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ORIGINAL ARTICLE

INTERPLAY OF RISKS IN BANKING: A SURVEY OF LITERATURE

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Abstract:

"It would be a mistake to conclude that the only way to succeed in banking is through ever-greater size and diversity. Indeed, better risk management may be the only truly necessary element of success in banking."-Alan Greenspan, Ex Chairman of the Federal Reserve of the United States, Speech to the American Bankers Association, May 2004

KEYWORDS:

Bank linage, Micro finance, NABARD. Self Help Group, Performance .

INTRODUCTION:

The word risk is derived from an Italian word "Risicare" which means "To Dare". It is an expression of danger of an adverse deviation in the actual result from any expected result. Another widely accepted definition of risk is given by Banks for International Settlement (BIS). It is defined as the threat that an event or action will adversely affect an organization's ability to achieve its objectives and successfully execute its strategies.

Risk Management is a planned method of dealing with the potential loss or damage. Financial risk management has been defined by the Basel Committee (2001) as a sequence of four processes:

Identification of events into one or more categories of market, credit, operational, and "other" risks and into specific subcategories
The assessment of risks using data and a risk model
The monitoring and reporting of the risk assessments on a timely basis
The control of these risks by senior management.

The risks faced by various banks increased over a period of time and they became highly vulnerable. This led to the emergence of the Basel Accord.The Basel Committee on Banking Supervision, which came into existence in 1974, volunteered to develop a framework for sound banking practices internationally. In 1988 the full set of recommendations was documented and given to the Central banks of the countries for implementation to suit their national systems. This is called the Basel Capital Accord or Basel I Accord. It provided level playing field by establishing a minimum level of capital for internationally active banks.

The Accord confirmed that the target standard ratio of capital to weight risk assets be set at 8%, at least 50% of which must be covered by Tier 1 capital.The equation of capital requirements is as follow:

(Tier 1 capital + Tier 2 capital)/ {RWA (0%) +RWA (20%) +RWA (50%) +RWA (100%)}>.08

Although the 1988 Accord increased the stability of the international banking system, the accord had several limitations.The Basel Committee on Banking Supervision (the Committee) recognized over

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time these limitations asbanking has changed dramatically since Basel I. Advances in risk management and the increasing complexity of financial activities / instruments (like options, hybrid securities etc.) prompted international supervisors to review the appropriateness of regulatory capital standards under Basel I. After the 1996 amendment to the Capital Accord of 1988 banks are required to measure and apply capital charges in respect of their market risks in additional to their credit risks.

As a result the bank's overall minimum capital requirement is the credit risk requirements of 1988 plus the capital charges for market risks described in the 1996 amendment. To calculate the capital ratio, an explicit numerical link is created by multiplying the measure of market risk by 12.5 (i.e., the reciprocal of the minimum capital ratio of 8%) and adding the resulting figure to the sum of risk-weighted assets (RWA) compiled for credit risk purposes. The ratio is then calculated in relation to the sum of the two, using as the numerator only eligible capital."The Committee suggests two methods to measure the market risks: the standardized approach and an alternative methodology—the bank's internal models approach.

In 1999 the Committee considered the possible use of portfolio credit risk models in setting regulatory capital requirements and issued a new Proposal of Capital Adequacy Framework to replace the 1988 Accord with a more risk-sensitive framework. The new proposal (BASEL II) is based on three mutually reinforcing pillars that allow banks and supervisors to evaluate properly the various risks that banks face and realign regulatory capital more closely with underlying risks.

Each of these three pillars has risk mitigation as its central board. The new risk sensitive approach seeks to strengthen the safety and soundness of the industry by focusing on:

Risk based capital (Pillar 1)
Risk based supervision (Pillar 2)
Risk disclosure to enforce market discipline (Pillar 3)

But this gradual inclusion of all the different types of risks has lead to a piecemeal approach. Their interaction remained highly ignored, at least till the time of the recent financial crisis of 2007.Thus, it became necessary to re-visit Basel II and plug the loopholes and make Basel norms more stringent and wider in scope. Basel III is a comprehensive set of reform measures, developed by the Basel Committee on Banking Supervision, to strengthen the regulation, supervision and risk management of the banking sector. To increase the loss-absorbing capacity of bank capital the Basel Committee have introduced two additional capital requirements for the trading book, the “incremental risk capital” charge (IRC) and the stressed value-at-risk.

Old capital requirement = Current VaR + Specific risk charge
New capital requirement = Current VaR + Specific risk charge + IRC + Stressed VaR

The Indian Banking Regulation Act of 1949 defines the term Banking Company as "Any company which transacts banking business in India" and the term banking as "Accepting for the purpose of lending all investment of deposits, of money from the public, repayable on demand or otherwise and withdrawal by cheque, draft or otherwise".

The Indian Banking industry can be broadly classified into two major categories, non-scheduled banks and scheduled banks.The scheduled banks are those, which are entered in the Second Schedule of RBI Act, 1934.Financial Sector Reforms set in motion in 1991 have greatly changed the face of Indian Banking. The banking industry has moved gradually from a regulated environment to a deregulated market economy.As per the Reserve Bank of India guidelines issued in Oct. 1999, there are three major types of risks encountered by the banks and these are Credit Risk, Market Risk & Operational Risk.

1.Capital and Risk

According to RBI, Capital is to provide a stable resource to absorb any losses arising from the risks in its business.Capital is divided into tiers according to the characteristics/qualities of each qualifying instrument. For supervisory purposes capital is split into two categories: Tier I and Tier II. These categories represent different instruments' quality as capital. Tier I capital consists mainly of share capital (Ordinary shares, Perpetual Non-cumulative Preference Shares (PNCPS) and innovative perpetual debt instruments (IPDI) and disclosed reserves and it is a bank's highest quality capital because it is fully available to cover losses. The elements of Tier II capital include undisclosed reserves, revaluation reserves, general provisions and loss reserves, hybrid capital instruments, subordinated debt and investment reserve account. The loss absorption capacity of Tier II capital is lower than that of Tier I capital.

The Economic Capital is the amount of the capital that the firm has to put at risk so as to cover the

potential loss under the extreme market conditions. In other words, it is the difference in mark-to-market value of assets over liabilities that the bank should aim at or target.According to Basel (Basel Committee, 2008) - Economic capital can be defined as the methods or practices that allow banks to attribute capital to cover the economic effects of risk-taking activities.

In the context of Basel II, the risk that the obligor (borrower or counterparty) in respect of a particular asset will default in full or in part on the obligation to the bank in relation to the asset is termed as Credit Risk.In RBI Guidelines Credit Risk is defined as-"The risk of loss arising from outright default due to inability or unwillingness of the customer or counter party to meet commitments in relation to lending, trading, hedging, settlement and other financial transaction of the customer or counter party to meet commitments".

In general Credit Risk is also defined, "as the potential that a borrower or counter party will fail to meets its obligations in accordance in agreed terms".It is the possibility of losses associated with diminution in the credit quality of borrowers or counterparties. The goal of credit risk management is to maximize a bank's risk-adjusted rate of return by maintaining credit risk exposure within acceptable parameters.

RBI has defined market risk as the possibility of loss to a bank caused by changes in the market rates/ prices. RBI Guidance Note focus on the management of liquidity Risk and Market Risk, further categorized into interest rate risk, foreign exchange risk, commodity price risk and equity price risk.The Bank for International Settlements (BIS) defines market risk as "the risk that the value of 'on' or 'off' balance sheet positions will be adversely affected by movements in equity and interest rate markets, currency exchange rates and commodity prices".

Thus, Market Risk is the risk to the bank's earnings and capital due to changes in the market level of interest rates or prices of securities, foreign exchange and equities, as well as, the volatilities of those changes.It is defined as "the possibility of loss caused by changes in the market variables such as interest rate, foreign exchange rate, equity price and commodity price". It is the risk of losses in, various balance sheet positions arising from movements in market prices.

As per RBI, "Liquidity is a bank's capacity to fund increase in assets and meet both expected and unexpected cash and collateral obligations at a reasonable cost. Liquidity risk is the inability of a bank to meet such obligations as they become due, without adversely affecting the bank's financial condition. Effective liquidity risk management helps ensure a bank's ability to meet its obligations as they fall due and reduces the probability of an adverse situation developing. Liquidity risk for banks mainly manifests on account of the following: (i) Funding Liquidity Risk – the risk that a bank will not be able to meet efficiently the expected and unexpected current and future cash flows and collateral needs without affecting either its daily operations or its financial condition. (ii) Market Liquidity Risk – the risk that a bank cannot easily offset or eliminate a position at the prevailing market price because of inadequate market depth or market disruption."

For many reasons, both historical and practical, different risks have often been treated as if they are unrelated sources of risk: the risk types have been measured separately, managed separately, and economic capital against each risk type has been assessed separately. It is done so on the basis of instruments, holding period, and trading book vs. banking book. This distinction is convenient but not totally correct, as the same factors cause both types of risk. And these factors interact among each other as well. And thus their interrelation is very complicated. The identification of common risk drivershints at important interactions between different risks.

So far, two different approaches have been developed in literature for risk aggregation purposes: the "top down approach", where the individual risk marginal distributions are derived separately and then aggregated through a variance covariance or copula approach and the "bottom up (or base level) approach", that builds on a full modelling of common risk drivers and their interaction to accounts for the effect on risky assets of possible dependencies between various risk components.

Most banks do not have an economic capital model capable of integrating credit and interest rate risk. This lack of integration of risks was also identified as one failure of stress testing practices at banks prior to the outbreak of the recent crisis. So far there has been a limited discussion of how interdependencies across risks impact on economic capital. Neglecting dynamic interaction among risk drivers when measuring aggregate risks may lead to biased estimates of the overall risk exposure.

Against this back ground,the Basel Committeeon Banking Supervision establisheda working groupin 2006 - 08 to study the interaction of market and credit risk (the IMCRgroup).The mandate of thegroup was to conduct research that would lead to an improved understanding of theinteraction between market and credit risk and how this interaction is related to risk measurement and management.

2.Literature Review

The contribution of the existing literature is that they help us understand how interactions between market and credit risk occur and why they are important. The objective is to summarize research on the interaction of market and credit risk and its implications for risk management.

Fridson, Garman, and Wu (1997) investigate the role of the real interest rates as one of the determinants of aggregate default rates on high-yield bonds. Their model uses quarterly data series for the period 1971-95. The variables they work on are default rate, nominal interest rate and inflation.

For Default rate trailing 12-months' default rate on high-yield bonds, percentage-of-issuers basis, from Moody's Investors Service is selected. Nominal interest rates are taken as yield on ten-year U.S. Treasuries, from the Federal Reserve Board. Year-on-year percentage change in the Consumer Price Index, from the Bureau of Labour Statistics is treated as a proxy for inflation. The real interest rate is defined as the nominal interest rate minus the inflation rate for the same period. The expected inflation rate is expected to be the same as current inflation rate.

The empirical results of the study show that real interest rates, lagged by two years, significantly increase the explanatory power of previously established models of aggregate default rates.(Higher correlation of 69.1% and R square 47.7%). The lag is significant as it helps investors to identify future default rates, without having to forecast the future state of the markets.The results are in line with the idea that an increase in the cost of capital (interest rates) would not immediately lead companies to default. Instead, the contraction in economic activity resulting from a rise in real interest rates may occur only gradually and thus corporate failures would come only after a delay.

The quote from Jarrow and Turnbull (2000) "Economic theory tells us that market and credit risk are intrinsically related to each other and, more importantly, they are not separable. If the market value of the firm's assets unexpectedly changes – generating market risk – this affects the probability of default – generating credit risk. Conversely, if the probability of default unexpectedly changes – generating credit risk – this affects the market value of the firm – generating market risk".

It is one of the initial researches to show theoretically how to integrate interest rate (among other market risks) and credit risk using a reduced-form factor approach.They challenge that standard credit risk management models are of limited value as these models make a constant interest rate assumption and cannot replicate empirical regularities between bond yields, equity index returns and macroeconomic variables. This paper also discusses current credit risk methodologies such as KMV, Credit Metrics and credit risk+, their advantages and disadvantages.

This paper describes the two approaches to credit risk modelling - the structural and reduced form approaches. The first approach as described by Merton (1974) relates default to the underlying assets of the firm. The second approach prices credit derivatives by the observable term structures of interest rates for the different credit classes. This approach is termed the reduced form approach.

This is done by modelling the default process as a multi-factor Cox process; In a Cox process, default probabilities are correlated due to their dependence upon the same economic factors. Because default risk and an uncertain recovery rate may not be the sole determinants of the credit spread, convenience yield (type of liquidity risk) isincorporated as an additional determinant. To describe the dependence of the probability of default on the state of the economy proxy variables are used: the spot interest rate and the unexpected change in the market index.

Barnhill, Papapanagiotou, and Schumacher (2000)develop a model to undertake financial institution assets and liabilities risk assessments for hypothetical banks operating in the South African financial environment as of June 1999 in the context of financial system stability assessment. They present a model that measures both market and credit risk and propose an explicit link between changes in the relevant variables that characterize the financial environment and changes in the value of the bank's capital ratio.

They use the financial characteristics of the South African aggregate banking system, with respect to original capital ratio, size and non-performing loans ratio to define all hypothetical banks. They simulate the future financial environment as a distribution of possible scenarios. Each scenario is represented by specific changes in a set of correlated environmental variables and a specific credit quality for each bank's clients.

For each simulation run, a new financial environment (interest rate term structures, FX rates, market equity and real estate indices, gold price, and inflation rate) as well as credit ratings, default rates, and default recovery rates are created. This information allows the market value of the bank's assets, liabilities, equity, and capital ratio to be calculated for each simulation run.

The total number of correlated environmental variables used for the model is 57. 8 domestic correlated arbitrage free interest rate term structures (T bill, AAA etc), US, UK and Japan T-bills rate term

structure as foreign interest rates. Three foreign exchange rates were taken(US dollar, British pound, Japanese yen), 20 market indices and 20 real estate price indices along with gold price was also simulated. South African inflation rate was also include. Approximately 200 business loans , 200 mortgage loans , 15 other fixed income securities, 20 equity securities, 20 real estate assets and gold was used to model the bank's portfolio.

The data taken is for the period January 1996 – June 1999.The period from 1998-99 is characterised as higher volatility period. For credit transition matrix and mapping debt to value ratios into credit ratings and analysis of 244 companies belonging to 8 different sectors was done. Some assumptions were made because of data limitation.

The simulated prices are used to recalculate the value of the bank capital under each scenario. One of the main outcomes of the model, after many simulation runs, is an estimated distribution of the bank's capital to asset ratio, characterized by a mean and a standard deviation, as well as a VAR output indicating how frequently the bank's capital to asset ratio might fall below a certain threshold.

The simulation results demonstrate that the banks with loan portfolios concentrated in low credit rating categories and with high volatile financial environments are likely to face significant risk, even if their loan portfolios are well diversified. In addition, the simulation output shows that as the degree of concentration (Sectoral/geographic) increases, credit quality of the bank's loan portfolios deteriorates and, the simulated mean capital ratio declines significantly. In general, the importance of undertaking correlated market and credit risk analysis becomes visible in the case of a bank with high credit risk operating in a high market risk.

Barnhill and Gleason (2001) compare bank capital requirements estimates with an integrated market and credit risk simulation (using Barnhill et al model) to those calculated under the 1988 Basel Accord and proposed New Accord (Basel II) for a set of 54 hypothetical banks.

The fifty-four hypothetical banks analyzed reflect the various possible combinations of the four factors (Financial Environment Volatility, Asset Liability Maturity Gap, Credit risk, Portfolio concentration). Approximately equal numbers of banks had similar, higher, and lower simulated versus Basel capital requirements.

The analytical results for banks operating in “volatile financial environments and with medium-to-low credit risk”and “stable financial environments with high- to medium-credit risk” indicate that the simulated capital required is almost the same for both the 1988 Basel Accord and proposed New Accord. However, the results show that for banks operating in volatile financial environments with high credit risk, the simulated capital is much higher than the 1988 Accord and proposed New Accord (19.08% compared to 4.21% and 5.94% respectively). On the other hand, for banks operating in stable financial environments with low credit risk, as well as the simulated capital is much lower than with the 1988 Accord and proposed New Accord (1.14% compared to 4.16% and 4.24%, respectively).

They emphasize the serious limitation of the proposed New Accord, which include the lack of a conceptual framework for undertaking integrated bank risk assessments. They argue that the New Accord recognizes some of the factors that affect the risk level of a bank portfolio but not all. For instance, the New Accord does not account for the correlation between market and credit risk. It ignores the viewpoint that both market and credit risks are affected by economic and financial volatility.

Their results point towards the crucial importance of developing conceptual frameworks for undertaking integrated bank risk assessments. Absence of such a framework leads to serious issues for the three pillars of the New Basel Capital Accord.For Pillar 1 (Minimum Capital Requirements) will have serious errors in measuring bank risk levels and estimating appropriate capital levels. Pillar 2 (Supervisory Review Process) will lack the capacity to quantify overall bank risk levels and develop effective pre-emptive measures for managing them. Pillar 3 (Market Discipline) will not identify all crucial data required from banks and other sources for the market to make informed risk assessments.

The paper recommends to the Basel Committee to encourage the development of improved conceptual frameworks and data bases for undertaking integrated bank portfolio risk assessments, and adopt financial reporting requirements for banks that provide the basic information needed to estimate overall portfolio risk levels. It advocates the development of financial databases by banks, bank regulatory authorities, multi-lateral financial institutions that can facilitate modelling of global financial environment. According to the authors of this paper, financial environment simulation modelling combined with portfolio theory offers a very promising integrated risk assessment approach.

Barnhill and Maxwell (2002) recognize the importance of integrated risk assessment methodology. They measure credit and market risk for the whole portfolio of banks by developing a diffusion-based methodology for assessing the value-at-risk (VaR) of a portfolio of fixed income securities with correlated interest rate, interest rate spread, exchange rate, and credit risk. This is accomplished by simultaneously simulating both the future financial environment and the credit rating of specific firms,

Branhill et al model.

Overall portfolio risk in this model is a function of six types of underlying correlated and uncorrelated stochastic variables including interest rates, interest rate spreads, FX rates, returns on equity market indices (i.e. systematic risk), firm specific equity returns (i.e. unsystematic risk), and default recovery rates. The term market risk refers to the aggregate impact of interest rate, interest rate spread, and FX risk. These risks are jointly estimated by simulating both the future financial environment in which financial instruments will be valued and the credit rating of specific firms

The risk assessment methodology applied to a single bond demonstrates that while all four risk factors (interest rate, spread, credit, and FX risk) are important the most important for non-investment grade bonds is credit risk.The methodology is shown to produce reasonable credit transition probabilities, prices for bonds with credit risk, and portfolio value-at-risk measures.

Alexander and Pezier (2003) develop a common risk factor model to characterize the joint distribution of market and credit risk factors. The volatilities around P&L functions by business unit are related through a linear regression model to six common market and economic risk factors. These factors are modelled as leptokurtic normal mixture distributions and only tail correlations are used to model the dependence between risk factors and aggregate economic capital.

Economic capital data from 3 major banks is collected to construct the economic capital for the fictitious sample bank by taking a simple average. The economic capital estimates of the model are then compared with this sample bank EC data. They find that the aggregate economic capital estimates benefit of negative risk factor correlations (Approximate reduction of 20%). Another application of the model shown in the paper is for the purpose of constrained optimization of risk and return objective.

A total of 1000 observations historical Data is taken for the US market (4 January 1999 to 31 December 2002) to construct the model.

S No.	Main Risk	Factor	Variable used
1	Interest rates	Parallel shift	I year interest rate
		Slope	10year interest rate- 1 year interest rate
		Volatility	3 month volatility on 1 year interest rates MOVE (implied volatility index)
2	Equity	Overall level	S&P 500 equity index
		Volatility	Implied volatility index (CBOE VIX index)
3	Credit	Credit spread	credit spread of 10year Baa bond index over matching treasuries

Sy, A. (2005) measures and assesses the management of interest rate risk of banks' government securities portfolios in India, which it identifies as a key risk for the banking system using duration and value-at-risk methods. Weighted durations and convexities of government securities portfolios are calculated using the maturity profile of government securities investments and data from the NSE government securities index.

Under scenario analysis, 3 scenarios are created and their effect is studied. In scenario 1, a one percentage point parallel rise in the entire yield curve is considered. Second scenario assumes a shock double the size of that in Scenario 1. Scenario 3 assumes a 320 basis point increase, the worst-case increase in government securities yields over one year with a 1 percent probability. It is assumed that yields are normally distributed. A duration mapping method with linear interpolation using information from zero coupon government securities from the National Stock Exchange (NSE) is used.

In particular, it is found that the current aggregate level of investment fluctuation reserve (IFR) in the banking system would be insufficient to compensate for market losses resulting from a one percentage point parallel shift in the yield curve. Some PSBs and old private banks are vulnerable to a reversal of the

interest rate cycle, foreign and new private banks have built in an adequate cushion. In this regard, the paper makes a number of recommendations regarding government policies and individual bank practices to manage interest rate risk.

FioriandIannotti(2008)examinedtheinteractions of market risk and credit risk inalarge dimensional factor model to identify the common sources of risk driving fluctuations in the economic and the financial sectorfortheItalian economy.The common factors are then analyzed in a Factor Augmented Vector Autoregressive (FAVAR) approach in order to understand the co-movement of the risk factors and the response of key selected variables to specific shocks.The paper allows for feedback dynamics and interdependence between the financial sector and the real economy.

The data used consists of a balanced panel of 99 quarterly time series over the period March 1991-September 2006. Different risk variables are included in the dataset:

· Macroeconomic risk variables (real GDP growth, industrial production indexes, unit labour costs, productivity, new orders, household consumptions, exchange rate changes, inflation rate changes, indicators of the monetary and credit conditions- indicators of money supply, the spread between the rate on loans to firms and the risk free rate, the difference between the average and the minimum rate on loans to firms);

· Credit risk variables (Corporate default rates defined as the ratio of the number of new borrowers defaulting to the number of performing borrowers at the beginning of the reference period)

· Market risk variables (Italian equity stock indexes returns and their realized volatilities calculated as the sum over a three-month period of squared returns on a weekly basis, slope of the yield curve, long term interest rates, DataStream Global Index for the Italian market and for the different economic sectors ,price-earnings ratio of the Italian stock market global index, Proxy for investors risk appetite- the equity market risk premium- difference between the inverse of the PE ratio and the redemption yield on the 10 year benchmark government bond, Fama and French factors- momentum UMD, excess return on market MKT, size effect SMB, High minus low HML);

· Global cycle variables (oil price and S&P 500, as indicators of global conditions).

The analysis is done in two steps after all the series are transformed to induce stationarity. In the first step, few unobservable factors are extracted from a large panel of cross sectional data using Principal Component Analysis. 4 significant risk latent factors are found explaining 55 per cent of total variation. To interpret these latent factors the variables in the original dataset are regressed onto each factor and looking at the R-squared of these regressions the factors are identified as the equity risk driver, the macroeconomic risk driver, the volatility risk driver, the credit risk driver. These drivers together with the short term interest rate (observable risk driver) represent the common forces in the Italian economic and financial sector affecting the credit and market risk of an asset portfolio.

In the second step, the estimated risk factors are inserted in a VAR framework (FAVAR) to analyze the impulse response functions (IRF) and the patterns of co-movement in key selected variables (default rates, real activity measures, asset prices, price-earnings ratio) to a 50-basis point increase in short term interest rate. The IRF reflect the dynamic interaction of the underlying risk factors.

For credit risk, results demonstrate that an increase in interest rates determines higher financing costs for firms, with higher probability of financial distress and default, both at aggregate and sectoral level. As for market risk, a 50-basis point increase in short term interest rate leads to an immediate decline in equity returns (different intensity across sectors) and the price-earnings ratio of the Italian stock market index. The slope of the yield curve declines but not significantly. The spread also declines and its adjustment is more rapid than the slope adjustment. Finally, the risk premium increases but not significantly. All the shocks vanish in about two years. The exchange rate appreciates as the likely capital inflow increases when interest rates increase.

The second set of results deals with the role of the dynamic interactions among different risk drivers. In order to better understand the role performed by each underlying common factor in the system, The VAR model is simulated with the five factors (the four latent factors plus the interest rate shock) by sterilizing the effect of each factor, one at a time. This is done by setting the coefficients of the underlying common risk factor of interest in the equation in the VAR system to 0. This helps to see how impulse response functions of key selected variables change when imposing zero restrictions on each latent risk driver.

These interactions appears clearly when considering not only the direct impact of the shock on each risk variables, but also the feedback effect deriving from the dynamic responses of all risk factors to the same shock. It is found that in response to a positive shock in interest rates both market and credit risk increase, with the latter effect being amplified by a deterioration of the macroeconomic conditions. The impact of a monetary policy shock on credit risk is amplified when considering the feedback effect deriving from the dynamic interaction among risk factors (macroeconomic and market risk factors) in response to

the same shock. In particular, the true response of sectoral corporate default rates (proxy for credit risk) to a shock in the short-term interest rate (50 basis points increase in the monetary policy rate) increase six-fold when one accounts for the dynamic interactions of market risk proxies with other risk drivers. The same happens for the macroeconomic risk factor.

Drehmann et al. (2010) models both sides of the assets, liabilities and off-balance-sheet items, by accounting for their re pricing characteristics to assess the integrated impact of credit and interest rate risk on banks' economic value and capital adequacy. Their model exhibits three types of interaction between interest rate and default risk: (i) common factors drive interest rates and defaults, (ii) interest rates are an important determinant of defaults and (iii) defaults significantly influence net interest income (NII). They also conduct stress testing exercise on a hypothetical but realistic bank to assess how important interactions between the two types of risk are and their effect on bank profitability and bank capital.

Their stress test follows the assumptions of the Financial Sector Assessment Program conducted by International Monetary Fund in UK in 2002:

(i)a 12% decline in property prices,
(ii)an inflation shock driven by a 1.5% unanticipated rise in earnings growth and
(iii)A 15% unanticipated depreciationin the sterling exchange rate.

They judge the results of the stress-test by two criteria (economic value condition, capital adequacy condition). Economic value condition is based on whether the mark to model value of the bank's assets is large enough relative to the value of its liabilities. The capital adequacy condition reflects current general regulatory approaches i.e. whether a bank is sufficiently well capitalised in all future states of the world.

As a result of these shocks, NII first declines as margins between short-term borrowing rates and long-term lending rates are compressed. At the same time, number of borrower defaults increases leading to an increase in credit losses. Over time, however, banks regain their profitability as assets are re-priced, and lending margins recover as higher interest rates and credit risk are passed on to borrowers.

The simulations illustrate the importance of the interactions between market and credit risk. If net profitsover the forecast horizon are assessed, the largest part of the impact of the stress scenario is explained by "pure" interest rate risk. The effects of interactions between interest rates and defaults are greater than the effects of "pure" default risk. For capital adequacy, however, the effects of interactions reach almost two- thirds, much larger than either "pure" interest rate or "pure" default risk. They show that the interaction term is a significant driver of net-profitability and capital adequacy. The result of this paper suggests that the banks and supervisors should pay close attention to the interactions of market and credit risks in the banking book.

Alessandri&Drehmann, (2010) demonstrates non-linear, dynamic interactions between interest rate and credit risk in the banking book, taking the example of a representative UK bank (an average of the top-10 UK banks).They develop a framework to assess aggregate risk and derive integrated economic capital and compare it to economic capital set against credit as well as interest rate risk when interdependencies are ignored.

The credit risk component in the model is based on the same conceptual framework of Basel II. Interest rate risk is captured by earnings at risk approach. Economic capital is set in line with current market and regulatory practices. Credit risk and the yield curve are conditioned on a common set of systematic risk factors. Furthermore, the loss in coupon payments if assets default is also accounted for. The risks are integrated using the framework proposed by Drehmann et al. (2010), taking into account all relevant interactions between both risks. These are threefold: (a) both risks are driven by a common set of risk factors; (b) interest rates are an important determinant of credit risk; and (c) credit risk impacts significantly on net interest income.

A two-country Global Vector Auto regression (GVAR) model is used to model the macro environment.UK is treated as a small open economy and the US as a closed economy that is only subject to domestic shocks.12 Variables and data include real output, consumer price inflation, real equity prices, an overnight nominal interest rate, a 20-year synthetic nominal bond interest rate for UK and the real exchange rate against the dollar. For the US, the latter is replaced by oil prices. The model is estimated over a 1979Q1–2005Q4 sample. Simulations are driven by (a sequences of) macroeconomic shocks drawn from a multivariate normal distribution based on the estimated historical variance–covariance matrix. The pricing model requires a full risk-free nominal yield curve, obtained by a linear interpolation of the overnight and 20-year UK rates.) To estimate the impact of macro factors on PDs linear regressions are used where each asset's default frequency (log-odd transformed) is modelled as a function of output growth, return on equity and interest rates.

The results show that a relatively large portion of credit risk is idiosyncratic, and thus independent of the macroeconomic environment, and the correlation between systematic credit risk factors and interest rates is itself not perfect. Furthermore, assets in the bank's portfolio are repriced relatively frequently, and hence increases in credit risk can be partly passed on to borrowers.The results show that interactions matter, and that ignoring them leads to risk overstatement.

They compare the results from "bottom-up" simulations with "top-down" simulations and find that capital derived from a "top-down" calculation exceeds the capital derived from the "bottom-up" calculation, under a broad range of circumstances, suggesting that diversification effects emerge (some of them sizable), but compounding effects are absent. The difference between the two measures depends on various features of the bank.

Breuer et al. (2010)challenges a "top-down" aggregation of different types of risk, as it can neglect "compounding effects,". They argue that when, for example, market and credit risk are calculated separately, then whether the sum of the two risks is a "conservative" estimate of the overall risk depends on whether portfolio value changes caused by market and credit risk factors can be clearly divided into changes owing to market risk and changes owing to credit risk. If this cannot be done, there are a range of relevant cases in which harmful risk interactions lead to compounding.

They undertake a simulation exercise for foreign currency loans in Austria. The exercise starts from estimates of the distribution of risk factors and macro variables for Austria, France, Germany, Italy, Switzerland and the United States. Market, credit and overall risk are then simulated for a hypothetical portfolio of loans over a one-year risk management horizon.They use a GVAR to model the probability of risk factors. The variables considered for each country are real GDP, the three month LIBOR interest rate, and the exchange rate to the US dollar. Quarterly data from 1980q1 to 2005q4 is used to estimate the parameters and the distributional assumptions of the model based on which 1 year ahead paths of the relevant risk factors are simulated. Quarterly data 1989–2005 from the IFS of the International Monetary Fund is used to estimate the distribution of the macro risk factors.

This distribution along with the model assumptions is used to simulate the profit distribution for the loan portfolio. The distribution of the profit is calculated by a Monte Carlo simulation of 100 000 draws. In each macro scenario defaults of the customers' payment abilities is determined by draws from the distribution of the payment ability process. It is assumed that the bank leaves its loan portfolio unchanged over the time horizon.

Simply adding up the separately measured exchange rate and default risk components underestimates the actual level of risk by a factor of several times. For example, for a B+ rated obligor, the integrated risk measurement approach leads to an overall risk that is 1.5–7.5 times larger than the risk derived from a compartmentalized approach in which the risks are measured separately and then added up. This bias becomes more pronounced for portfolios with lower ratings.

Other examples where such malign interactions take place include adjustable rate loans and matching long and short positions in OTC derivatives.

Tang and Yan (2010)analyze the determinants of credit default swap (CDS) spreads and Moody's KMV expected default frequencies (EDFs), two widely used measures of default risk. They relate them to measures of market sentiment and volatility, which are the two widely used market risk factors.

The CDS data used in the analysis is from 2 CDS brokers- Credit trade (June 1997- March 2006) and GFI (Jan 2002- Nov 2006). They also undertake their analysis with Moody's Baa- Aaa spreads to alleviate concerns for the short time span. This data is available for the period 1976 – 2007. For Moody's KMV EDF, firms with outstanding CDS contracts between June 1997 and November 2006 are taken.

The analysis proceeds in two steps. First a time series estimations are conducted (both for cross-sectional averages of default risk proxies and for firm-by-firm regressions that are then averaged) to study the aggregate determinants of credit risk.

The proxies used to define the variables used in the aggregate analysis are as follows.

For Economic growth, Real GDP growth rate and Industrial production Growth rate numbers are used. To estimate for the volatility of the economic growth rate, unexpected growth rate is estimated using AR (1) process. Because of lack of a direct measure of level of investor risk aversion, Consumer confidence index numbers are used. Source for the same is Conference Board Consumer Confidence Index and the University of Michigan Consumer Confidence Index. Authors also include jump risk as a variable, which is measured by slope of implied volatility over strike prices (the 'smile") for S&P 500 index options.

The results for the aggregate time series analysis show that corporate default risk in the US increases with declining economic growth, increasing growth volatility, declining consumer confidence, and increasing implied stock market volatility.While macroeconomic conditions have a significant impact, but of all the

variables consumer confidence comes out as the strongest, whereas stock market volatility is significant in the averaged firm-by-firm regressions.When EDFs are used instead of CDS spreads, the results are relatively weaker in the aggregate regressions

An unbalanced panel analysis is undertaken to study the implications of firm heterogeneity for the interaction between credit risk and market risk.The variables used for the panel regression are defined as follows. Cash flow is taken as the quarterly operating cash flow adjusted for working capital accruals. Cash flow volatility is measured as the coefficient of cash flows for firm over a 6 year rolling window period. The cash-flow variables are, however, fully captured by individual firm leverage and stock return volatility (Control variables in the regression).

The results for the firm-by-firm panel suggest that the credit risk of US corporations increases with rises in the volatility of their cash flow and with declines in the so-called cash-flow beta (the estimated effect of general GDP growth on firms' cash flow). Firm-level variables account for a larger portion of the variation in CDS spreads (over 80%) compared with aggregate factors. They highlight the importance of firm heterogeneity in assessing the credit risk.

They regress credit spreads for the negative and positive period of GDP growth rate separately and conclude that the effect of the cash-flow beta is time-varying. In periods of positive growth firms with on average high cash-flow betas have lower CDS spreads. Systematic jump risk is more significant for short term default risk than long term default risk. These results strongly underline the role of market sentiment for CDS spreads, implying that care should be exercised not to interpret them as "pure" measures of default risk in isolation from market risk.

VarottoS. (2011) aims to understand the impact of new bank capital regulation for trading portfolios introduced by Basel III is investigated in this paper. The author estimates the new capital requirements for banks against market, credit and liquidity risk in their trading books. The results show a much greater increase in capital following the introducing of the new rules, much more than suggested by extensive impact studies conducted by the regulators with the participation of a large sample of banks. It is suggested in this paper that the lower impact on capital reported by the banks may be due to the assumed risk reduction because of the hedging strategies, which may be not very effective in crisis scenario, like the one witnessed recently. The efficacy of the new bank capital adequacy rules may be greatly impaired by the assumptions that banks make about their ability to manage risk in extreme scenarios.

To compare the size of new and old capital requirements in the trading book IRC, the pre-crisis VaR and the stressed VaR for bond portfolios with different credit rating and maturities and industry sectors is estimated. The portfolios comprises of 12 US corporate bond indices compiled by Bank of America-Merrill Lynch, sourced from DataStream. The indices characteristics are as follows. It covers 2 industry sectors (industrial and financial), two rating groups (AAAAA and A-BBB) and three maturity bands (5 to 10 years, 10 to 15 years and 15+ years). The sample consists of daily returns for the period May 2004 – August 2009.

Stressed VaRs estimated on corporate bond portfolios during the current crisis show that market risk related losses may be far greater and, depending on the characteristics of the portfolio, be more than ten times as large as the IRC.

The growth of securitisation over the years will make it increasingly important to betterunder stand the interaction of market, credit and liquidity risk. Develop aframe work that better integrates all three types of risk (Credit, market liquidity).

Various Issues / Questions Raised

What distinction can be drawn between these 2 risk types and if possible then how?
What relationships exist between them?
How should regulation and supervision account for these relationships?
Are present risk management and aggregation approaches precise in measuring and managing their combined risk?
Does simple additive rule provide a good approximation to the true integrated capital?
How should risk aggregation within the economic capital framework recognize the links between the two risk categories?
How to correctly measure the aggregate risk and the optimal level of capital required for it.
Whether the assessment of the risks jointly leads to diversification benefits or compounding effects?
What role does market liquidity play in the interaction of them?

These issues needs to be addresses in the future research done in this area.

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