Comments On The New Basel Capital Accord: The Crucial Importance of a Conceptual Framework*

By:

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Synopsis

This comment compares bank capital requirements estimated with an integrated market and credit risk simulation to those calculated under the 1988 and proposed new Basel Capital Accords for a set of banks. Under lower volatility (e.g. U.S.) financial market conditions the New Basel Capital Accord generally produces required capital adequate to protect against bank failure with a ninety-nine percent probability over a one-year time step. It is found that the simulated and Basel capital requirements are frequently close. However for banks with lower credit risk operating in lower volatility environments the Basel capital requirements generally appear to be to high. Alternatively for other banks with higher credit risk and concentrated portfolios the Basel capital requirements are too low, particularly so for those operating in higher volatility environments (e.g. emerging markets). It is shown that due to correlated interest rate and credit risk positive (negative) asset/liability maturity gaps likely increase (decrease) a bank's risk of failure. Recommendations focus on the crucial importance of continuing work to develop conceptual frameworks for undertaking integrated risk assessments and ad hoc improvements to the current proposals.

Summary and Introduction

The most serious limitation of the proposed New Basel Capital Accord is the lack of a conceptual framework(s) for undertaking integrated bank risk assessments. It is widely believed that economic and financial volatility drives both market and credit risk. This suggests that these two risks vary over time and location (e.g. country or region) and are correlated with one another. Simulation modeling can essentially match any assumed volatility and correlation structure for important financial environment variables (e.g. interest rates, FX rates, returns on corporate equities, returns on real estate assets, etc.). Earlier work on U.S. bond portfolios (Barnhill and Maxwell 2000), South African banks (Barnhill, Papapanagiotou, and Schumacher 2000), and Japanese Banks (Barnhill, Papapanagiotou, and Souto 2001) has shown that bank capital levels appropriate for reducing the risk of failure to a given probability over a given time step are related to:

- the volatility of the financial environments in which banks operate,
- the correlations between important financial market variables,
- the mean returns on important financial market variables (e.g. real estate),
- the distribution of credit qualities in the bank's loan portfolio,
- the diversification of the loan portfolio across types of loans (business loans, residential mortgage loans, commercial mortgage loans, etc.),
- the diversification of the business loan portfolio across sectors of the economy (e.g. agriculture, manufacturing, etc.),
- the diversification of the mortgage loan portfolio across geographic regions,
- asset and liability maturity and currency mismatches.
- the amount and diversification of equity and other direct investments across sectors of the economy (e.g. agriculture, manufacturing, etc.) and regions of the country.

The proposed Basel Capital Accord accounts for some but not all of these important factors. For example, the volatility of the relevant financial environments only affects

required credit risk capital levels indirectly through its impact on the credit rating of the borrower. This implies that banks operating in more stable financial environments may not have their lower risk levels fully recognized. Further the correlation between market risk (e.g. interest rates, exchange rates, and equity prices) and credit risk is not accounted for. Capital charges for these two risk factors are not simply additive. This means that if capital charges are set appropriately for credit and market risk separately and then added together overall bank capital requirements will likely be to high.

This comment compares minimum capital requirements estimated with an integrated market and credit risk simulation to those calculated under the 1988 and proposed new Basel Capital Accords for a set of fifty-four hypothetical banks. Approximately equal numbers of banks had similar, higher, and lower simulated versus Basel capital requirements. Banks operating in either a lower volatility financial environment with medium to higher credit and portfolio concentration risk, or in a higher volatility environment with medium to lower credit and portfolio concentration risk are found to have simulated capital requirements similar to the Basel capital requirements. Banks operating in a lower volatility financial environment with lower credit risk, or medium credit risk and lower portfolio concentration risk are found to have simulated capital requirements lower than to the Basel capital requirements. Similarly banks operating in a higher volatility financial environment with lower credit risk, and lower portfolio concentration risk are found to have simulated capital requirements lower than to the Basel capital requirements. Banks operating in a higher volatility financial environment with medium to higher credit risk and medium to higher portfolio concentration risk are found to have simulated capital requirements significantly higher than the Basel capital requirements.

In general due to negative correlations between interest rate changes and equity returns (and thus simulated credit risk) banks with a negative (positive) asset/liability maturity gap have lower (higher) simulated capital requirements. This suggests that it is very misleading to simply add capital requirements estimated for market and credit risk separately.

These results illustrate the crucial importance of developing conceptual frameworks for undertaking integrated bank risk assessments. Absent such a conceptual framework, each of the three pillars of the New Basel Capital Accord will have significant problems. Pillar 1 (Minimum Capital Requirements) will be based on a set of ad hoc rules that can lead to 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 preemptive 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.

Given that agreement on a conceptual framework is not anticipated prior to adoption of the New Accord, some of the above problems are unavoidable. However, to the extent practical, the New Accord should anticipate plausible conceptual frameworks for undertaking integrated bank risk assessments and incorporate their most important

insights. We believe that the New Accord should be viewed as an interim improvement over existing rules. A continued active effort on the part of the Basel Committee and others to resolve underlying conceptual and data issues is required. Waiting a number of years before taking the issue up again would seem inappropriate.

It is proposed that the Basel Committee:

- Explicitly endorse the need for and adopt rules that encourage the development of improved conceptual frameworks and data bases for undertaking integrated bank portfolio risk assessments which handle correlated market risk, credit risk, and ultimately operational risk.
- Adopt financial reporting requirements for banks that provide to the public the basic information needed to estimate overall portfolio risk levels. This would include information on credit quality distributions, sector and region loan concentrations, etc.
- Encourage banks, bank regulatory authorities, multi-lateral financial institutions, and others to develop financial databases that will facilitate modeling the global financial environment in which all institutions operate. This database should extend to real estate assets since much lending is secured by mortgages.
- Develop a conceptual framework for undertaking integrated bank risk assessments. Prior to the development of a conceptual risk analysis framework, the Committee should:
  - Identify a base level of assumed financial market volatility that underlies the proposed minimum capital requirements and adopt ad hoc adjustments to the proposed capital requirements that increase (decrease) required capital levels for banks operating in more (less) volatile financial environments.
  - Adopt ad hoc adjustments to the proposed capital requirements which further increase required capital levels for banks having multiple risk characteristics including high concentrations of high credit risk loans, high concentrations of loans in particular sectors or regions, and high financial market volatilities.

The remainder of this comment is organized as follows. First a brief introduction to the conceptual framework of the proposed simulation model is given. Next the simulation and Basel accords are applied to a set of fifty-four banks to estimate required capital levels. Comparisons of the two approaches ate then undertaken. Finally recommendations are offered.

A Conceptual Framework for Integrated Bank Risk Assessment: The Portfolio Simulation Approach

In the authors' view, financial environment simulation modeling combined with portfolio theory offers a very promising integrated risk assessment approach. In general, risk assessment methodologies seek to assess the maximum potential change in the value of a portfolio with a given probability over a pre-set horizon resulting from changes in market factors, credit risk, and liquidity risk. The current practice is to undertake market and credit risk assessments separately. Combining such separate risk measures into one overall portfolio risk measure is not easily accomplished. The absence of reliable overall

portfolio risk measures creates problems for determining capital adequacy requirements, capital-at-risk measures, hedging strategies, etc.

Given the correlated nature of credit and market risk (Fridson, Garman, and Wu 1997), the importance of an integrated risk assessment methodology seems apparent. To address the above risk measurement problem Barnhill and Maxwell (2000) develop 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. Barnhill, Papapanagiotou, and Schumacher (2000) extend the model to undertake financial institution asset and liability risk assessments for South African banks. Barnhill, Papapanagiotou, and Souto (2001) apply the model to Japanese banks.

As an overview, both the future financial environment in which the assets will be valued and the credit rating of specific loans are simulated. The financial environment can be represented by any number of correlated random variables. The correlated evolution of the market value of a business firm's equity, its debt ratio, and credit rating are then simulated in the context of the simulated financial environment. For non-recourse real estate loans a similar approach is used where the market value of the real estate property, its loan to value ratio, and credit rating are simulated. The structure of the methodology is to select a time step over which the stochastic variables are allowed to fluctuate in a correlated random process. The firm specific and property specific returns (as distinct from economic sector index and real estate index returns) and security specific default recovery rates are assumed to be uncorrelated with each other and the other stochastic variables. For each simulation run a new financial environment (correlated interest rate term structures, FX rate, market equity returns, and regional real estate index returns) as well as firm specific and property specific debt ratios, credit rating, and default recovery rates are created. This information allows the correlated values of financial assets (including direct equity and real estate investments) to be estimated, and after a large number of simulations, a distribution of portfolio values is generated and analyzed.

Simulating Interest Rates

The Hull and White extended Vasicek model (Hull and White; 1990a, 1993, 1994) is used to model stochastic risk-free interest rates. In this model interest rates are assumed to follow a mean-reversion process with a time dependent reversion level. The simulation model is robust to the use of other interest rate models. The model for *r* is:

$$\Delta r = a\left(\frac{\theta(t)}{a} - r\right)\Delta t + \sigma \Delta z \qquad (1)$$

where

Δr = the risk-neutral process by which *r* changes,

a = the rate at which *r* reverts to its long term mean,

r = the instantaneous continuously compounded short-term interest rate,

$\theta(t)$ = "Theta" is an unknown function of time that is chosen so that the model is consistent with the initial term structure and is calculated from the initial term structure

Δt = a small increment to time,

σ = "sigma" the instantaneous standard deviation of *r*, which is assumed to be constant, and

Δz = a Wiener process driving term structure movements with Δr being related to Δt by the function $\Delta z = \varepsilon\sqrt{\Delta t}$.

The above mean reversion and volatility rates can be estimated from a time series of short-term interest rates or implied from cap and floor prices. Credit spreads can either be modeled as correlated log normal variables or as fixed values.

Simulating Asset Prices and Returns

The model utilized to simulate the value of the equity market indices and FX rate (*S*) assumes that (*S*) follows a geometric Brownian motion where the expected growth rate (*m*) and volatility (σ) are constant (Hull 1997, p. 362). The expected growth rate is equal to the expected return on the asset (μ) minus its dividend yield (*q*). For a discrete time step, Δ*t*, it can be shown that

$$S + \Delta S = S \exp\left[\left(m - \frac{\sigma^2}{2}\right)\Delta t + \sigma\varepsilon\sqrt{\Delta t}\right] \tag{2}$$

where:

ε = a random sample from a standardized normal distribution.

The return on the market index (K_m) is estimated as

$$K_m = ((S + \Delta S)/S) + q \tag{3}$$

The return on equity for individual firms and individual real estate properties is simulated using a one-factor model.

$$K_i = R_F + Beta_i\,(Km - R_F) + \sigma_i \Delta z \tag{4}$$

where

K_i = the return for the $asset_i$

R_F = the risk-free interest rate,

$Beta_i$ = the systematic risk of $asset_i$,

K_m = the simulated return on the equity or real estate index from equation 3,

σ_i = the asset specific return volatility, and

Δz = a Wiener process with Δz being related to Δt by the function $\Delta z = \varepsilon\sqrt{\Delta t}$.

As discussed in the next section the parameters needed to implement the above model for the positive and negative financial environment cases were estimated from historical data.

Simulating an n-variate Normal Distribution

Many authors have reported positive correlations between default rates and financial environment variables such as interest rates (see Fridson et. al. (1997)), and negative correlations with variable such as GNP growth rates. This is consistent with negative correlations between interest rate changes and equity returns.

In the proposed portfolio risk assessment model, the equity indices and FX rate returns are simulated as stochastic variables correlated with the simulated future risk-free interest rate and interest rate spreads. Hull (1997) describes a procedure for working with an *n*-variate normal distribution. This procedure requires the specification of correlations between each of the *n* stochastic variables. Subsequently n independent random samples ε are drawn from standardized normal distributions. With this information the set of correlated random error terms for the *n* stochastic variables can be calculated. For example, for a bivariate normal distribution,

$$\varepsilon_1 = x_1 \tag{5}$$

$$\varepsilon_2 = \rho x_1 + x_2\sqrt{1-\rho^2} \tag{6}$$

where

x_1, x_2 = independent random samples from standardized normal distributions,

ρ = the correlation between the two stochastic variables, and

ε_1, ε_2 = the required samples from a standardized bivariate normal distribution.

It can be shown that the simulated volatilities and correlations for all of the stochastic variables match closely the assumed values that are typically estimated from historical time series data.

Mapping Debt Ratios into Credit Ratings

The above-discussed simulated equity and real estate returns are then used to estimate a distribution of possible future equity and real estate market values and debt ratios. The simulated debt ratios are then mapped into credit ratings. This methodology assumes a

deterministic relation between a firm's or property's debt ratio and its credit rating[1]. In a contingent claims framework this is equivalent to assuming a constant volatility for the value of the firm.

After simulating the bond's or loan's future credit rating its value is calculated using the simulated term structure of interest rates appropriate for that risk class. If the bond or loan is simulated to default, the recovery rate on the bond is simulated as a beta distribution[2] with a specified mean value and standard deviation.

Application of the Simulation Model and Basel Accords to Estimating Bank Capital Requirements

The fifty-four hypothetical banks analyzed reflect the various possible combinations of the following four factors:

1. Financial Environment Volatility
   - Higher
   - Lower
2. Asset/Liability Maturity Gap
   - Zero years
   - Plus One year
   - Minus one year
3. Credit Risk
   - High
   - Medium
   - Low
4. Portfolio Concentration
   - High
   - Medium
   - Low

Financial Environment: The higher financial environment volatility case is modeled in part on conditions found in South Africa during 1998-1999 (see Barnhill, Papapanagiotou, and Schumacher 2000). For example in this case the assumed annualized volatility of returns on sector equity indices is forty-six percent, and the assumed volatility of changes in short-term risk free interest rates is 4.7 percent. The volatility of returns on individual real estate assets is assumed to be twenty-five percent, which is an increment over the approximately fifteen percent observed in the U.S. for commercial real estate.

The lower financial environment volatility case is modeled in part on conditions found in the United States during 1998 (see Barnhill and Maxwell 2000). For example in this case

[1] Blume, Lim, and MacKinlay (1998) suggest that leverage ratios and credit ratings are not constant over time. However, their results are over a longer time frame than simulated in this framework.
[2] Utilizing a beta distribution allows the recovery rate to fall within 0% and 100% while maintaining the same mean and standard deviation.

the assumed annualized volatility of returns on sector equity indices and real estate assets was twenty-three percent and fifteen percent respectively, and the assumed volatility of changes in short-term risk free interest rates was 0.74 percent.

The correlations among financial environment variables are also important. For the higher (lower) volatility financial environment the assumed average correlations between interest rate changes and returns on equity indices was –0.538 (-0.3), interest rate changes and returns on real estate was –0.125 (0), the various equity indices was 0.524 (0.4), the various real estate indices was 0.305 (0.4), and the equity indices versus the real estate indices was 0.206 (0).

Not presented in this comment are capital requirement estimates for banks operating in economies with depressed economic conditions (e.g. negative inflation rates, deflating asset prices, etc.). For more on this scenario see Barnhill, Papapanagiotou, and Souto (2001).
Interest rates on the various credit quality loans are adjusted so as to allow bank's to earn on average a risk premium adequate to cover the default loses on the loans.

Asset/Liability Maturity Gap: The various asset/liability maturity gaps are the assumed maturity of the banks' interest bearing assets (one or two years) less the maturity of their liabilities (one or two years).

Credit Risk: The various credit risk cases reflect the assumed distribution of business loans by credit rating, and mortgage loans by loan to value ratio as shown in Tables 1 and 2. For individual business loans, credit risk is driven by the assumed volatility of the returns on the sector equity indices, and the firm's assumed target debt to value ratio, beta, and firm specific equity return volatility. Table 3 gives the assumed target debt to value ratios for firms with various credit qualities. These values are assumed to be the same for both the higher and lower financial environment volatility cases. Table 4 gives the assumed betas and firm specific equity return risk levels for firms with various credit qualities. These values are based on U.S. data (see Barnhill and Maxwell 2000) and are assumed to be the same for both the higher and lower financial environment volatility cases.

Portfolio Concentration: Bank portfolios are modeled as having approximately two hundred business loans and two hundred mortgage loans (i.e. non-recourse loans secured by real estate). Table 7 gives the number of assumed economic sectors and geographic regions over which these business loans and mortgage loans are assumed to be spread.

Calculating Comparable Basel Accord Capital Ratios

To compare the portfolio simulation approach to determining bank capital requirements with the Basel Accord approach, capital requirements are estimated for the hypothetical banks based on the 1988 Basel Accord and New Basel Accord standards and compared to the simulated capital required to protect the bank against a 1% probability of failure over a one-year time step as determined using the portfolio simulation approach. As discussed

above, these ratios are computed and compared under various assumptions about the volatility of the financial environment in which the bank operates, the credit risk profile and concentration of the bank's loan portfolio, and the maturity gap between the bank's interest-bearing assets and liabilities.

The Basel Accord ratios are computed under the assumptions shown in Textbox 1. The first set of assumptions defines the simulated bank's characteristics, and the second set of assumptions defines the different scenarios for the financial environment in which the bank operates. Required capital ratios are computed for all fifty-four banks under both the 1988 and New Accord ratios. Market risk is measured according to the guidelines of the 1996 Market Risk Amendment to the 1988 Accord.

The Basel Accord ratios are adjusted to account for the fact that the Basel Accord and portfolio simulation approaches use a different basis for the measurement of capital required. The portfolio simulation approach measures capital required as a percentage of the market value of total assets, while the Basel Accords measure book value of equity capital required as a percentage of risk-adjusted assets. To provide a common basis for comparison, capital ratios are also computed that are based on Basel Accord standards, but using a market value of assets basis rather than a Tier 1 and 2 equity basis. Market value-based 1988 Accord and New Accord capital ratios are computed as follows:

$$\text{Capital ratio} = (\text{credit risk-weighted assets} + 12.5\times\text{market risk})(.08)/(\text{MVTA})$$

Where the numerator on the right hand side of the equation is the denominator of the Basel Accord capital ratio multiplied by the 8% required ratio, and the denominator is the market value of total assets (MVTA).

Analytical Results

The bank capital ratio requirements computed using the portfolio simulation approach, the 1988 Accord standards, and the New Accord Simplified Approach standards are presented in Tables 8-11. The portfolio simulation approach uses 10% of the market value of total assets as a starting capital ratio and computes the capital required to maintain a positive ratio at a 99% probability. The rows in Tables 8-11 correspond to different scenarios for the volatility of the financial environment, the degree of credit risk in the bank's portfolio, and the degree of concentration in the bank's portfolio. Table 8 details the simulation results. Tables 9-11 correspond to different assumptions about the maturity gap between the bank's interest-bearing assets and liabilities.

Data column 1 of Tables 9-11 show that bank capital ratio requirements vary dramatically from one bank operating environment to another when correlation among risk sources is taken into account. Capital requirements are above the 10% assumed starting value when high financial market volatility is combined with medium or high bank loan portfolio credit risk profiles and concentration levels. The variation is most pronounced for the plus one maturity gap scenario. Moreover, these ratios are 2-3 times

the ratios required under the Basel Accord standards (data columns 2 and 3 of Tables 9-11).

Data columns 2 and 3 of Tables 9-11 show that under all scenarios, the market value-adjusted capital ratios as measured using the Basel Accord standards are in the four-to-six percent range. Banks operating in either a lower volatility financial environment with medium to higher credit and portfolio concentration risk, or in a higher volatility environment with medium to lower credit and portfolio concentration risk are found to have simulated capital requirements similar to the Basel capital requirements. Banks operating in a lower volatility financial environment with lower credit risk, or medium credit risk and lower portfolio concentration risk are found to have simulated capital requirements lower than to the Basel capital requirements. Similarly banks operating in a higher volatility financial environment with lower credit risk, and lower portfolio concentration risk are found to have simulated capital requirements lower than to the Basel capital requirements. Banks operating in a higher volatility financial environment with medium to higher credit risk and medium to higher portfolio concentration risk are found to have simulated capital requirements significantly higher than the Basel capital requirements. The discrepancy is most pronounced for the plus one maturity gap scenario where the simulated capital requirement for banks operating in a high volatility environment with high credit risk and a highly concentrated portfolio reaches twenty-three percent of assets. This occurs in part because of the negative correlation between interest rate and credit risk. This very large capital requirement occurs because on those periodic occasions where interest rate spike to very high levels such banks are simultaneously suffering large credit losses and large losses on their asset/liability maturity mismatch.

Overall, the Basel Accord standards perform well under typical developed country economic conditions. As long as the bank loan portfolio credit risk profile or concentration level is low, the Basel Accord standard protects the bank against failure with a 99% probability over a one-year time step. In fact, under most of the low volatility, low credit risk profile and low credit risk/low concentration, and low volatility/low concentration cases, required bank capital ratios under the Basel Accord are too high. Thus, it appears that the Basel Accord accurately captures the bank capital ratio required to protect against bank failure under normal economic conditions. Moreover, it appears that the New Accord is better than the 1988 Accord at capturing the impact of credit risk profile variation, which is a stated goal of the New Accord.

Recommendations

Comments on Pillar 1 (Minimum Capital Requirements)

Ad hoc adjustments to the New Basel Capital Accord Pillar 1 (Minimum Capital Requirements) appear justified to reflect the different operating environments and portfolio characteristics of banks. The results of the simulation comparisons suggest that required bank capital ratios should be doubled or even tripled for banks with medium or high loan portfolio credit risk profiles and concentrations operating in high volatility

financial environments. Conversely, when credit risk is low or when both volatility and concentration levels are low, required capital ratios could be adjusted downwards by at least twenty percent.

Comments on Pillar 2 (Supervisory Review Process)

In our view the supervisory review process should be a pro-active one where potential risks are identified and preemptive actions taken before the risks materialize. As can be seen from the above discussion and analysis we believe that integrated market and credit risk models offer both the opportunity to identify risks and test alternatives for dealing with them. The potential preemptive actions which governments may take revolve around monetary and economic polices which foster stable long-term economic growth. The potential preemptive actions which banks and/or bank regulators may take include changing the lending standards and credit quality of the portfolio, changing the level of direct equity and real estate investment, changing the sector and region concentration levels of the loan portfolio, changing the asset/liability maturity structure and currency structure, and changing capital levels.

Comments on Pillar 3 (Market Discipline)

Pillar 3 (Market Discipline) is generally well conceived and has the potential to be of significant value. Our comments will focus on a comparative analysis of the data needed to undertake integrated bank risk assessments and systemic risk analyses along the lines developed by Barnhill, et al (2000, 2001) with that proposed in the new Basel Capital Accord. We will also suggest a split in reporting requirements between banks, and other parties (e.g. bank regulatory authorities, multi-lateral financial organizations, data vendors, etc.). In general banks would be responsible for reporting required data on their portfolios, and others would be responsible for the data required to model the financial environment.

Again based on earlier work the following data is needed to model a country's financial environment and undertake an integrated market and credit risk analysis on banks (or other financial institutions). In cases where all of the data is not available expert opinions (e.g. central bank officials, commercial bank officials, etc.) may be utilized. In some cases it may be necessary to use data from other countries which are believed to be comparable.

I. Financial Market Data for all Countries to be Provided by Multi-lateral Financial Organizations, and Data Vendors

A. Monthly time series data over as many years as possible including in particular ones where unusual financial stresses and levels of loan defaults occurred:

1. Foreign exchange (FX) rates to be used to model the FX risk in Bank balance sheets.
2. Consumer price index.

3. Major commodity prices (e.g. gold $/oz, crude oil $/bbl).
4. Capitalization weighted overall Stock Price Indices for all Equity Markets.
5. Short-term risk-free interest rates in each country.

B. Current estimates for variables needed as of the date the risk analysis is to be undertaken

1. Specific estimates of the term structure of risk-free interest rates (short, medium, and long-term) for each currency.
2. Prices for a set of interest rate options (e.g. Euro-currency caps, floors, and swaptions) for each currency.

II. Financial Market and Other Data for all Countries to be Provided by Bank Regulatory Officials, Security Market Exchanges, and Data Vendors

A. Monthly time series data over as many years as possible including in particular ones where unusual financial stresses and levels of loan defaults occurred:

1. Capitalization weighted stock price indices for major economic sectors (e.g. agriculture, automobiles, etc.) in each country. These need to be chosen carefully in each country because returns on these sectors will be used in the modeling of credit risk for bank business borrowers. If stock index returns are not available then estimates of return on equity in various sectors of the economy may be utilized.
2. Return on equity (i.e. (dividends + stock price change)/stock price), estimated credit rating on senior subordinated securities (i.e. AAA,.., default), and debt to value ratios (i.e. total liabilities / (total liabilities + market value of equity)) for a large group of companies operating in the various economic sectors of each country identified in A.1. If public credit ratings are not available then private bank credit ratings on publicly traded companies may be utilized. If there are few publicly traded companies then bank credit ratings on private companies together with sample balance sheets and income statements may be reported.
3. Real estate price indices for various regions in all countries. These need to be chosen carefully (e.g. commercial versus residential) because returns on these indices will be used in the modeling of credit risk for bank mortgage borrowers in various regions of the country.
4. If available, rate of return estimates for a large group of specific real estate assets in the various regions identified in A.3
5. Short-term interest rates (or credit spreads) on various credit quality loans in each country including:
   - Short-term interest rate for risk-free debt,
   - Short-term interest rate for AAA rated debt,
   - Short-term interest rate for AA rated debt,
   - Short-term interest rate for A rated debt,
   - Short-term interest rate for BBB rated debt,
   - Short-term interest rate for BB rated debt,

- Short-term interest rate for B rated debt,
- Short-term interest rate for CCC rated debt,

6. Short-term risk-free interest rates in each country.

B. Current estimates for variables needed as of the date the risk analysis is to be undertaken

1. Total asset growth rates and dividend yield estimates for firms operating in the various sectors of the economy.
2. Mean and standard deviation of recovery rates on defaulted business loans (e.g. .34 and .25) reflecting typical loan seniority and security characteristics. If available this information broken down by the sectors identified in II. A.1 would be useful.
3. Mean and standard deviation of recovery rates on defaulted mortgage loans (e.g. .7 and .15) across the economy. If available this information broken down by the regions identified in II.A.3. would be useful.
4. Typical dividend yields on companies rated AAA, AA, A, BAA, BA, B, and CCC.
5. Specific estimates of the term structure of risk-free interest rates (short, medium, and long-term) for each currency.
6. Typical loan to value ratio for defaulting mortgage loans (e.g. 1.1).

III. Business loan portfolio information to be provided by banks for each currency

1. Total amount of business loans.
2. Credit quality distribution (i.e. % AAA... % CCC, % Defaulted) of total business loans.
3. Sector distribution (i.e. % Agriculture, etc.) of total business loans.
4. Optionally and preferably specify the credit quality distribution of business loans by sector (e.g. % AAA Agriculture, etc.).
5. Maturity Distribution of Business Loans.

IV. Loan guarantee portfolio information to be provided by banks for each currency

1. Total amount of loan guarantees.
2. Credit quality distribution (i.e. % AAA... % CCC, % Defaulted) of loan guarantees.
3. Sector distribution (i.e. % Agriculture, etc.) of loan guarantees.
4. Optionally and preferably specify the credit quality distribution of loan guarantees by sector (e.g. % AAA Agriculture, etc.).
5. Maturity Distribution of loan guarantees.

V. Mortgage loan portfolio information to be provided by banks for each currency

1. Total amount of mortgage loans.
2. Credit quality distribution of total mortgage loans (i.e. percent in various loan to value ratio ranges).
3. Regional distribution (i.e. % Capital City Region, etc.) of total mortgage loans.

4. Optionally and preferably specify the credit quality distribution of mortgage loans by region.
5. Maturity Distribution of Mortgage Loans.

VI. Other Portfolio Asset and Liability Data to be provided by banks

Other data required to undertake an integrated bank risk assessment includes:

1. Domestic public funding - amounts, maturity distribution, and interest rate spreads relative to benchmark term structures (e.g. risk-free).
2. Foreign public funding - currency, amount, maturity distribution, and interest rate spreads relative to benchmark term structures (e.g. risk-free).
3. Non-interest bearing liabilities - amount.
4. Equity and reserves less - amount.
5. Debt capital - amounts, maturity distribution, and interest rate spreads relative to benchmark term structures (e.g. risk-free).
6. Legal tender and non-interest bearing deposits - amount.
7. Gold coins and bullion - amount.
8. Domestic credit risk-free loans - amount and maturity distribution.
9. Foreign credit risk-free loans - currency, amount, maturity distribution, and interest rate spreads relative to benchmark term structures (e.g. risk-free).
10. Equity investments - country, amounts, and sectors of the economy.
11. Real estate investments - country, amounts, and regions of the economy.
12. A time series of data on fee income, other income, operating expenses, and total assets to model operating risk.
13. Income tax rate.

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Textbox 1: Assumptions Underlying Basel Accord Capital Ratio Computations

Bank Characteristics:

1.1 Tier 1 equity is defined as common stock and disclosed reserves, while Tier 2 equity consists entirely of subordinated debt.

1.2 Credit risk-weighted assets consist of corporate, inter-bank, foreign, and residential mortgage loans.

1.3 Three credit risk rating scenarios are used for the corporate loans:

Rating Profile	AAA to AAA-	AA+ to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	Below B-
Low Risk	0%	0%	33.33%	33.33%	33.33%	0%	0%
Medium Risk	0%	0%	19.40%	19.40%	19.40%	19.40%	22.40%
High Risk	0%	0%	12.33%	12.33%	12.33%	39.00%	24.00%

Interbank and foreign loans are assumed to be AAA-rated.

1.4 The trading book consists of long and short positions in domestic risk-free and foreign loans as well as equity investments. These three types of financial instruments are held in the same proportion in the trading book as in the bank as a whole. Domestic risk-free loans are treated as government securities, foreign loans are treated as AAA-rated, and equity investments are treated as diversified.

1.5 The maturity method is used to measure general interest rate risk.

1.6 Foreign exchange risk is defined as the risk due to a full long position in gold as well as the risk due to the net position in one foreign currency-based financial instrument.

1.7 Commodity risk is assumed to be zero.

1.8 Operational risk is assumed to be zero.

Financial Environment:

2.1 Three simple interest rate risk environments are considered. Under the zero gap scenario, both assets and liabilities have a 12-month maturity. Under the plus one gap, assets have a 2-year maturity and liabilities have a 12-month maturity. Under the minus one gap, assets have a 12-month maturity and liabilities have a 2-year maturity.

2.2 Economic volatility is assumed to be either high or low (does not impact computation of Basel Accord ratios).

Given the permutations of all of these assumptions, 1988 and New Basel Accord capital ratios are computed under $3 \times 3 \times 3 \times 2 = 54$ scenarios.

Textbox 1: (continued)

Simplified Percentage Balance Sheet

Liabilities	
Public Funding (inter-bank, non-bank)	
Domestic Funding (inter-bank, demand, savings, fixed deposits, NCD's, repos, other)	0.7701
Foreign Funding	0.0645
Total Public Funding	0.8346
Non-Interest Bearing Liabilities	0.0677
Equity and Reserves less Impairments	0.0977
Total Capital and Liabilities	1.0
Assets	
Legal Tender, Non interest bearing deposits, and gold	0.0209
Domestic Risk-Free Loans	0.1073
Domestic Business loans	0.4449
Domestic Mortgage loans	0.3000
Foreign Loans	0.0486
Equity Investments	0.0316
Real Estate Investments	0.0491
Other Assets	0.0125
Reserves	(0.0149)
Total Assets	1.0

Table 1. Assumed Distribution of Business Loans by Credit Rating

Credit Risk Level	AAA	AA	A	BBB	BB	B	CCC	D
High	0	0	0.1233	0.1233	0.1233	0.39	0.19	0.05
Medium	0	0	0.194	0.194	0.194	0.194	0.194	0.03
Low	0	0	0.33	0.33	0.33	0	0	0.01

Table 2. Assumed Distribution of Mortgage Loans by Loan to Value Ratio

Credit Risk Level	LTV= 0.4	LTV= 0.5	LTV= 0.6	LTV= 0.7	LTV= 0.8	LTV= 0.9	LTV= 1.07	LTV= 1.2
High	0	0	0.1233	0.1233	0.1233	0.39	0.19	0.05
Medium	0	0	0.194	0.194	0.194	0.194	0.194	0.03
Low	0	0	0.33	0.33	0.33	0	0	0.01

Table 3. Assumed Target Debt to Value Ratio for Business Loans by Credit Rating

Credit Rating	AAA	AA	A	BBB	BB	B	CCC	D
Target Debt to Value Ratio	0.101	0.1405	0.2355	0.3145	0.432	0.513	0.595	0.95

Table 4. Assumed Betas and Firm Specific Equity Return risk Level by Credit Rating

Credit Rating	AAA	AA	A	BBB	BB	B	CCC	D
Beta	0.670	0.774	0.916	1.0250	1.191	1.311	1.393	n.a.
Firm Specific Equity Return Risk	0.317	0.363	0.412	0.507	0.729	0.727	0.954	n.a.

Table 5. Simulated Default Rates for Business Loans for Higher and Lower Volatility Financial Environments

Credit Rating	AAA	AA	A	BBB	BB	B	CCC	D
Default Rate in Lower Volatility Environment	0	0	0	0	.01	.05	.236	1.0
Default Rate in Lower Volatility Environment	0	0	0	.001	.026	.109	.307	

Table 6. Simulated Default Rates for Mortgage Loans for Higher and Lower Volatility Financial Environments

Credit Rating	LTV= 0.4	LTV= 0.5	LTV= 0.6	LTV= 0.7	LTV= 0.8	LTV= 0.9	LTV= 1.07	LTV= 1.2
Default Rate in Lower Volatility Environment	0	0	0	0	.0055	.022	.277	1.0
Default Rate in Lower Volatility Environment	0	0	0.006	.035	.102	.203	.453	1.0

Table 7. Assumed Number of Sectors for Business Loans and Regions for Mortgage Loans

Portfolio Concentration Level	Number of Sectors	Number of Regions
High	1	1
Medium	5	1
Low	20	20

Table 8: Simulated Market Value Capital Ratios (Assets-Liabilities)/Assets at a one-year timestep (Initial Value=.10)

Volatility	Interest Rate Gap	Credit Risk Profile	Portfolio Concen-tration Level	Mean	Standard Deviation	Max	Min	Value-at-Risk 99%	Value-at-Risk 95%	Capital Req'd: 1% Failure Probability	Capital Req'd: 5% Failure Probability	Interest Rate Gap 0-M1 (Holding Volatility/Credit Quality/Concen-tration Constant)	Interest Rate Gap 0-P1 (Holding Volatility/Credit Quality/Concen-tration Constant)
High	0	High	High	0.110	0.056	0.197	-0.217	-0.091	-0.012	0.191	0.112	0.039	-0.035
			Medium	0.111	0.044	0.185	-0.112	-0.023	0.018	0.123	0.082	0.023	-0.076
			Low	0.111	0.027	0.170	-0.017	0.024	0.060	0.076	0.040	0.026	-0.056
		Medium	High	0.110	0.043	0.179	-0.136	-0.043	0.023	0.143	0.077	0.032	-0.048
			Medium	0.111	0.036	0.179	-0.083	-0.007	0.040	0.107	0.060	0.036	-0.028
			Low	0.109	0.021	0.155	0.004	0.038	0.067	0.062	0.033	0.021	-0.056
		Low	High	0.111	0.013	0.151	0.019	0.060	0.089	0.040	0.011	0.008	-0.089
			Medium	0.111	0.012	0.151	-0.002	0.069	0.092	0.031	0.008	0.004	-0.095
			Low	0.109	0.010	0.146	0.056	0.079	0.093	0.021	0.007	-0.008	-0.092
	-1	High	High	0.112	0.045	0.208	-0.175	-0.052	0.023	0.152	0.077		
			Medium	0.113	0.034	0.184	-0.068	-0.001	0.044	0.101	0.056		
			Low	0.113	0.021	0.176	0.016	0.050	0.075	0.050	0.025		
		Medium	High	0.113	0.036	0.191	-0.083	-0.011	0.041	0.111	0.059		
			Medium	0.113	0.027	0.195	-0.037	0.029	0.061	0.071	0.039		
			Low	0.112	0.019	0.168	0.031	0.060	0.077	0.040	0.023		
		Low	High	0.111	0.019	0.165	-0.032	0.067	0.081	0.033	0.019		
			Medium	0.111	0.017	0.167	0.059	0.073	0.084	0.027	0.016		
			Low	0.109	0.019	0.175	0.056	0.071	0.079	0.029	0.021		
	1	High	High	0.109	0.078	0.291	-0.292	-0.126	-0.042	0.226	0.142		
			Medium	0.110	0.072	0.267	-0.206	-0.099	-0.029	0.199	0.129		
			Low	0.110	0.051	0.224	-0.066	-0.032	0.012	0.132	0.088		
		Medium	High	0.108	0.069	0.251	-0.136	-0.091	-0.031	0.191	0.131		
			Medium	0.097	0.048	0.245	-0.086	-0.035	0.010	0.135	0.090		
			Low	0.093	0.045	0.202	-0.092	-0.017	0.012	0.117	0.088		
		Low	High	0.101	0.045	0.208	-0.113	-0.029	0.014	0.129	0.086		
			Medium	0.101	0.044	0.200	-0.095	-0.026	0.020	0.126	0.080		
			Low	0.097	0.039	0.181	-0.078	-0.012	0.024	0.112	0.076		
Low	0	High	High	0.106	0.025	0.180	-0.031	0.024	0.058	0.076	0.042	0.005	-0.018
			Medium	0.111	0.020	0.167	0.006	0.045	0.072	0.055	0.028	0.005	-0.010
			Low	0.115	0.012	0.153	0.060	0.080	0.094	0.020	0.006	0.003	-0.008
		Medium	High	0.109	0.021	0.166	-0.013	0.047	0.068	0.053	0.032	0.005	-0.019
			Medium	0.110	0.017	0.172	0.030	0.061	0.078	0.039	0.022	0.002	-0.013
			Low	0.114	0.012	0.174	0.053	0.081	0.095	0.019	0.005	0.005	-0.006
		Low	High	0.107	0.008	0.141	0.074	0.087	0.094	0.013	0.006	-0.002	-0.016
			Medium	0.107	0.008	0.144	0.070	0.089	0.095	0.011	0.005	-0.001	-0.012
			Low	0.108	0.008	0.146	0.083	0.091	0.096	0.009	0.004	-0.002	-0.012
	-1	High	High	0.110	0.025	0.172	-0.078	0.029	0.058	0.071	0.042		
			Medium	0.111	0.019	0.176	0.008	0.050	0.075	0.050	0.025		
			Low	0.116	0.012	0.166	0.063	0.084	0.097	0.016	0.003		
		Medium	High	0.109	0.019	0.159	0.011	0.052	0.071	0.048	0.029		
			Medium	0.110	0.016	0.157	0.029	0.063	0.081	0.037	0.019		
			Low	0.114	0.011	0.154	0.074	0.086	0.096	0.014	0.004		
		Low	High	0.107	0.009	0.149	0.067	0.085	0.093	0.015	0.007		
			Medium	0.108	0.008	0.170	0.074	0.088	0.094	0.012	0.006		
			Low	0.108	0.008	0.153	0.078	0.089	0.095	0.011	0.005		
	1	High	High	0.110	0.033	0.184	-0.039	0.006	0.044	0.094	0.056		
			Medium	0.112	0.026	0.179	0.000	0.035	0.062	0.065	0.038		
			Low	0.117	0.016	0.170	0.045	0.072	0.089	0.028	0.011		
		Medium	High	0.110	0.028	0.191	-0.046	0.028	0.059	0.072	0.041		
			Medium	0.111	0.022	0.180	0.024	0.048	0.071	0.052	0.029		
			Low	0.116	0.015	0.175	0.054	0.075	0.090	0.025	0.010		
		Low	High	0.105	0.012	0.151	0.044	0.071	0.084	0.029	0.016		
			Medium	0.105	0.012	0.145	0.000	0.077	0.086	0.023	0.014		
			Low	0.106	0.010	0.148	0.052	0.079	0.088	0.021	0.012		

Table 9. A Comparison of Capital Ratio Requirements of a Simulated Bank With a Zero Maturity Gap Between Interest-Bearing Assets and Liabilities Computed Using a Portfolio Theory-Based Approach and Computed Using the Basel Accord Standards. The Portfolio Theory-Based Approach Computes the Capital Ratio Required to Prevent Bank Failure with a 99% Probability and the Basel Accord Capital Ratios are Market Value-Adjusted to Provide a Common Base for Comparison.

Financial Market Volatility	**Credit Risk Profile**	**Portfolio Concentration**	**Capital Ratio Required:** As Determined by the Portfolio Theory-Based Approach (1)	**Capital Ratio Required:** As Determined by the Basel Accords Capital Ratio = .08 × {Credit Risk-Weighted Assets + 12.5 × (Market+Operating Risks)}/ Market Value of Total Assets	
				1988 Accord (2)	New Accord, Simplified Approach (3)
High	High	High	19.08%	4.15%	5.94%
		Medium	12.32%		
		Low	7.63%		
Low		High	7.57%		
		Medium	5.50%		
		Low	1.95%		
High	Medium	High	14.30%	4.16%	5.44%
		Medium	10.72%		
		Low	5.34%		
Low		High	5.29%		
		Medium	3.86%		
		Low	1.93%		
High	Low	High	4.00%	4.16%	4.42%
		Medium	3.06%		
		Low	2.06%		
Low		High	1.29%		
		Medium	1.14%		
		Low	0.87%		

Table 10. A Comparison of Capital Ratio Requirements of a Simulated Bank With a Minus One Maturity Gap Between Interest-Bearing Assets and Liabilities Computed Using a Portfolio Theory-Based Approach and Computed Using the Basel Accord Standards. The Portfolio Theory-Based Approach Computes the Capital Ratio Required to Prevent Bank Failure with a 99% Probability and the Basel Accord Capital Ratios are Market Value-Adjusted to Provide a Common Base for Comparison.

Financial Market Volatility	**Credit Risk Profile**	**Portfolio Concentration**	**Capital Ratio Required:** As Determined by the Portfolio Theory-Based Approach (1)	**Capital Ratio Required:** As Determined by the Basel Accords Capital Ratio = .08 × {Credit Risk-Weighted Assets + 12.5 × (Market+Operating Risks)}/ Market Value of Total Assets	
				1988 Accord (2)	New Accord, Simplified Approach (3)
High	High	High	15.21%	4.17%	5.96%
		Medium	10.06%		
		Low	5.03%		
Low		High	7.08%		
		Medium	4.97%		
		Low	1.62%		
High	Medium	High	11.07%	4.17%	5.46%
		Medium	10.72%		
		Low	5.34%		
Low		High	4.83%		
		Medium	3.68%		
		Low	1.44%		
High	Low	High	3.25%	4.17%	4.44%
		Medium	2.66%		
		Low	2.85%		
Low		High	1.53%		
		Medium	1.21%		
		Low	1.10%		

Table 11. A Comparison of Capital Ratio Requirements of a Simulated Bank With a Plus One Maturity Gap Between Interest-Bearing Assets and Liabilities Computed Using a Portfolio Theory-Based Approach and Computed Using the Basel Accord Standards. The Portfolio Theory-Based Approach Computes the Capital Ratio Required to Prevent Bank Failure with a 99% Probability and the Basel Accord Capital Ratios are Market Value-Adjusted to Provide a Common Base for Comparison.

Financial Market Volatility	**Credit Risk Profile**	**Portfolio Concentration**	**Capital Ratio Required:** As Determined by the Portfolio Theory-Based Approach (1)	**Capital Ratio Required:** As Determined by the Basel Accords Capital Ratio = .08 × {Credit Risk-Weighted Assets + 12.5 × (Market+Operating Risks)}/ Market Value of Total Assets	
				1988 Accord (2)	New Accord, Simplified Approach (3)
High	High	High	22.61%	4.17%	5.96%
		Medium	19.94%		
		Low	13.22%		
Low		High	9.37%		
		Medium	6.48%		
		Low	2.79%		
High	Medium	High	19.14%	4.17%	5.45%
		Medium	13.51%		
		Low	11.72%		
Low		High	7.19%		
		Medium	5.17%		
		Low	2.49%		
High	Low	High	12.85%	4.17%	4.44%
		Medium	12.59%		
		Low	11.23%		
Low		High	2.86%		
		Medium	2.31%		
		Low	2.05%		