Model Hypothesis are:

Null Hypothesis Ho: states that GDP, Nonperforming Assets and leverage does not have an impact on the credit risk.

Alternative Hypothesis Ha: states that that GDP, Nonperforming Assets and leverage have an impact on the credit risk.

The proposed model for credit risk has been given as follows:

logpro = a_{c0} + a_{c1} * lognpa + a_{c2} * loglev + a_{c3} * logGDP

where,

a_{c0} = constant

a_{c1}, a_{c2}, a_{c3} = coefficients of factors used

logpro	=	Credit Risk Value = Provision for doubtful debt of bank / Total Assets
lognpa	=	Ratio of Net Non-Performing Assets to Net Advance of the banks each year
loglev	=	Tier 1 capital/Tier 2 capital
logGDP	=	Gross Domestic Product of India

Credit Risk Model Variables

Table 3: Summary of regression result for credit risk

Variables	Coefficient	Coefficient Value
Constant	a_{c0}	0.147
lognpa	a_{c1}	0.510
loglev	a_{c2}	-0.294
logGDP	a_{c3}	-0.148

Using the coefficients calculated using SPSS tool in Table 3 as above, the proposed model can be written as below:

logpro = 0.147 + 0.510 lognpa - 0.294 loglev - 0.148 logGDP

This equation with Adjusted R2 is 0.235or 23.5% demonstrates and signifies that the GDP, Nonperforming Assets and leverage define 23.5% of the behavioral aspect of credit risk for Indian public sector bank for the considered time frame.

Table 4: Table defining F-test for credit risk b

	Sum of Squares	Degree of Freedom	Mean Square	F value	Sig.
Regression	.113	3	.038	14.028	.000(a)
Residual	.334	124	.003		
Total	.447	127			

At 1% significance level F_{cal}=14.028, standard $F_{tab(3,124)}$=3.95.

As $F_{cal} > F_{tab}$ so the null hypothesis is rejected. Hence GDP, Nonperforming Assets and leverage have an impact on the credit risk.

Integrated Model-Market Risk & Credit Risk

Model Hypothesis are:

Null Hypothesis Ho: states that GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate , Nonperforming Assets and leverage does not have an impact on the integrated market & credit risk measurement.

Alternative Hypothesis Ha: states that that GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate , Nonperforming Assets and leverage have an impact on the integrated market & credit risk measurement.

The proposed model for integrated (credit & market) risk has been given as follows:

$$Logpro\_\beta = a_{i0} + a_{i1} * log\$ + a_{i2} * log€ + a_{i3} * logGDP + a_{i4} * loggsec + a_{i5} * logequity + a_{i6} * logdebon + a_{i7} * logothers + a_{i8} * logtbill + a_{i9} * lognpa + a_{i10} * loglev$$

where,

a_{i0} = constant

a_{i1}, a_{i2}, a_{i3}, a_{i4}, a_{i5}, a_{i6}, a_{i7}, a_{i8}, a_{i9}, a_{i10} = coefficients of factors used

Logpro_β	=	Integrated value of Credit risk measure (Provision for doubtful debt of bank / Total Assets)and Market Risk (Beta)
log$	=	The exchange rate as Rs/$
log€	=	The exchange rate as Rs/€
logGDP	=	Gross Domestic Product of India
loggsec	=	Investment Ratio of a bank in Government Securities = Investment in Government Securities by a bank in a year 'n' Total investment by a bank in a year 'n'
logequity	=	Investment Ratio of a bank in Equity = Investment in Equity by a bank in a year 'n' Total investment by a bank in a year 'n'
logdebon	=	Investment Ratio of a bank in Debentures & Bonds = Investment in Debentures & Bonds by a bank in a year 'n' Total investment by a bank in a year 'n'
logothers	=	Investment Ratio of a bank in other investments = Investment in other investments by a bank in a year 'n' Total investment by a bank in a year 'n'
logtbill	=	Treasury bill rate
lognpa	=	Ratio of Net Non-Performing Assets to Net Advance of the banks each year
loglev	=	Tier 1 capital/Tier 2 capital

Integrated market & credit risk model Variables

Table 5: Summary of regression result for integrated (market & credit risk)

Variables	Coefficient	Coefficient Value
Constant	a_{i0}	0.248
log$	a_{i1}	0.005
log€	a_{i2}	0.142
logGDP	a_{i3}	0.057
loggsec	a_{i4}	0.029
logequity	a_{i5}	-0.421
logdebon	a_{i6}	0.733
logothers	a_{i7}	-0.475
logtbill	a_{i8}	-0.331
lognpa	a_{i9}	0.632
loglev	a_{i10}	-0.286

Using the coefficients calculated using SPSS tool in Table 5 as above, the proposed model can be written as below:

$$logpro\_\beta = 0.248 + 0.005 * log\$ + 0.142 * log€ + 0.057 * logGDP + 0.029 * loggsec - 0.421 * logequity + 0.733 * logdebon - 0.475 * logothers - 0.331 * logtbill + 0.632 * lognpa - 0.286 * loglev$$

This equation with Adjusted R2 is 0.479or 47.9% demonstrates and signifies that the GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate, Nonperforming Assets and leverage define 19.5% of the behavioral aspect of integrated market and credit risk for Indian public sector bank for the considered time frame.

Table 6: Table defining F-test for integrated (market & credit) risk b

	Sum of Squares	Degree of Freedom	Mean Square	F value	Sig.
Regression	.272	10	.027	12.693	.000(a)
Residual	.251	117	.002		
Total	.524	127			

At 1% significance level F_{cal}=12.693, $F_{tab(10,117)}$= 2.66.

As Fcal >Ftab so the null hypothesis is rejected. Hence GDP, Exchange rate for Euro & US Dollar, investment portfolios of the banks, t-bill rate, Nonperforming Assets and leverage have an impact on the integrated market & credit risk measurement.

Conclusion

This paper formulates a regression based approach for measuring the credit & the market risk in an integrated and disintegrated manner based on number of factors. In the integrated manner the market and credit risk are defined based on several factors. These models are focused on Indian public sector banks i.e. the model equations derived on Indian banking sector. One of the important points of the study is the number of factors we have considered for our study which are significantly large. Based on above proposed model and the various statistical analysis, the paper is defining a method for public sector banks in India that can be used to determine the credit risk and market risk based on considered factors. The market risk and credit risk can be individually calculated or can also be calculated with an integrated approach based on the scenario for which risk needs to be determined.

Future Scope

As per the future scope this study can be implemented to any country banking system with factors that affect risk in that economical, social & political condition. The main objective for any risk measurement is a better risk mitigation. Secondly, a situational analysis can be done wherein various other situations where these risks should be measured separately and in a combined way can be determined by defining portfolios of organizations assets. Based on the derived portfolios better risk measurement techniques between integrated or disintegrated approach can be determined.

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Appendix

Market Risk Model

Table 7: Table defining model summary for market risk [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin - Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.637(a)	.406	.366	.0259493	.406	10.182	8	119	.000	2.585

Credit Risk Model

Table 8: Table defining model summary for credit risk b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin - Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.503(a)	.253	.235	.0519071	.253	14.028	3	124	.000	1.538

Integrated Market & Credit Risk Model

Table 9: Table defining model summary for integrated (market & credit) risk b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin - Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.721(a)	.520	.479	.0463339	.520	12.693	10	117	.000	1.808

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