Credit institutions' capital viewed from a business and a regulatory perspective

Risk and equity capital are two key concepts both in the management of a bank's business and in prudential regulation. With regard to creditor and systemic protection, they are closely and inseparably linked. Adequate capital cover cushions individual banks against losses and contributes towards the stability of the banking system as a whole. At the same time, the amount of capital held limits the extent of risk-bearing operations. Hence an individual bank's risk position determines the level of capital it needs from both a business and a regulatory perspective. Regulatory and internal (economic) capital requirements differ, however. Although today's prudential capital rules are based on banks' best practices, they cannot be tailored to banks' individual circumstances. The declared aim of the Basel Committee on Banking Supervision is to closely align the regulatory capital requirements with banks' economic capital requirements through new capital rules (Basel II). But for capital to perform the aforementioned protective functions, the disclosed amount must be actually available. It is therefore crucial that banks' assets and liabilities are valued accurately and do not contain any hidden losses.

Creditor and systemic protection through capital

Creditor protection through stipulated capital requirement

Stipulating the amount of capital which banks are required to hold remains one of the main instruments of banking supervision with a view to upholding the soundness and ability to function both of individual institutions and the overall financial system. Adequate capital cover is necessary to protect institutions in case they incur losses resulting from their business operations and to safeguard their solvency vis-à-vis customers and creditors. That is why section 10 (1) of the Banking Act requires that: "In order to meet their obligations to their creditors, and particularly in order to safeguard the assets entrusted to them, institutions must have adequate own funds." Like the regulatory provisions of the Banking Act (BA), the accounting rules of the German Commercial Code (CC) are primarily geared to protecting creditors.

Equity capital requirements as a limit on debt financing

Equity capital requirements directly limit the degree of credit institutions' debt financing. To the extent that losses can be absorbed by capital, the institution's continued existence, and thus its liquidity, are assured. In principle, a bank could ensure its perpetual solvency by relying totally on equity financing; by contrast, a certain degree of debt financing implies a positive default probability commensurate with the credit institution's risk position.

Components of capital

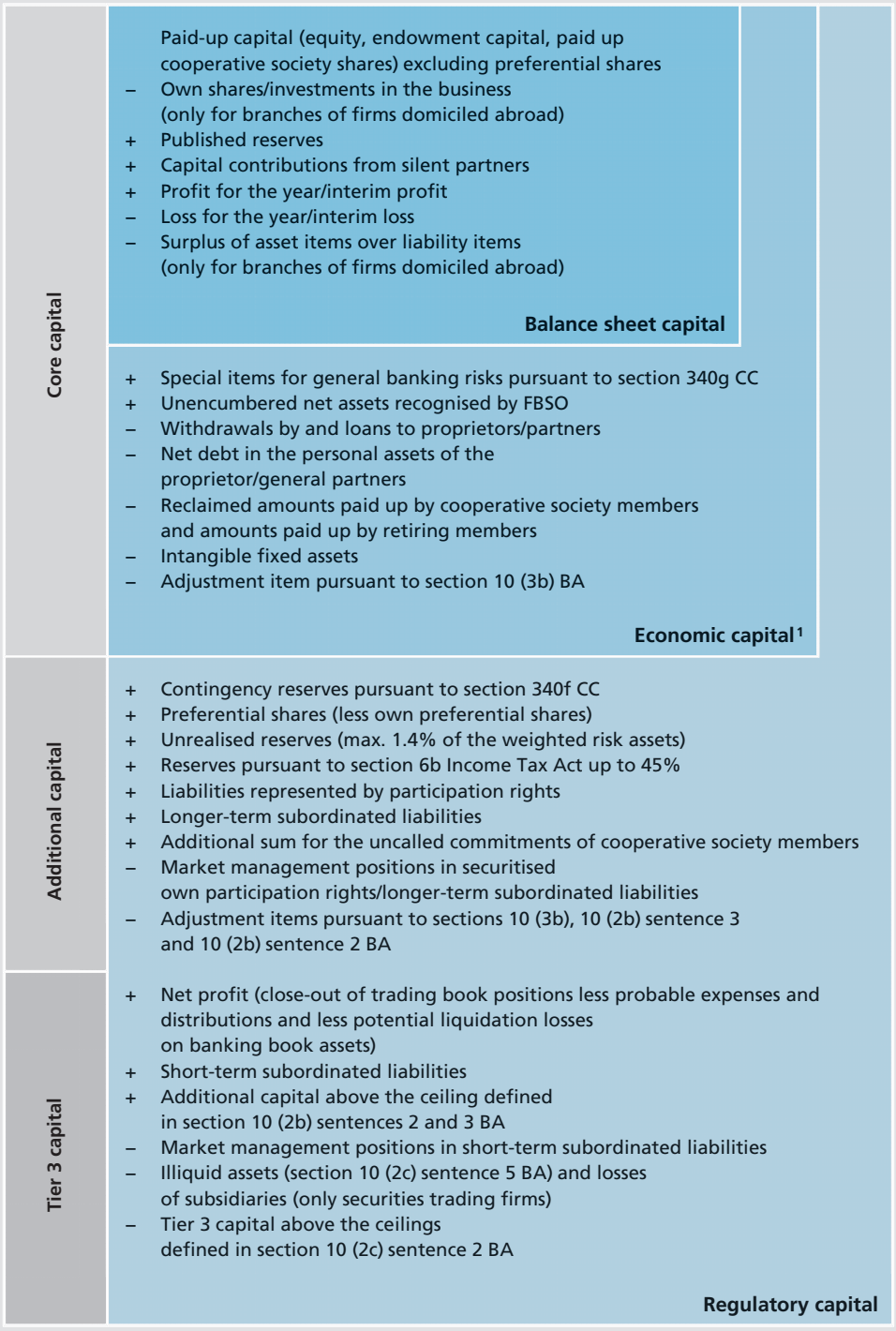
The Banking Act defines three categories of own funds, which differ in their ability to cover losses: core capital, additional capital (which together constitute the liable capital) and tier 3 capital. This regulatory definition of capital is broader than that contained in the German Commercial Code, although the latter concept is the starting point. The ongoing international development of accounting standards will therefore also have an impact on regulatory capital, since Basel II will leave the recognised own funds components unchanged until further notice.

Own funds and capital as defined in BA and CC

The concept of economic capital

The equity capital measure which institutions themselves use for managing their business operations bank-wide (economic capital) is usually not fully identical either to their capital as shown in the balance sheet or to the definition of regulatory capital. A bank's economic capital is inevitably shaped by the subjective judgements of its managers. The way banks assess the risk-sustainability (maturity, valuation reserves) of their liabilities may differ from the commercial-law provisions or the regulatory provisions. On the other hand, institutions are keen to clearly signal their creditworthiness to outsiders, for instance by gaining a certain rating grade from one of the big agencies. The upshot of this is that most banks use a concept of capital for operational purposes which is close to their balance sheet capital or to the concept of core capital as defined in the Banking Act (see chart on page 41).

Composition of capital/own funds



1 It should be noted that there is no uniform definition of economic capital. According to a survey carried out by the Bundesbank, most institutions use core capital as their gauge, though some also incorporate components of additional capital (e.g. preferential shares, unrealised reserves).

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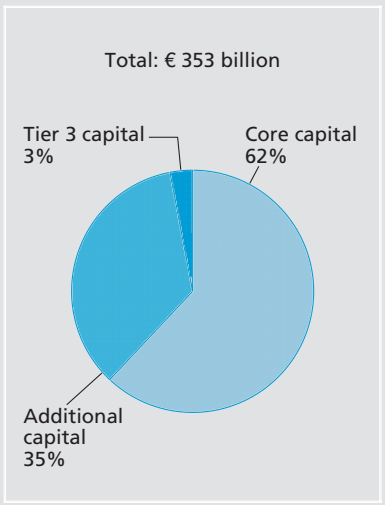
Institutions' own funds*
in December 2000



Source: Returns submitted by the institutions. — * Own funds are the sum of core capital, additional capital and tier 3 capital (totalling € 364 billion) less the positions pursuant to section 10 (6) sentence 1 (1 to 5d) BA (totalling € 11 billion).

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Balance sheet capital

Function and derivation of capital under the Commercial Code

Definition of equity capital in CC narrower than that of liable capital in BA

The definition of liable capital used in the Banking Act creates a specific regulatory concept of capital which differs from the more narrowly defined concept of balance sheet capital as used in the German Commercial Code. According to the balance sheet classification system defined in the Commercial Code, equity capital comprises subscribed capital, capital reserves and revenue reserves, other reserves created by virtue of law or company statutes plus the net profit (or loss) for the year. From a regulatory point of view, these components constitute core capital. The fund for general banking risks, which for prudential purposes is likewise recognised as core capital, is shown separately from the equity capital item in the balance sheet. The regulatory category of additional capital, in the form of participation rights and subordinated liabilities, is classified as debt in the balance sheet.

Distinction between equity and debt blurred

The Commercial Code does not give a legal definition for the equity capital to be shown in the balance sheet. Instead, the balance sheet (or implied) equity capital is derived as a residual after subtracting total debt plus deferred income from total assets plus prepaid expenses. The disclosure and valuation rules must be observed in the definition and valuation of the asset and debt items in the balance sheet. There is a certain blurring of distinctions, however. Firstly, not all of the capital components that are effectively available to the company are recorded under the equity capital item on the balance sheet. Secondly, it is impossible in practice to cleanly divide all liability-side items into equity or debt. Thus items classified as debt in the balance sheet may actually contain other equity components (e. g. provisions for future expenses or the special reserves), or the disclosed equity capital may contain capitalised items that are not assets at all but simply accounting conveniences (e. g. goodwill). For balance sheet analysis, in particular, such effects on the disclosed capital therefore need to be taken into consideration in a separate account.

Accurate valuation of assets crucial

A valuation of balance sheet assets which contains no hidden losses and takes immediate account of any diminutions of value

through appropriate write-downs and value adjustments is an indispensable condition for ensuring that equity capital, computed in the balance sheet as a residual item, is accurately calculated and so performs its function of creditor protection. This is assured by the proper application of the existing German and European accounting rules. An international harmonisation of the concept of capital also requires the harmonisation of accounting rules as the basis for defining capital. A methodology of valuing assets that contains no hidden losses has likewise already been conceptually implemented in internationally accepted accounting standards.

Implications of the internationalisation of accounting regimes

Internationalisation of German accounting regime through ...

The Act to Facilitate International Equity Financing *(Kapitalaufnahmeerleichterungsgesetz),* which entered into force in April 1998, introduced a new paragraph into the German Commercial Code in the form of section 292a. It grants certain parent companies which compile consolidated accounts according to internationally accepted accounting standards an exemption up to 2004 from the requirement to submit an additional set of group-wide accounts according to German accounting principles. This marked a turning point with regard to traditional German accounting practices based on the Commercial Code. From the present perspective it seems likely that this new trend will continue. The EU Commission has meanwhile submitted a proposal for the further harmonisation of EU accounting rules. It would make the use of the International Accounting Standards (IAS),[1] which are geared more to the concept of "fair value", obligatory from 2005 for the consolidated accounts of capital market-oriented firms[2] (once the compatibility of IAS with European accounting legislation has been verified). In addition, the EU Commission is envisaging the possibility of giving EU member states the option of introducing the compulsory or voluntary use of IAS for the consolidated accounts of other firms (i.e. firms which are not publicly listed) and also for individual company accounts.

... exemption for consolidated accounts pursuant to section 292a CC

... EU Commission proposal to adopt IAS

Concept of capital according to IAS

Under the IAS rules, as under the German Commercial Code, capital is derived as a residual after subtracting liabilities from total assets. However, the assets and liabilities as shown in a set of annual accounts drawn up according to the Commercial Code may differ somewhat from the same accounts compiled in line with IAS – principally owing to methodological differences in distinguishing between equity and debt items and to divergent disclosure and valuation rules – which in turn leads to differences in the amount of equity capital shown in the balance sheet (besides valuation at current or market or fair value,

1 International Accounting Standards (IAS) are developed by the International Accounting Standards Committee (IASC). In line with its statute, this independent private-sector organisation develops and adopts international accounting standards in the public interest (to date there are 41 IAS). In May 2000 the International Federation of Accountants approved a new structure for the main IASC body (International Accounting Standards Board, IASB). Independent accounting experts from various countries will sit on the new Board; some of them also have the task of maintaining contacts with their respective national accounting bodies.

2 EU enterprises whose securities are admitted for trading on a regulated market or whose securities are offered to the public pending their admission for trading on a regulated market.

this concerns the balance sheet treatment of pension and tax accruals).

Disclosure at market values under IAS

The marking-to-market valuation method used under IAS is currently applied especially to all financial instruments in the banking book and trading book apart from self-originated loans and refinancing liabilities in the banking book, which have to be valued at amortised cost.

Implications of the marking-to-market method for equity capital

Accounting for items at their "fair value" has implications for the equity capital to be shown in the financial statements, as fluctuations in value are reflected in the net profit or loss for the period and/or equity. However, the option under IAS of disclosing such revaluation amounts of financial instruments that are available for sale either as a net gain or loss (i. e. in the income statement) or as a neutral event (i. e. under equity) must not result in the identical economic situation of a revaluation reserve leading to different treatments as regards regulatory capital.[3]

Market-related valuation changes should have no substantive consequences

Given the traditional (and unquestioned) importance of preserving capital, it is important that market-related valuation changes have no substantive impact on the level of equity capital. This will continue to be ensured as long as the payment and dividend distribution function is based on the parent company accounts rather than the group accounts and the parent company accounts are not drawn up according to IAS. When calculating the regulatory liable capital, a similar solution should be applied to the treatment of liability items included as the counterparts of market price-related write-ups (e. g. revaluation reserves) or which result from unrealised gains. This problem will arise already in connection with the 2001 financial year for consolidated accounts which, pursuant to section 292a of the Commercial Code, are drawn up according to IAS or US GAAP[4] and which are used as the basis for calculating regulatory capital. That is the case for internationally active institutions which, in a voluntary agreement with the Federal Banking Supervisory Office, have committed themselves to comply with the Basel Committee's new capital recommendations.

Capital requirements

The three aspects of the capital requirements

The regulatory capital requirements are minimum requirements imposed on credit institutions by the banking supervisory authorities. By contrast, a bank's economic capital requirements represent the equity capital which the credit institution itself deems necessary or which should be considered necessary in the light of prudent risk management. Economic and regulatory capital requirements basically comprise three aspects:

– the definition of capital or own funds,

– a measure of the exposure to risk, and

3 It is likely that this option will be dropped and that such revaluation amounts will then always be offset against equity with no impact on the net profit or loss.
4 Generally Accepted Accounting Principles (GAAP) are developed by the Financial Accounting Standards Board (FASB) in the USA and are binding on all firms that have to draw up independently audited accounts in the United States; some large companies in the EU and in Germany also apply US GAAP, mainly prompted by the desire to be listed in the US capital markets.

– the relationship between capital and that measure.

Differences between regulatory and economic capital requirements

Economic and regulatory capital requirements are normally not identical. For one thing, as was pointed out in the section on capital components, the capital concept used internally by banks tends to be narrower than the regulatory concept. For another, regulatory and economic capital requirements differ with respect to the measurement of the risks that are to be backed by capital. This concerns, for example, the choice of the relevant risk factors. For example, so far the banking regulators have not required institutions to back their operational risk with capital, even though most banks regard this as a significant risk factor.[5] Furthermore, there are also substantial differences when it comes to quantifying risks. For instance, some banks plan to use credit risk models in order to compute their aggregate credit risk. But such models are not yet authorised for determining the regulatory capital requirement. A third point is that the relationship between the risk measure and the required amount of capital is not the same for the economic and regulatory capital requirements. The level of capital actually held is largely determined by the institution's subjective risk propensity or the rating it aspires to achieve. For this reason there is also no clear, objective level of economic capital. Many institutions actually hold distinctly more than the stipulated prudential minimum of 8 % (see table on page 46).

Regulatory capital arbitrage

If the gap between the regulatory and economic capital requirements is too wide, this may lead to undesirable capital arbitrage by institutions. This means that banks favour types of business which carry low regulatory capital requirements compared with other risk-bearing operations or which reduce their overall capital requirements (e. g. securitisations). Another danger is that credit risks might be assumed by financial market players who are not subject to banking supervision. The goal of banking regulators and supervisors must therefore be to achieve a close convergence between regulatory and economic capital requirements without acting too prescriptively.

Scope of convergence limited by divergent goals of regulators and banks

However, complete convergence between regulatory and economic capital requirements is impeded by the limitations arising from the divergent goals of banking regulators and banks in pursuing their commercial business. Owing to their binding nature, regulatory capital requirements have to be

– objective and verifiable,

– comparable for a wide array of credit institutions, and

– not too restrictive (regulatory capital requirements are minimum requirements).

By contrast, economic capital requirements are

– largely subjective, based on the risk assessment made by the bank's managers,

5 The general consensus among banks is that operational risk is more significant than market risk. However, reliable statistics on the precise level of operational risk do not yet exist.

Banks' balance sheet and regulatory capital ratios *

December 2000

Category of banks	Balance sheet capital (€ million)	Balance sheet total (€ million)	Capital (as % of balance sheet total)	Regulatory capital ratio (in %)
Big banks	60,200	1,684,634	3.57	13.0
Regional banks	29,037	605,642	4.79	12.9
Savings banks (including regional institutions)	74,624	2,517,341	2.96	10.7
Credit cooperatives (including regional institutions)	31,177	776,860	4.01	11.5
Mortgage institutions	14,769	914,967	1.61	11.1
Building and loan associations	7,322	153,163	4.78	11.1

* Source: annual accounts data and returns submitted by the institutions as well as Bundesbank calculations.

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– heterogeneous, depending on the business policy pursued and the institution's risk propensity, and

– binding on the bank's various business units.

Given the resulting constraints, the new version of the capital rules which the Basel Committee is currently developing (Basel II) seeks to achieve a convergence between regulatory and economic capital requirements. The objective, through adequate risk measurement, is to avoid misalignments in the financial system, to improve the supervisory authorities' assessment of the macroeconomic risk position and to safeguard the stability of the financial system.

Computing economic capital

Quite apart from Basel II, growing competitive pressures and declining profit margins are likewise forcing many banks to allocate scarce capital to their individual business units more efficiently and risk-sensitively than hitherto. This necessitates above all a comprehensive evaluation of the classical banking risks (credit risk, market risk, liquidity risk and operational risk) based on sophisticated financial methods.

Expected and unexpected losses

The real risk to banks comes from unexpected losses, as the expected losses are usually covered by the contractual terms agreed with the customer (e.g. through corresponding margins in lending business). But capital buffers have to be created for unexpected losses

in an amount depending on the institution's risk propensity. The expected loss is normally defined via the expected value of the loss distribution, while the unexpected loss is the difference between the future (uncertain) loss and the expected loss. The unexpected loss is customarily quantified using the value at risk[6] or the standard deviation of the loss distribution.

Computing economic capital using the example of credit risk

Thanks not least to Basel II, credit risk is becoming the focus of banks' risk management strategies. The following section is therefore confined to an outline of some state-of-the-art approaches to computing the economic capital requirement for backing credit risk.

Computing default risk

A key factor in computing economic capital is the risk that the borrower will default. The many different methods which banks use to forecast the default probabilities of their borrowers can be grouped into the following three categories:

– expert systems,

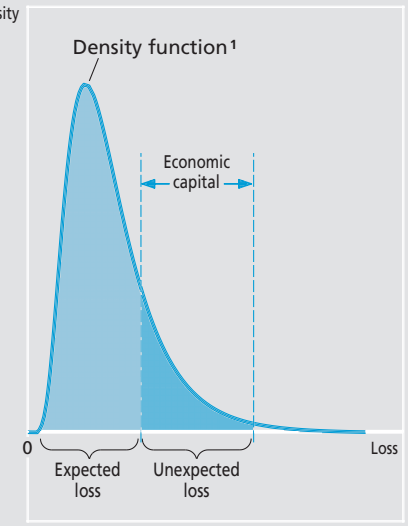
– statistical models,

– financial models.

Expert systems

Historically, internal expert systems have been the starting point of banks' assessment of their borrowers' creditworthiness. Expert systems value the firm in question predominantly on the basis of accumulated knowledge and experience. Among the main inputs are the quality of the firm's management, its capital structure, its profit outlook, the volatility of its earnings and the quality of its collateral. At the end of the assessment process the firm is assigned a credit score. Default and migration probabilities[7] are derived from historical default rates.

Loss distribution of a loan portfolio



1 Probability distribution of future losses. The area below the curve from the origin to a point *x* on the loss axis represents the probability that a loss amounting at most to *x* will occur.

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Statistical models

Statistical models determine the default risk with the aid of complex econometric methods, mainly using balance sheet and sectoral ratios as explanatory variables. At least four different approaches may be distinguished: linear probability models, logit models, probit models and discriminant analyses. The most widely used system is dis-

6 The value at risk (VaR) at a probability level *p* is the upper bound of the unexpected loss that will not be exceeded with probability *p*.
7 Migration probability denotes the likelihood that a borrower will be reclassified from one credit grade to another.

criminant analysis. Essentially, this method identifies the linear function in balance sheet ratios and market variables that can most clearly segregate firms into the categories of "default" and "non-default". One perceived drawback of statistical models is that they chiefly rely on firms' book values, which frequently fail to give a complete picture of the firm's real situation.

Financial models

Financial models are based on quantitative theories of firms' default risk. Some of the established credit risk models regard a firm's equity as a call option on its total assets. Thus the firm becomes insolvent when the market value of its assets falls below the value of its debt. According to the option pricing approach, the probability that a firm will default depends on the ratio of its liabilities to its assets and on the volatility of its assets. For publicly listed enterprises, both parameters can be inferred from the share price provided it represents an accurate indication of the firm's intrinsic value. For non-listed enterprises, by contrast, proxy variables have to be used instead (e. g. EBITDA: earnings before interest, taxes, depreciation and amortisation). A different approach computes the default probabilities from the yield spreads of corporate bonds. This is done by calculating the implied forward rates of risk-free and risk-bearing bonds, from which the risk premia to cover the likelihood of non-repayment can then be derived in relation to maturity.

Based on the aggregate default probabilities of its individual borrowers, a bank must then calculate the economic capital requirement for its loan portfolio as a whole. The traditional approaches to managing credit risk at the portfolio level were often based on a subjective analysis of borrowers and of the general risk situation of a given sector or country together with a system of limits which defined the credit line for individual borrowers and sectors. At the same time, considerable advances have been made in recent years in the measurement of default risk and in the design, calibration and implementation of credit risk models. Since they are based on financial portfolio theories, they have the advantage – in contrast to the traditional practice of setting limits – of providing an objective framework for computing the economic capital requirement.

Computing the economic capital on the basis of portfolio theories

Actuarial approaches

Some credit risk models are based on an actuarial approach which records only whether an obligor defaults (default mode) but not how his creditworthiness changes over time. It is assumed that the default probabilities are known. Under certain probabilistic assumptions, a loss distribution is derived from which the required level of economic capital can then be calculated (default mode models are discussed in Annex 1 on pages 52 f.).

Models based on rating data

Other models, by contrast, are based on rating data. They model not only an obligor's default probability but also the possibility that his creditworthiness may improve or deteriorate. The loss distribution of the loan portfolio is usually computed by numerical simulation. The principal input is migration matrices, which map the probability that a borrower will migrate from one credit grade to another.

Capital allocation and bank-wide business management

Risk-adjusted returns

Like any business undertaking, a bank seeks to make a profit. To avoid misallocating its resources, it must consider the generated or projected returns in relation to the expected risk. A number of banks now calculate ratios for risk-adjusted returns which are used as a decision-making basis for the institution's strategic orientation, for measuring the performance and managing the risk of the individual business units as well as for calculating the compensation of employees. Ratios such as RORAC (return on risk-adjusted capital) and RAROC (risk-adjusted return on capital) have become standard market benchmarks used by advanced institutions and are increasingly replacing the traditional ratios such as ROE (return on equity) or ROA (return on assets).

RORAC and RAROC are better gauges of operational performance than the traditional ratios as they relate the return to the risk incurred. On the other hand, rates of return say nothing about the absolute level of the expected or generated profit. If RAROC is used as the sole tool for measuring the commercial performance of individual business units, there is therefore a danger that only the most profitable investments will be made. Yet business considerations mandate that every investment is worthwhile as long as the marginal return exceeds the marginal cost of the required economic capital. Calculating the economic capital requirement for the bank as a whole is highly complex and varies from one institution to another. Methods with differing levels of sophistication are therefore employed to allocate economic capital; the most advanced methods, in particular, take due account of the diversification effects of the individual business units (see Annex 2, pages 53 ff.: Computing the bank-wide economic capital requirement).

Risk-adjusted rates of return

The **return on risk-adjusted capital** denotes the yield represented by the net result in relation to the allocated economic capital *(K)*

$$RORAC = \frac{net\ result}{K}.$$

The **risk-adjusted return on capital** additionally takes account of the opportunity cost of carrying capital:

$$RAROC = RORAC - r,$$

where *r* denotes the target rate of return on the economic capital employed. This target rate of return can be computed, for example, on the basis of a market comparison or by using portfolio theories.

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Overview of the regulatory capital requirements

Status quo of the regulatory capital requirements

The regulatory capital requirements are enshrined in the Banking Act and, in addition, in Principle I concerning the capital of institutions. The basis of these regulations is the Basel Capital Accord of 1988 (Basel I), which has been translated into German law through the national implementation of EU Directives. Principle I stipulates that at least 8 % of the

exposures arising from credit and market risks must be backed by own funds:

Basel I

$$\frac{\text{Eligible own funds}}{\text{Risk-weighted exposures from credit risk} + 12.5 \times \text{Charges for market risk}} \geq 8\%.$$

In order to determine the risk-weighted exposures, the risk assets (asset items and off-balance-sheet positions) are classified into risk buckets subject to different prudential weightings (0 %, 10 %, 20 %, 50 %, 70 %, 100 %) pursuant to section 13 of Principle I. For example, claims on zone A central governments carry a zero weighting, claims on credit institutions have a 20 % weighting and claims on enterprises (irrespective of their actual credit standing) are weighted at a full 100 %. This regime of weighting exposures irrespective of creditworthiness has led to a marked discrepancy between economic and regulatory capital requirements and has therefore been criticised. There was a danger that banks might tend to incur higher risks since the capital charges are not risk-sensitive. This made it necessary to revise the Basel Accord.

Regulatory capital requirements ...

Basel II aims to align the risk weightings with the actual default risk. Moreover, for the first time the prudential capital requirements are to explicitly embrace not just credit and market risk but also operational risk. This results in the following prudential capital requirements:

... according to Basel II

$$\frac{\text{Eligible own funds}}{\text{Risk-weighted exposures from credit risk} + 12.5 \times (\text{Charges for market and operational risk})} \geq 8\%.$$

Basel II provides for a spectrum of approaches to measuring credit risk with a view to giving banks an incentive to progressively change over to more advanced methods and thus to align regulatory capital more closely with economic capital.

Standardised approach

Under the standardised approach the credit risk and the resulting capital charge are calculated with the aid of external ratings. Different groups of borrowers (e. g. sovereigns, banks, corporates) are assigned standardised risk weightings depending on their creditworthiness (0 %, 20 %, 50 %, 100 %, 150 %, 1,250 %). Unrated claims are automatically given a weighting of 100 %.

IRB approach

In contrast to the rigid standardised approach, in which the risk weights are laid down by the supervisory authorities, risk weights under the internal ratings-based (IRB) approach are computed on an exposure-specific basis subject to a regulatory risk-weight function. A bank's exposures are divided into five classes (corporate, bank, sovereign, retail and equity exposures). Banks can choose between using the foundation approach, under which they themselves may merely assess the probability of default (PD) of their borrowers, and a more advanced approach in which the bank itself is largely responsible for assessing the other inputs, too (LGD, EaD, M).[8]

Corporate, bank and sovereign exposures

Exposures to corporates, other banks and sovereigns are given the same methodological treatment. Obligors are divided into grades based on the lending institution's internal rating system. The risk weights are computed

8 LGD = loss given default; EaD = exposure at default; M = maturity.

according to a set risk function laid down by the regulators (see chart opposite).

Retail exposures

There is only one approach for the retail customer portfolio (which includes, for example, mortgage loans). The input parameters are PD and LGD; one of the parameters may be derived from the expected loss EL. As a general rule, exposures to retail borrowers will carry a much lower capital charge.

Equity exposures

Two parallel approaches to equity exposures are being considered: the market-based approach and the PD-LGD approach. For both approaches a simple method exists by which set risk weights are laid down by regulators. Under the more advanced methods banks may use their own estimates; under the market-based approach internal models or a scenario approach may be applied.

Collateral

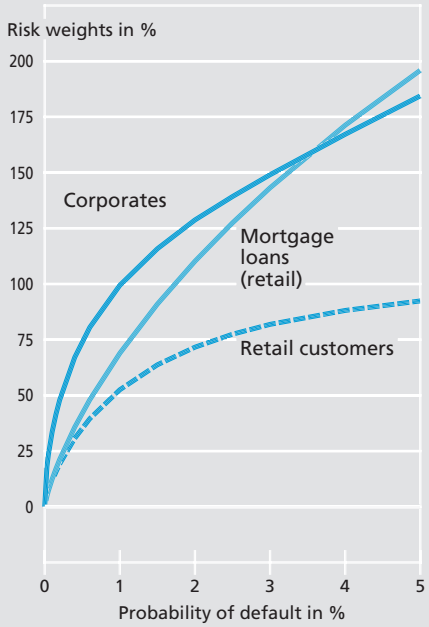
A more risk-sensitive treatment of exposures is additionally assured under Basel II by widening the recognition of guarantees and collateral. The range of eligible collateral and guarantees depends on which approach a credit institution opts to use. In the advanced approach, which comes closest to the concept of economic capital, institutions may themselves determine the range of their eligible collateral and the loss rates for collateral losses.

Significance of credit risk models

Problems in granting prudential recognition to credit risk models

As mentioned, credit institutions are increasingly seeking to use credit risk models to calculate their economic capital requirements. In principle, it is conceivable that such internal

Planned risk weight functions under the internal ratings-based (IRB) approach



models could be granted prudential recognition, as is already the case for market risk. However, the use of credit risk models to compute the regulatory capital requirement raises considerable problems which do not occur, at least on the same scale, in the field of market risk. Therefore, it has hitherto been rejected by the regulators. A key problem is validating the model being used. Unlike market risk models, there is still an insufficient pool of data for backtesting credit risk models. Particular problems are posed by the modelling of portfolio effects, the stability of the default correlations, the lack of market data on traditional lending business and the absence of sufficient historical data on default rates. The last-mentioned aspect is largely related to the long time horizon of

one year that is customary in credit risk models.

Derivation of Basel II risk weights from a credit risk model

A certain convergence between regulatory and economic capital requirements is nevertheless achieved by Basel II in that the risk weights are derived from a simplified credit risk model (see Annex 3, pages 55 ff.: Economic capital in a one-factor model). The key assumptions are that firms' returns are determined by just one systematic risk factor and that the loan portfolio is sufficiently granular. Under these (restrictive) assumptions, risk weights can be derived which are based on the value-at-risk concept that is typically used in credit risk models.

Annex 1

Economic capital in the default mode model

Default mode models basically capture borrower-specific characteristics as well as systematic or market-wide factors in a statistical loss distribution of the loan portfolio. The loss distribution has the following basic parameters:

- the exposure at default (*EaD*),
- the borrowers' probability of default (*PD*),
- the loss given default (*LGD*), and
- the correlation between the defaults of different borrowers (ρ).

The exposure at default is the sum of the current exposure and the loan commitments taken up until the time of default. Most credit risk models assume a constant, i. e. non-stochastic, bankruptcy rate, with the most conservative assumption being a rate of 0 %. The loss given default is the counterpart to the bankruptcy rate, which is chiefly calculated from the level and quality of the collateral and the bankruptcy costs incurred.

If the loans remain in the banking book portfolio throughout the contractually agreed period, the value of the loan claim when the contract expires – in relation to the present time – can be expressed as a binomially distributed random variable: with a probability of (1 - *PD*), the full loan amount will be repaid; with a probability of *PD,* the bank will receive only (1 - *LGD*)·*EaD*. The loss (*L*) on the loan is likewise binomially distributed. It is customarily specified per unit of exposure at default. The expected loss on the loan is therefore expressed as:

$$EL = PD \cdot LGD.$$

The unexpected loss on the individual loan is usually expressed as the standard deviation of *L*:

$$UL = \sigma_{Kredit} = LGD \cdot \sqrt{PD\,(1-PD)}$$

The loss on the overall loan portfolio equals the sum of the weighted individual losses:

$$L_{Portfolio} = \sum_i w_i L_i\,,$$

where $w_i = \frac{EaD_i}{\sum_k EaD_k}$

The overall loss is likewise a random variable as it depends directly on the realisations of the individ-

ual losses. However, the unexpected loss on the portfolio as a whole is usually far smaller than the sum of the unexpected losses on the individual loans owing to diversification effects. Thus the standard deviation for the portfolio loss is determined not only by the standard deviation of the individual losses but to a large extent also by correlations between the loans:

$$\sigma_{Portfolio} = \sum_i \sum_k w_i w_k \sigma_i \sigma_k \rho_{ik}.$$

The risk contribution of an individual loan to a portfolio is therefore smaller than its *UL*:

$$RB_i = w_i \sigma_i \overline{\rho_i},$$

where $\overline{\rho_i}$ denotes the correlation between the individual loss and the portfolio loss:

$$\overline{\rho}_i = \sum_k w_k \sigma_k \rho_{ik} \Big/ \sigma_{Portfolio}.$$

The following holds for the risk contribution:

– The sum of the risk contributions equals the standard deviation of the portfolio loss.

– The risk contribution increases as the *UL* rises and as the weight of the individual loan increases.

– The smaller the correlation with the portfolio loss, the smaller the risk contribution. (The usual correlation is positive and, for a typical loan portfolio, amounts to between 0.5 % and 3 %).

The *UL* for the overall loan portfolio is frequently defined not by the standard deviation but by the value at risk (VaR). As a rule, however, the VaR is much harder to determine than the standard deviation and in many cases can be computed with sufficient accuracy only via default simulations.

Annex 2

Computing the bank-wide economic capital requirement

Stand-alone approach

Under the stand-alone approach the individual business units of a bank autonomously calculate their profit and the amount of capital required to cover their unexpected losses. In this approach the sum of the economic capital of all the business units determines the bank's aggregate economic capital requirement. The major disadvantage of this method is that it disregards diversification effects between the business units. The stand-alone approach produces the correct capital requirement for the bank as a whole only in the special case that the returns of the individual business units are perfectly correlated. But if the correlation is lower (which is empirically likely), it produces an excessive capital requirement.

Proportional scaling method

Some banks seek to counter the shortcomings of the stand-alone approach by resorting to the proportional scaling method, under which a business unit's capital requirement is scaled in line with the bank's total capital as laid down by the central management. If a business unit reports a capital requirement of K_i^* under the stand-alone approach, it is allocated economic capital amounting to

$$K_i^{**} = K_{Bank} \cdot \frac{K_i^*}{\sum_k K_k^*}$$

where K_{Bank} denotes the bank's total capital. Yet this method of capital allocation is also imperfect as it ultimately does not allocate capital according to the originator principle. A business unit whose returns have a low correlation with those of the bank as a whole would be allocated too much capital even under the proportional scaling method.

Internal beta method

The internal beta method allocates capital to the individual units in line with their actual contribution to the bank's aggregate risk; it expressly takes account of correlations between the returns of the units. Under this approach the bank's aggregate risk is determined using the standard deviation of future returns. The marginal contribution of a given unit to the bank's aggregate risk is given by its "beta":

$$\beta_i = \frac{A}{\sigma^2_{Bank}} \sum_k w_k \, cov_{ik} \,,$$

where cov_{ik} denotes the correlation between the returns of the units i and k, A denotes the bank's financial resources, w_k is the share of unit k in the financial resources and σ_{Bank} is the bank's aggregate risk. The economic capital allocated to a given unit is given by the equation

$$K_i = \beta_i \cdot w_i \cdot K_{Bank} \,.$$

The impact of diversification effects is clear under this approach: the higher the correlation of the returns with those of the bank as a whole, the higher the economic capital allocated to the business unit. It should be noted that because

$$\sum_i \beta_i w_i = 1$$

the sum of the economic capital of the individual business units equals the economic capital for the bank as a whole stipulated by the central management.

Theoretically, the internal beta method – as long as certain assumptions hold – enables the bank to optimise its profitability (see following section). The implementation difficulties associated with this highly advanced approach are considerable, however. A key requirement for being able to set the betas objectively is the availability of a sufficient pool of data. As the betas largely determine the provision with capital and hence the individual units' cost of capital, this method may be a source of considerable conflict.[9]

The internal beta method from a theoretical perspective

The internal beta approach has the advantage that diversification effects are explicitly taken into account in the allocation of economic capital to the bank's individual business units. However, it must be demonstrated that this approach really does meet the aim of optimal risk diversification in the context of decentralised decision-making. This question is investigated below using a simple model.

Assuming the bank has an unlimited capacity to procure capital, its profit maximisation problem, taking its risk costs into account, may be formulated as follows:

$$\max A \cdot \sum_i \overline{R}_i(\sigma_i) \, w_i - rK$$

9 Theoretically, the beta of a business unit may even be negative, which would imply a negative cost of capital. But this case is highly improbable as the units are subject to common systematic (macroeconomic) risk factors.

subject to the constraint that the economic capital corresponds to the actual capital:

$$\alpha \cdot \sigma \left(\sum_i R_i w_i\right) A = K$$

where the variables denote the following:

R_i *and* $\overline{R_i}$ the uncertain returns and the expected returns on the resources deployed by the unit *i,* respectively

r the bank's cost of capital,

K_i, K the economic capital of the unit and of the overall bank, respectively

σ the standard deviation of the returns, and

α the multiplication factor for the unexpected loss.

It is assumed that the expected return of a unit $\overline{R_i}$ depends on the risk incurred. (In the following all optimum values are marked by an asterisk).

The crucial question is whether, in the context of decentralised decision-making, the interests of the individual business units can be harmonised with those of the bank as a whole. In the model considered here, this is possible if each business unit is allocated capital amounting to $K_i = w_i^* \beta_i^* K^*$ and the cost of capital is determined by

$$r_i = r \alpha \frac{\sigma^*}{\sigma_i^*} \sigma_i .$$

Under these conditions, a business unit's profit maximisation problem may be expressed as

$$\max_{\sigma} \overline{R_i}\ w_i A - r_i K_i$$

subject to the constraint $\alpha \sigma w_i A \leq K_i$.

It can be shown that σ_i^* is a solution to this maximisation problem; the optimum for the bank as a whole is therefore also achieved in the context of decentralised decision-making.

The above model is based on some simplifying assumptions, especially that the bank is able to set the betas and determine the optimal allocation of the resources. Normally, however, the central management will be able to base its decisions only on historical data. Hence application of the internal beta method presupposes that future returns will have the same distribution as past returns.

Annex 3

Economic capital in a one-factor model

If the economic capital is computed with the aid of a credit risk model, the capital charge to cover an individual exposure depends not only on loan-specific criteria (PD, LGD, EaD) but also on the characteristics of the overall portfolio (default correlations) of which the loan forms part. The economic capital of a portfolio thus generally differs from the sum of the economic capital of the individual loans. By contrast, the regulatory capital (under both Basel I and Basel II) is merely the weighted sum of the individual exposures and is thus portfolio-independent. However, it can be shown that, under certain assumptions, set risk weights can be harmonised with general VaR-based risk models. The two key conditions for this are:

– The obligors' returns are determined by a single systematic risk factor.

– The portfolio is composed of a large number of small loans – i. e. it is "infinitely granular".

These assumptions are of course very restrictive and can be considered good approximations for a real loan portfolio only in exceptional cases. For example, it is normally impossible to assume that there is just one systematic risk factor (such as general cyclical developments) because the cycles of different sectors are generally not congruent with one another. Moreover, the assumption of infinite granularity is a mathematical limiting case which only imperfectly mirrors the features of a real loan portfolio. Putting aside these objections, VaR-based risk weights can be derived as described below.

Most risk models based on a default-mode approach can be reduced to a simple basic formula. Let X denote the systematic risk factor and let $PD_i(x)$ denote the default probability of the i-th loan conditioned on a realisation x of X. It is assumed that the future value of a firm i depends on the systematic risk factor X and also on the idiosyncratic (i. e. diversifiable) risk ε_i as expressed in the following:[10]

$$R_i = \xi_i \varepsilon_i - \omega_i X .$$

The parameters ξ_i and ω_i are firm-specific weighting factors which determine the influence of the risk factors on the default risk. It is assumed that the loan will default if the firm's value falls below a certain level γ_i. Conditioned on a realisation of the systematic risk factor and assuming normal distribution of the idiosyncratic risk, the probability of a loan default is expressed as

$$PD_i(x) = \Pr(\varepsilon_i \leq (\gamma_i + x\omega_i) / \xi_i) = \Phi((\gamma_i + x\omega_i) / \xi_i)$$

where Φ denotes the distribution function of the standard normal distribution. It should be noted that the a priori unknown parameter γ_i can be inferred from the unconditional default probability $\overline{PD_i}$ of the loan through $\gamma_i = \Phi^{-1}(\overline{PD_i})$ (given a normal distribution of R_i). If A_i denotes the amount of the loan and the random variable U_i the random loss (LGD_i for a default, otherwise 0), the loss rate of the overall portfolio is given by

$$L^n = \frac{\sum_{i=1}^{n} U_i A_i}{\sum_{i=1}^{n} A_i}.$$

Let $\alpha_q(Y)$ denote the q-quantile of a random variable Y. It remains to be demonstrated that the VaR of the portfolio loss $\alpha_q(L^n)$ for a sufficiently granular portfolio (large n, small A_i) depends solely on the specific characteristics of the loans. The idiosyncratic risks do indeed cancel each other out at the limit. The VaR of the portfolio loss thus converges towards $E[L^n \mid X = \alpha_q(X)]$. This expression is portfolio-invariant since the default probabilities conditioned on a realisation x are uncorrelated:

$$E[L^n \mid X = x] = \frac{\sum_{i=1}^{n} LGD_i \cdot PD_i(x) \cdot A}{\sum_{i=1}^{n} A_i}.$$

The above relationship suggests a simple capital rule: let every loan i be backed by $LGD_i \cdot PD_i(X = \alpha_q(X))$ worth of capital per unit of money of the loan's nominal value. If X is normally distributed and if s is the uniform correlation of the firm's value, the risk weight function of a loan with an LGD of 100 % is given, depending on the unconditional default probability, by

$$f(PD) = \Phi\left[\frac{1}{\sqrt{1-s}}\Phi^{-1}(PD) + \frac{\sqrt{s}}{\sqrt{1-s}}\Phi^{-1}(q)\right].$$

10 Without loss of generality, it can be assumed that R_i, X and ε_i have an expected value of 0 and a variance of 1.

This formula also forms the basis for the benchmark risk weight function of the second Basel II consultative paper.