Lean IRB Approaches and Transition Design:

The Basel II Proposal

This version: October 2001

Hans Gersbach* and Uwe Wehrspohn**

Abstract:

The internal ratings based approach (IRB) of the Basel Committee has three problems: few incentives for banks to adopt the IRB approach, a complicated technical framework and very conservative aggregation rules. We suggest the following remedies: First, we suggest a new design of transition rules that produce strong incentives for banks to adopt the IRB approach. Second, we outline a *lean* IRB approach which is simpler and avoids adjustments and caps that are difficult to justify. This approach can be flexibly calibrated to proxy any IRB approach. Third, we suggest a simple aggregation rule for capital requirements across portfolio segments that takes the diversification effect across segments into account.

*Alfred-Weber-Institut,

University of Heidelberg, Grabengasse 14, D-69117 Heidelberg, Germany.

E-mail: gersbach@uni-hd.de.

** CSC Ploenzke AG – Computer Sciences Corporation,

Competence Center Controlling & Risk Management, Bahnhofstrasse 27-33, D-65185 Wiesbaden,

Germany. E-mail: Uwe.Wehrspohn@csc.com

Extended Summary:

The internal ratings based approach (IRB) of the Basel Committee has three problems:

- On average, capital requirements under the IRB approach would increase considerably in comparison with the *present* regulatory approach implying that banks have little incentives to improve risk assessment by adopting the IRB approach.

- The IRB approach is too complicated compared to its achievements and creates barriers for the transition towards more advanced and more sensitive credit risk management techniques.

- The aggregation rule of the IRB approach underestimates risk diversification across segments.

We suggest the following remedies:

- Firstly, we suggest transition rules that produce strong incentives for banks to adopt the IRB approach and are easy to implement.

- Secondly, we outline a *lean* IRB approach that leads to equivalent results as the existing IRB approach, but is much simpler and avoids adjustments and caps that are difficult to justify. Furthermore, the lean IRB approach can flexibly be calibrated to proxy the existing or any modified IRB approach including flexible adjustments and thereby would facilitate the transition towards credit risk models. The *lean* IRB approach encompasses:

  - Risk weights calculated directly from the analytic loss distribution of the Merton-style credit risk model without further adjustments increasing interpretability and general acceptance of the approach.

  - Apart from default probabilities, all other risk drives such as granularity will be incorporated in the correlation assumption of the analytic loss distribution..

- Thirdly, we suggest a simple aggregation rule for capital requirements across portfolio segments that in contrast to the current proposed aggregation rule takes into account the diversification effect across segments.

The applicability of our proposal is demonstrated by simulation exercises with real and generic bank portfolios.

Contents

Table of Exhibits

Table of Formulas

1. Introduction

Credit risk measurement and management has evolved considerably over past years. The development of regulatory capital requirements reflects this evolution and involves three major steps:

- The standard approach and the modified standard approach

- The IRB approaches

- Portfolio credit risk models

The 1988 Basel Capital Accord has started the international convergence of capital standards and has led to improvements of these standards in various countries. The 1988 Accord explicitly required internationally active banks from the G10 countries to hold a minimum of total capital of 8% of risk-weighted assets with at least half of this met by first tier capital (equity capital and disclosed reserves). The main rule has been the assignment of on-balance sheet assets to one of four risk buckets (0%, 20%, 50% and 100%). Off-balance sheet assets were converted to credit equivalents.

Over time, the conceptual limitations together with financial innovations have prompted a debate on the design of capital standards and have put pressure on regulatory bodies to revise the Accord. In a first step, the Accord was amended in 1996 to allow banks to use their internal models to determine the capital requirements for market risk. The market risk capital requirement with the internal models approach is based on the VaR estimate calibrated to a 10-day, 99th percentile standard.

Concerning credit risk, the Basel Committee has drawn the conclusion that portfolio credit risk models will finally be allowed by regulatory authorities, but that current credit risk models cannot yet be used to determine regulatory capital and that additional extensive backtesting will be necessary. Therefore, in the Committee's current proposal the IRB approach has been defined as an intermediate step towards credit risk models. The IRB approach will be discussed in detail in the next section.

The evolution towards sophisticated credit risk measurement and management raises a number of important issues.

- Firstly, from an economic viewpoint, do banks have sufficient incentives or possibilities to raise a socially efficient level of equity?

- Secondly, what is the purpose of capital adequacy rules? Should such rules be made sensitive to banks' credit risk?

- Thirdly, when does a credit risk model satisfy the theoretical foundations of modeling individual and joint defaults as well as derivations of loss distributions and value-at-risk?

- Fourthly, does data availability at individual banks and at the level of the banking industry allow the use of advanced credit risk models? Is the IRB approach as an intermediate step useful?

- Fifthly, will the transition from standard approaches over IRB frameworks to credit risk models increase capital requirements?

- Sixthly, what is a meaningful IRB approach?

- Seventhly, how does regulatory design need to be modified to ensure a smooth transition for individual banks and the banking industry towards accurate credit risk methodologies?

While we do not address the first four issues in this paper[1], we develop answers for some of the other questions. Therefore, for the purpose of this paper, we assume that the IRB approach is a useful intermediate step in banking regulation. In our paper, we also neglect all issues regarding credit rating systems in banks.[2]

The new capital adequacy framework of Basel II has triggered a large number of critical evaluations, some of them have been published in scientific journals (see e.g. Altman and Saunders 2001 and Linnell 2001). We are not aware however, of proposals for a lean IRB approach and transition rules as we develop in this paper.

---

[1] For the first issue see Gersbach [2001] for a recent discussion. For the second issue, see the recent surveys and discussions by Hellwig (1995), Bhattacharya, Boot and Thakor (1998), Goodhart, Hartmann, Llewellyn, Rojas-Suarez and Weisbrod (1998) Kaufmann and Scott (2000), Santos (2001), The third and fourth issue have been addressed e.g. in [Crouhy, Galai and Mark 2000, Gordy 2000, Nickell, Parraudin and Varotto 2000 and Erlenmaier (2001)]. It is argued that there is still scope for considerable improvements in current credit risk models. For instance, credit risk models should employ stochastic interest rates instead of deterministic ones and capture that default and rating transition probabilities vary over the business cycle. Moreover, the appropriate balance between realism, sound theoretical framework and tractability is not known yet.

[2] How credit risk rating systems can be designed and maintained under Basel II has been recently addressed for instance by Krahnen and Weber (2001), Altman and Saunders (2001) and Crouhy, Galai and Mark (2001).

The paper is organized as follows. In the next section, we provide a brief summary of the IRB approach. In the third section we discuss its main problems. In section four we present our *lean* IRB approach and the aggregation rule. We discuss the application of the lean IRB approach for two bank portfolios in section five. Section six contains the design of transition rules. Section seven concludes.

2. The IRB Approach

Besides the desire for continuity as expressed in the modified standard approach, the major aim of the new design of the Basel Capital Accord is to increase the risk sensitivity of equity allocation and to more precisely adapt regulatory capital to the actual risk profiles of banks' portfolios. Therefore, the Basel Committee has suggested two methods, the so-called internal ratings based approaches (IRB) that allow banks to use their internal assessments of risk factors to calculate capital requirements. The Committee wants to offer incentives for banks to adapt the IRB approaches.

The Committee distinguishes five risk factors that combined describe a contract's, a client's and the portfolio's gross credit risk (i.e. the credit risk net of risk mitigation techniques):

- The client's one-year probability of default estimated by his internal rating,
- The specific contract's loss given default,
- The contract's exposure at default,
- The contract's mean maturity (duration),
- The portfolio's granularity.

Both IRB Approaches differ only in the assumptions concerning the correct values of these risk factors. While the IRB Foundation Approach only employs a bank's estimations of clients' default probabilities and assumes standard supervisory rules for the other factors, in the IRB Advanced Approach a bank has to supply meaningful estimates of all risk factors. Given the specific values of risk factors, the methodology of calculating risk weights is the same in both approaches.

Since not all components of a bank's total portfolio have the same characteristics, it is therefore proposed to segregate the portfolio into segments with relatively homogenous risk profiles such as sovereigns, corporates, banks, retail credits, project finance, and equities. Within each segment the same formula is used for all exposures to calculate capital requirements while formulas differ between segments. Finally, contracts' capital requirements are added to reach the necessary regulatory capital for the entire portfolio.

Besides the rules stated above, there are a large number of further reflections, either for adjustments of risk weights and capital requirements, based for instance on maturity or granularity considerations, or rules to calculate exposures, collaterals and other data inputs. As a result of the former adjustments, the formulas become complicated. While the adjustments may be rationalized as a single item, it is doubtful whether they increase the accuracy of capital requirements within the IRB approach.

3. Main Issues of the IRB Approach

The current proposal of the Basel Committee has three main problems: On average, capital requirements would increase considerably so that banks have no incentive to adopt the IRB approach. The IRB approach is too complicated compared to its achievements and creates barriers for the transition towards credit risk models. And risk diversification across segments is underestimated. We will discuss each in turn.

First, as is generally acknowledged, the current Basel II proposal will have drastic consequences for capital requirements: the IRB approach of the Basel Committee on Banking Supervision will increase capital requirements of banks for the corporate segment compared to the modified standard approach except for banks with very skewed portfolios towards high rating classes. Only in the retail segment do capital requirements tend to be alleviated.

As a result, average capital requirements would increase considerably if the current proposal were implemented, which is in conflict with the intention to leave the total capital requirements for an average risk portfolio unchanged. The vast majority of banks will not want to qualify for the IRB approach since they would need considerably more capital than today. Therefore only banks with very good corporate portfolios or an extremely large share of the retail portfolio in the total bank portfolio will voluntarily migrate to IRB capital requirements. This will create a two-tier banking industry and will delay the spread of first-

best credit risk management approaches. Moreover, the stability concerns of the banking and financing market system would increase. Temporary cap rules, which protect banks against increasing capital requirements for a certain time, will only delay the problem.

Whatever final capital requirements under the IRB approach will be, it is important that regulatory design provides appropriate incentives to adopt the IRB approach. In section six we suggest an appropriate incentive scheme that allows for a feedback from the advanced IRB approach back to the modified standard approach in the following way:

- Adjustments of risk weights of the (modified) standard approach so that average regulatory capital under the modified standard approach moves closer - on average - to the average capital of the same banks under the IRB framework.

This suggestion for regulatory design would alleviate the obstacles in the current proposal for fostering the adoption of advanced credit risk management.

Second, simplicity and efficiency of IRB rules is a goal explicitly defined in the Consultative Paper[3]. However, the current IRB rules are very complex and most likely too complicated compared to what they achieve. In Gersbach and Wehrspohn (2001) we provide a detailed account of the current formal framework of the Basel II proposal and its interpretations. While the proposed elements of the IRB approaches in the derivation of bank capital requirements may be sensible as single measures, it is unclear whether adding adjustment effects for many different considerations should be incorporated in this step. Otherwise, since regulation should not be changed at high frequencies, not allowing for credit risk models is difficult to rationalize. The complexity of the current proposal can delay the transition to the IRB approach without, however, really capturing a portfolio based VaR or shortfall calculation.

As long as credit risk models are not allowed, a *lean* IRB approach could be based on two or three simple principles. The *lean* IRB approach will be introduced in the next section. As we will discuss, such a lean IRB approach can almost replicate the capital requirements of the current proposal.

Third, the aggregation of regulatory capital from the contract to the portfolio level proceeds by mere summation. This is only correct if all portfolio segments are affected in the same way by the systematic risk drivers. However, it is conceivable that the credit risk of corporate and retail clients does not depend on the same set of systematic risk drivers, which generally

---

[3] See, for instance, §§ 85, 111, 132 and other quotations in *The Internal Ratings Based Approach*.

implies that the risk of the total portfolio will be much less than the sum of values at risk of portfolio segments. It is therefore possible that the current aggregation rule overstates capital requirements. We suggest that the current aggregation method be replaced by

- An aggregation rule for capital requirements which takes the diversification effect into account.

In the next sections we discuss our suggestions in detail. We start with the lean IRB approach and the aggregation rule. Later we will address the transition design.

4. A lean IRB Approach and alternative Aggregation Rules

A *lean* IRB approach could be based on the following pillars:

- Risk weights calculated directly from the analytic loss distribution of the Merton-style credit risk model without further explicit adjustments.

- Adjusting the correlation assumption in the analytic loss distribution according to the concentration of the credit portfolio to account for granularity.

We first discuss the calculation of simple risk weight functions for corporate and retail borrowers that replicate the existing IRB approach.

4.1. Simple Risk Weight Functions for Corporate and Retail Borrowers

At the heart of the risk weight functions, as proposed in paragraphs 174 and 310 of *The Internal Ratings Based Approach,* is the portfolio loss distribution for a one-year time horizon as calculated by the Merton-style-model for an infinitely large portfolio of identical clients and identical exposures. This distribution is given by the well-known formula, proved in Gersbach and Wehrspohn (2001):

Formula 1: Analytic Loss Distribution for homogenous Portfoliosl

$$L(p;\rho,q) = \lambda \cdot \Phi\left(\frac{\Phi^{-1}(p) - \sqrt{\rho} \cdot \Phi^{-1}(1-q)}{\sqrt{1-\rho}} \right)$$

p is the clients' probability of default and λ their loss given default, ρ is the correlation between each two clients, q is the percentile of this point on the distribution, $\Phi(\cdot)$ is the

cumulative normal distribution function with inverse $\Phi^{-1}(\cdot)$.[4] The Committee uses $\rho = 20\%$ and $q = 99.5\%$ as a realistic value for these parameters[5].

Note that the portfolio loss distribution L stems from a portfolio model and is designed to answer the question: "How will the value of my portfolio change within the next year?" It is, therefore, focused on the value of the respective portfolio under the assumption that the portfolio structure and exposure is exactly the one we see today. The maturity of the particular credit's plays no role in this argument.

We suggest that the analytic loss distribution be used directly to calculate risk weights without further maturity adjustment. This is sensible for four reasons. First, it provides a convenient benchmark in terms of marginal value at risk for the capital an individual loan requires in a portfolio, if the portfolio were composed of homogenous loans.

Second, at a one-year horizon credit portfolio risk generally does not depend, at least not in a straightforward way, on individual contracts' maturities. Portfolio structures are far more stable than the individual contract's since there is a permanent need in the market for different forms of financing. For example, a six-month short-term money market loan will cease to exist after six months. The total amount of six-month-credits in the portfolio will, however, normally change slowly.[6]

Third, as discussed in detail in Gersbach and Wehrspohn (2001), the maturity adjustment of the Basel Committee essentially is a heuristic approximation to the Value at risk of homogenous portfolios for longer time horizons in line with Standard & Poor's multi-year default probabilities. Whether such a deviation from a one-year time horizon can be justified is questionable. Requiring bank capital today for risks that only come into existence in the coming years could only be justified in two ways: smoothing capital requirements over the business cycle and making risk weights more conservative.

From an economic viewpoint it can be argued that capital requirements should remain smooth over the business cycle, which could therefore justify a multi-year time horizon. However, multi-year default rates also vary considerably over the business cycle and therefore may not

---

[4] Confer to § 446 footnote 28 *The Internal Ratings Basel Approach*.

[5] See § 172 *The Internal Ratings Basel Approach*.

[6] Moreover, companies in default usually have a great diversity of contracts in their individual portfolio. They hold contracts of all maturities, short-term and long-term credits alike, i.e. banks turn out to not be reliably able to withdraw short-term debt from clients prone to default. Therefore, the maturity of loan contracts only vaguely reflects the abilities of banks to secure repayment.

fulfill smoothing purposes. Smoothing capital requirements over the business cycle and in particular allowing for less stringent capital requirements in recessions could be achieved by allowing for smoothing of one-year default rates over the business cycles or by explicit reductions in recessions.[7] Using the maturity adjustment to make risk weights more conservative could be achieved simply by choosing an appropriate correlation assumption.

Fourth, the 3-year-maturity correction in the proposal can be replicated by a similar risk weight function based only on the simple analytic loss distribution. For corporate borrowers this is represented in Exhibit 1.
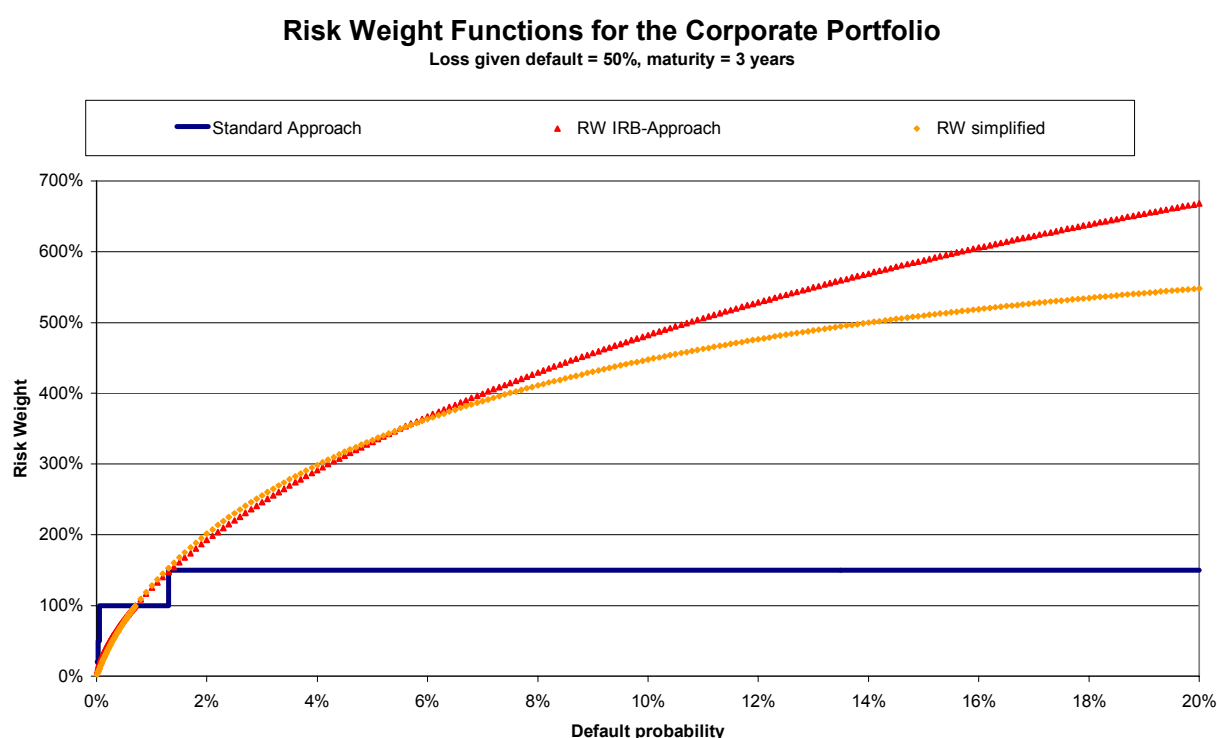
Risk Weight Functions for the Corporate Portfolio
Loss given default = 50%, maturity = 3 years

Exhibit 1: Risk Weight Functions for the Corporate Portfolio

As illustrated in Exhibit 1, the risk weight function presented in the Consultative Paper of Basel II (red line in Exhibit 1) for corporate borrowers can be considerably simplified if the analytic loss distribution is used with correlations of 44% and a percentile level of 99.5%.[8]

---

[7] There exists a considerable debate whether capital adequacy rules should be made dependent on the business cycle in order to ease credit constraints [see Dewatripont and Tirole 1994, Hellwig 1995, Holmström and Tirole 1997, Gersbach 2001]. Blum and Hellwig (1995) have shown that strict capital adequacy rules may reinforce macroeconomic fluctuations.

[8] The parameters are chosen so that the simplified IRB risk weight formula leads to a risk weight of 100% for a default probability of 0.7% and a loss given default of 50%. Cf. § 172 in *The Internal Ratings Based Approach*.

Using these assumptions, we obtain the simplified version of the existing risk weight function[9] for corporate clients, denoted by $RW_{simplified}$ as:

Formula 2: Simplified IRB Risk Weight Formula for the Corporate Portfolio

$$RW_{simplified} = 12.5 \cdot \lambda \cdot \Phi\big(2.283 + 1.336 \cdot \Phi^{-1}(p)\big)$$

Again, p is the client's probability of default, $\Phi(\cdot)$ the cumulative normal distribution function and $\Phi^{-1}(\cdot)$ its inverse. λ stands for the credit's loss given default. Note that this variation of the formula – like all of the subsequent suggestions – also solves the problem that risk weights imply higher capital requirements for low credit qualities than the contract's loss given default since the analytic loss distribution only takes on values between 0 and 1. Thus, cap rules, needed in the Committee's proposal, are superfluous.

The same procedure can be applied to other portfolio segments. As an example consider the retail portfolio. Going through the same procedure we obtain the simplified version[10] of the existing risk weight function for retail clients as:

Formula 3: Simplified IRB Risk Weight Formula for the Retail Portfolio

$$RW_{simplified} = 12.5 \cdot \lambda \cdot \Phi\big(1.368 + 1.132 \cdot \Phi^{-1}(p)\big)$$

---

[9] Here and in the following the risk weight functions are scaled as multiples of 8%.

[10] This formula results from the analytic loss distribution choosing correlations of 22% and the 99.5%-VaR. The formula was calibrated so that the existing and the simplified risk weight functions assign a risk weight of 100% to the same probability of default assuming a loss given default of 50%.

Risk Weight Functions for the Retail Portfolio

Loss given default = 50%

Standard Approach ▬ Risk Weights IRB-Approach ▲ RW simplified ◆
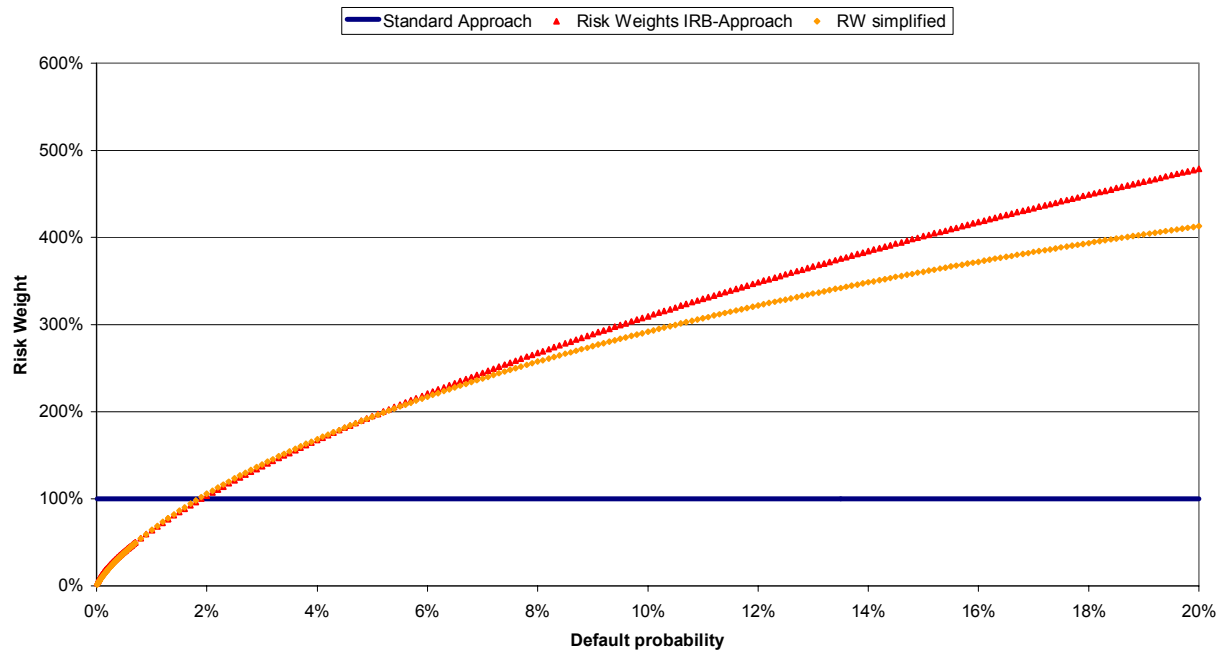

Exhibit 2: Risk Weight Functions for the Retail Portfolio

4.2. Granularity Adjustments

To gain an analytic solution for the analytic loss distribution it had to be assumed that all clients are identical twins with regard to their individual risk profile, their exposure, and their interdependence. It is evident that these assumptions are overly simplistic, since in real world portfolios we often observe that a small share of borrowers make up for a large share of the credit portfolio. Some kind of granularity adjustment is, thus, apparently necessary.

In the Consultative Paper a granularity adjustment is proposed that is derived from the Credit Risk+ model. Here the focus is put mainly on the exposure per rating category where the share s_b of the exposure in risk grade b in total exposure turns out to be the main driver (cf. paragraph 513 in *The New Basel Capital Accord*).

There are three main sources of heterogeneity effects in credit portfolios which may require a granularity adjustment: heterogeneity with respect to default probabilities, heterogeneity with respect to default correlations and heterogeneity of unsecured exposures across borrowers.

While the first source of heterogeneity does not invalidate the analytic loss distribution as an asymptotic result, the latter two sources require adjustments. Only credit risk models will be able to exactly derive the loss distribution incorporating all sources of heterogeneity. Moreover, to our experience and as indicated by real world portfolios discussed in the next section, the last two sources behind the granularity effect can be incorporated already in the IRB approach by appropriate adjustments of the correlation assumption.

Heterogeneity with respect to the asymmetries in exposures can lead to values at risk of the loss distribution that are 20% to 50% higher than those calculated by the analytic loss distribution even for portfolios containing several hundred thousand clients. The reason is that the analytic loss distribution is an asymptotic result that does not hold for the highly concentrated parts of actual portfolios that contain only a few very large customers.

The existing granularity correction, thus, understates a realistic granularity effect.[11] Exhibit 3 gives an impression of the heterogeneity in real world portfolios.
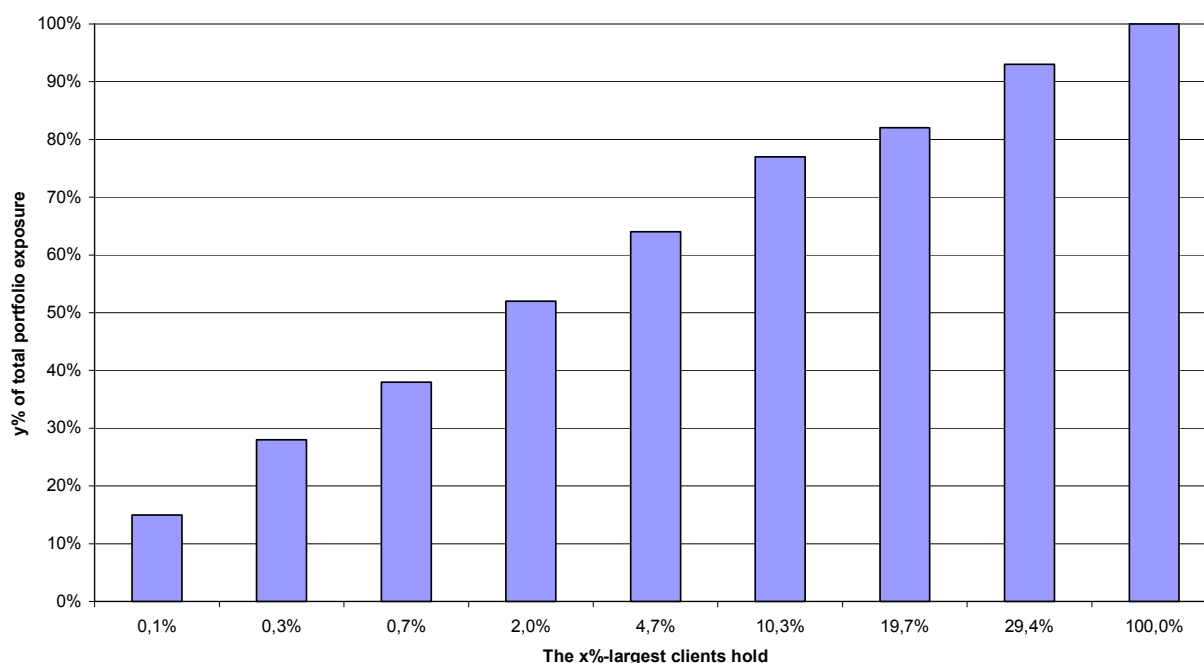
Exposure distribution in a large bank portfolio

Exhibit 3: Exposure Distribution in a large Bank Portfolio

---

[11] In practice equally important, the granularity effect is not influenced by the number of rating grades used by a bank, which, however, affects the granularity adjustment in the Basel II proposal. This implies in turn that an increasing number of rating categories reduces the portfolio risk, which is problematic.

A very simple but somewhat crude way to incorporate the granularity effect into the risk weight based on the analytic loss distribution is to increase correlations. In our experience verified by experimental analyses, correlations between clients of around 25%-35% in the analytic solution of the Merton-style-model are in line with simulation results of heterogonous real world portfolios if clients in the same sector are approximately 50% correlated and if clients in different sectors have correlations of around 20%.

A more sophisticated granularity adjustment would be the following: The increase of the correlations in the risk weight function for an individual borrower could be made dependent on the concentration of the credit portfolio. Correlations would increase if concentration increases. For instance, one could start with correlations around 25% if concentration is low and move to correlations up to 35% if concentration is high.

Still, the simple and the more sophisticated granularity adjustments are crude and do not take account of a particular bank's portfolio structure, but it is conceptually efficient as a first order approximation. It moves the IRB approach in the right direction and it is technically much easier to implement in a bank than the granularity correction by rule of thumb proposed in the Consultative Paper. We believe that more sophisticated assessments of portfolio structures and their concentration and diversification should be left for the next generation of banking regulation where internal credit portfolio models will be allowed.

4.3. Modifications of Risk Weight Functions

The lean IRB approach from the last section can flexibly be calibrated to proxy the existing or any modified IRB approach including flexible granularity adjustments and thereby would facilitate the transition towards credit risk models. As an example based on the simulation exercises with real portfolios, risk weights might be modified in the following way. The risk weight function for corporate borrowers could use the analytic loss distribution with correlations of 30% and a percentile level of 99.5% as depicted in dark green in Exhibit 4. This provides an alternative risk weight function for corporate clients including granularity and maturity adjustment:

Formula 4: Modified IRB Risk Weight Formula for the Corporate Portfolio

$$RW_{alternative} = 12.5 \cdot \lambda \cdot \Phi\big(1.686 + 1.195 \cdot \Phi^{-1}(p)\big)$$

Risk Weight Functions for the Corporate Portfolio
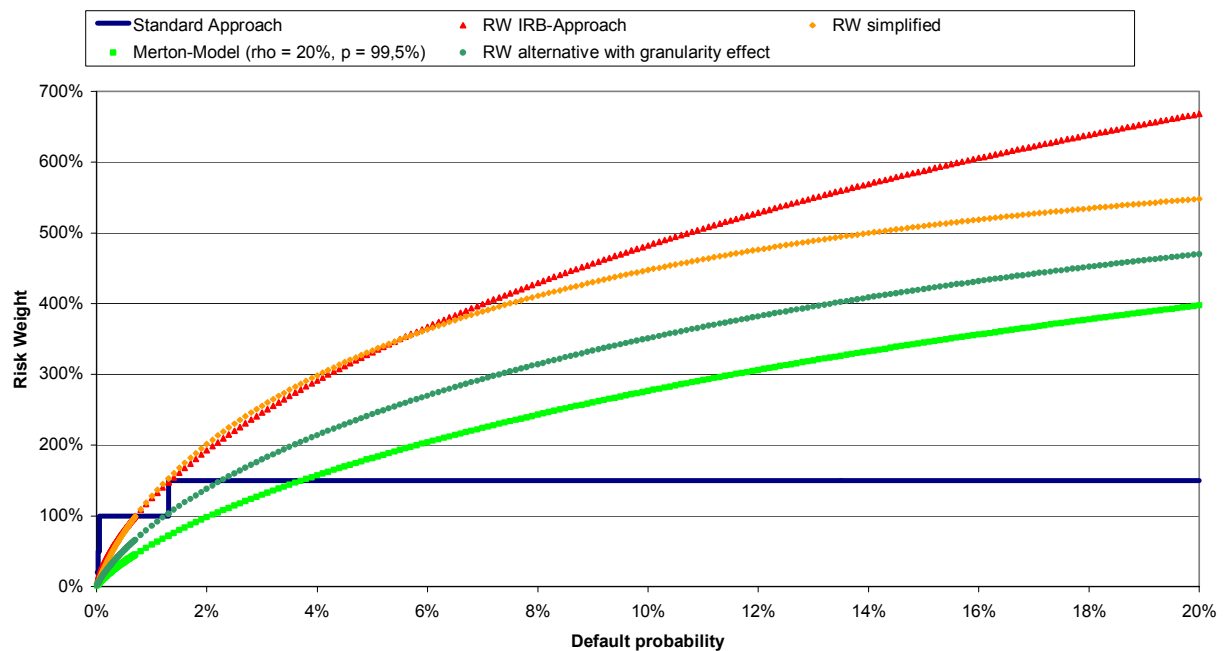Loss given default = 50%, maturity = 3 years

Exhibit 4: Modified Risk Weight Functions for the Corporate Portfolio

Note that a contract's maturity only enters into the regulatory capital requirements through the exposure at default. Note further that this risk weight function privileges the IRB approaches over the standardized approach up to a probability of default of 2.3% (in the existing formula or $RW_{simplified}$ only of 0.7%). This is more in line with the Committee's intention to provide incentives for banks to adopt the IRB approaches. For instance, 71% of all corporates in Germany have default probabilities of 0.7% or higher with an additional 24% defaulting with likelihoods between 0.5% and 0.7% while only approximately 5% of all corporates have default probabilities of less than 0.5% according to the Creditreform rating. However, unlike the correlation assumption of the Committee, this risk weight function was derived with correlations among borrowers between 20 and 50%.

As there is no comprehensive database on asset value correlations available for bank clients, whatever correlation assumption will be used ultimately in the IRB approach, it should be revised as more information becomes available.

Similarly, for the same example, our simple procedure would lead to the alternative risk weight function for retail clients, including granularity adjustment:

Formula 5: Modified IRB Risk Weight Formula for the Retail Portfolio[12]

$$RW_{alternative} = 12.5 \cdot \lambda \cdot \Phi\left(1.082 + 1.084 \cdot \Phi^{-1}(p)\right)$$

In the next exhibit we illustrate the simplified and the alternative risk weight function for retail borrowers.

Risk Weight Functions for the Retail Portfolio
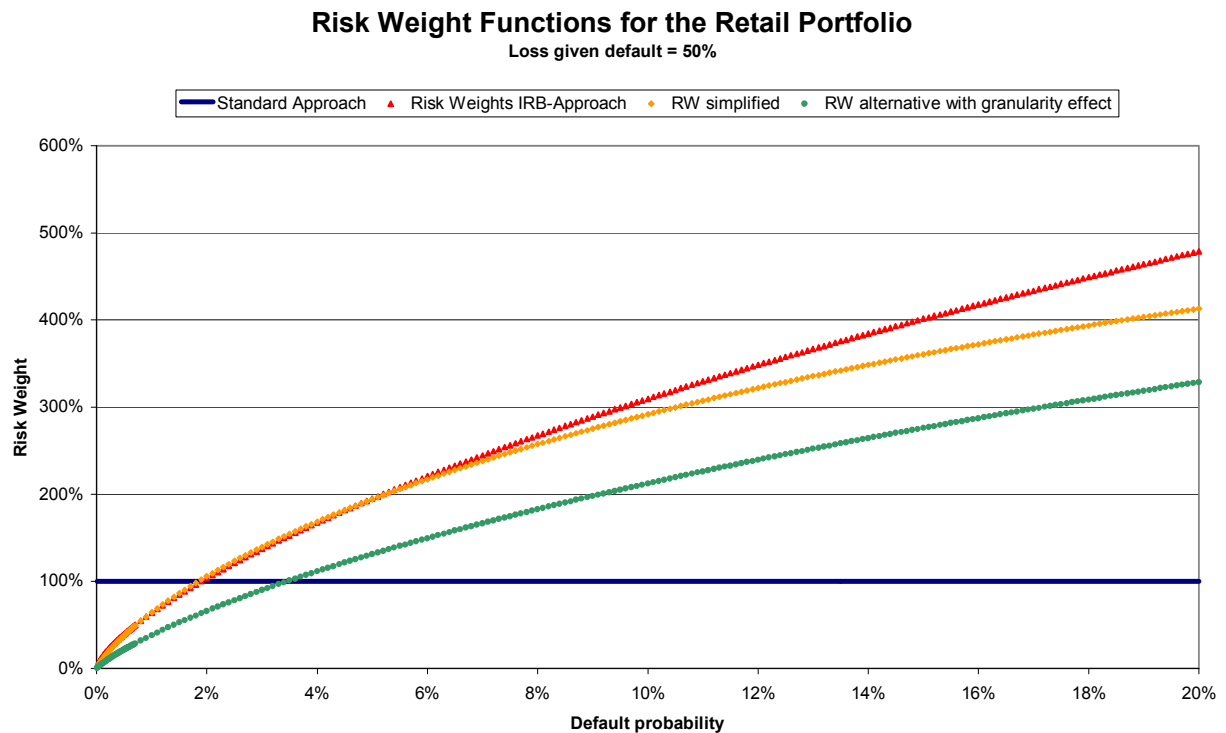Loss given default = 50%

Exhibit 5: Modified Risk Weight Functions for the Retail Portfolio

4.4. Aggregation Rules

The aggregation of regulatory capital from the contract to the portfolio level proceeds by mere summation. This aggregation rule is consistent with the model within each segment as all idiosyncratic risk has been diversified by assumption. The aggregation rule is also consistent with the model if there is only one common systematic risk factor across all segments

However, if systematic risk factors differ across segments, which is generally the case, the aggregation rule will overstate capital requirements. In fact, corporate clients and retail clients

---

[12] This formula results from the analytic loss distribution choosing correlations of 15% and the 99.5 percentile.

are very lowly correlated. In consequence, the value at risk of the complete portfolio will in general be less than the sum of the portfolio segments values.

As a more subtle aggregation rule that is still crude but comprises this diversification effect, we suggest the following formula:

Formula 6: Modified Aggregation Rule for Capital Requirements

$$C_P = 0.5 \cdot \max_S C_S + 0.5 \cdot \sum_S C_S$$

C_P stands for the total portfolio capital requirements, C_S for capital requirements in the segments, and the index S denotes the segment. The formula stems from the observation that total portfolio risk cannot be smaller than the largest risk contribution of a segment. Further segments, however, only contribute a smaller portion than their stand alone risk to the portfolio risk. The factor 0.5 appears to be conservative.

5. Two Bank Portfolios

To illustrate our suggestions we present the analyses of two realistic portfolios. We compare the current IRB approach of the Committee with the *lean* IRB approach in shape of the simplified and the modified IRB formulas and with the loss distribution simulated with a credit risk portfolio model. [13]

Portfolio A is a real world example of a mid-sized regional bank in Germany. Portfolio B is a generic bank portfolio composed of large and, on average, high-rated borrowers. Only unsecured exposures are considered. Maturity is assumed to equal three years.

5.1. Portfolio A

Portfolio A consists of approximately 9,000 corporate and 165,000 retail clients. Corporate clients hold 43% of total portfolio value, while retail clients make up for the remaining 57%.

---

[13] All calculations of portfolio risk were done with CreditSmartRisk, a model that comprises the Merton-style-model as a special case. For more details refer to www.creditsmartrisk.com.

Concentration in both portfolio segments is similar to the example given in exhibit 1. In particular, 2% of corporate clients owe 50% of total portfolio value in that segment. Default probabilities in the corporate portfolio range from 0.03% to 22%. Clients are dispersed over 8 sectors. Correlations between firms in the same sector are set equal to 50%. Corporates in different sectors are assumed to be 20% correlated[14].

Capital Allocations dependent on Loss given default
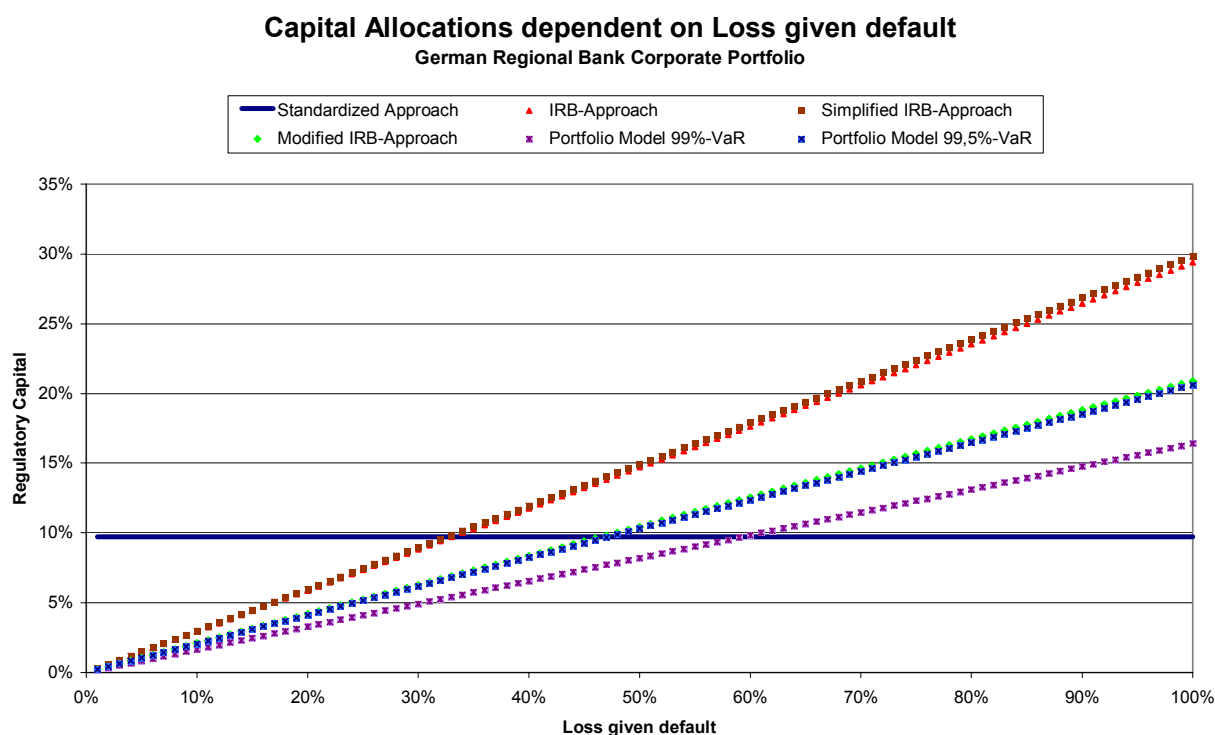German Regional Bank Corporate Portfolio

Exhibit 6: Capital Allocations dependent on Loss given Default: German Regional Bank Corporate Portfolio

Exhibit 6 shows simulation and calculation results for different values of average loss given default. The simulation exercise illustrates the following five observations:

1. The results obtained with the formula in the consultative document and its simplified version are practically identical (red and brown lines). This backs our suggestion that the current IRB approach can be simplified without sacrificing risk sensitivity.

2. The standardized approach leads to lower capital requirements than the IRB approaches for all average losses given default (LGD) over 33%. This implies that capital requirements for the corporate portfolio will increase in the current framework for realistic values of LGD, which can be assumed to lie above 33%.

---

[14] Note that this type of correlation already takes idiosyncratic risk components into account.

3. The modified IRB approach, as proposed above, leads to lower capital requirements than the IRB approaches, as described in the Consultative Paper, but to higher capital funding than the portfolio model calculates even for compensation of the 99.5%-value at risk.

4. The modified IRB approach is a very good proxy of 99.5%-value at risk as calculated by the portfolio model, thus taking account of the poor granularity of the portfolio.

5. Even if the portfolio model is used to calculate the risk of the corporate segment, capital requirements are likely to be larger than for the standardized approach, if realistic values of LGD are assumed. This implies that for this type of regional bank, bank capital of the corporate portfolio is expected to rise even if credit risk models are used.

In the bank's retail portfolio, default probabilities extend from 0.03% to 8%. 2.2% of retail customers hold 50% of the segment's portfolio value. Correlations between clients are uniformly set to 10%.
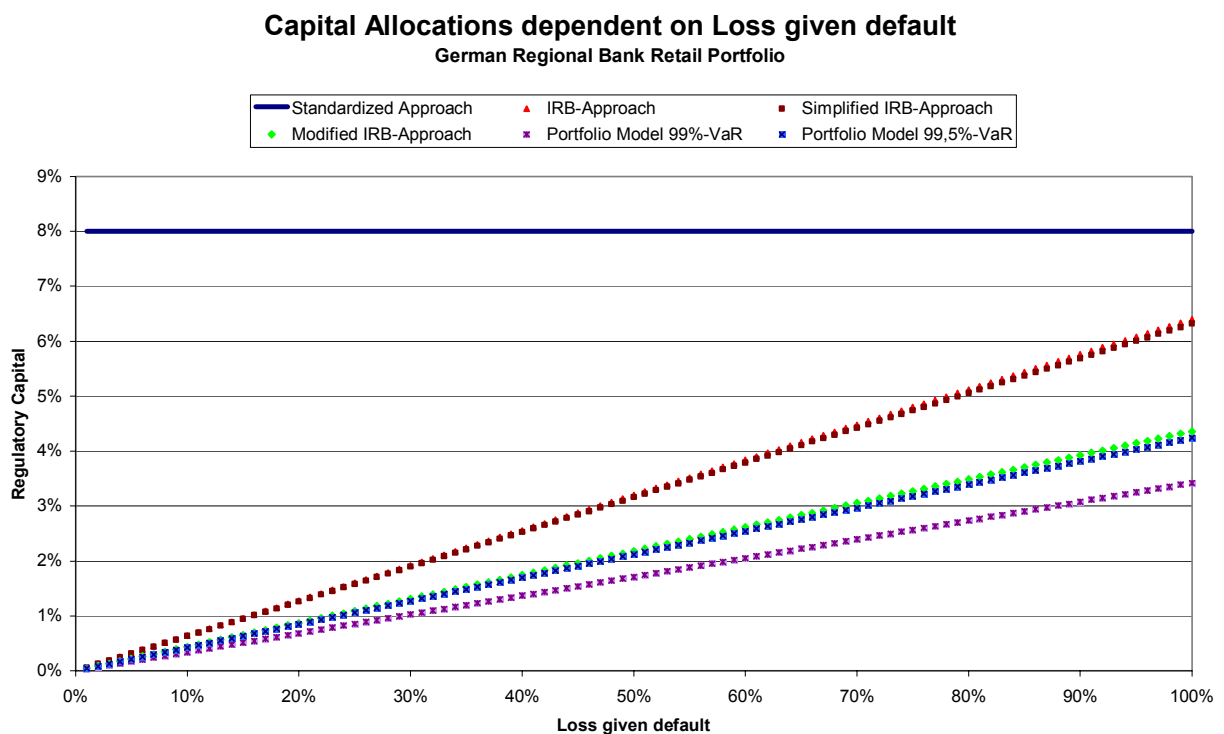

Capital Allocations dependent on Loss given default
German Regional Bank Retail Portfolio

Exhibit 7: Capital Allocations dependent on Loss given default: German Regional Bank Retail Portfolio

Results are illustrated in Exhibit 7. Note that the standardized approach obliges the bank to allocate much more capital in the retail portfolio than the IRB approaches for all values of LGD. This is a result of the fact that the IRB approaches lead to higher risk weights than the standardized approach only for comparatively high default probabilities of more than 1.9%.

Again it can be observed that the simplified IRB formula leads to results very similar to the formula in the Consultative Document, while the modified IRB formula requires much less regulatory capital, but finds consistently more risk in the retail portfolio than the portfolio analysis.

Capital Allocations dependent on Loss given default
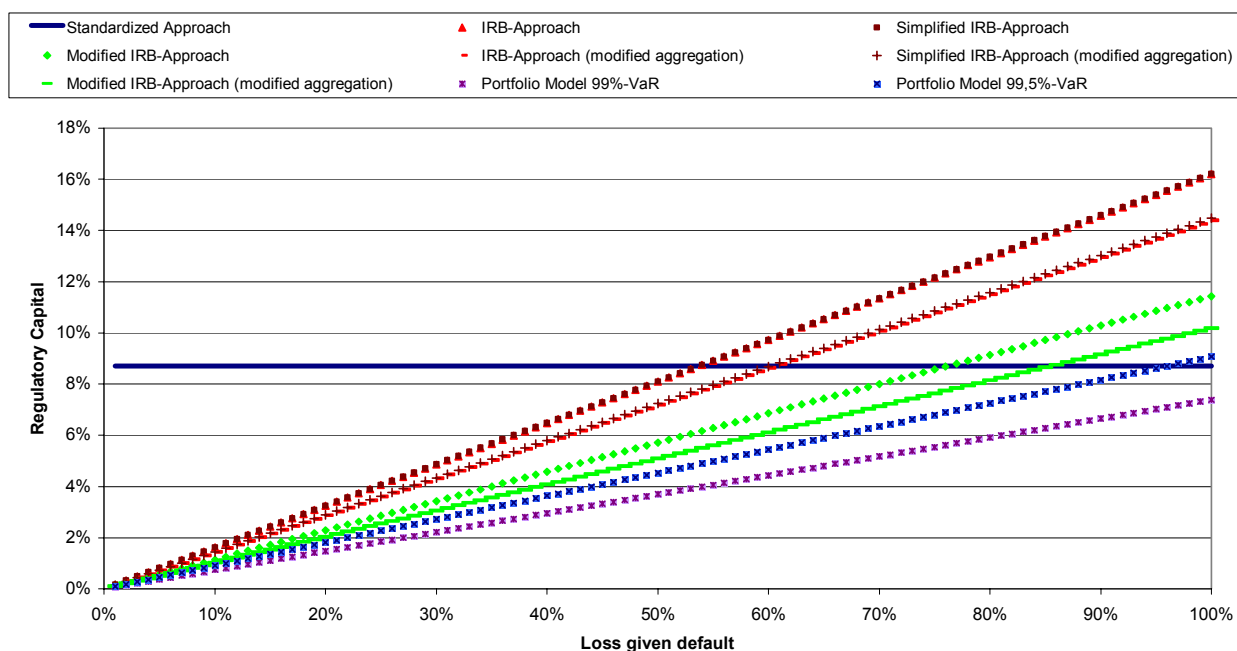**German Regional Bank: Total Portfolio**

Exhibit 8: Capital Allocations dependent on Loss given default: German Regional Bank: Total Bank Portfolio

Results for the total bank portfolio can be seen in Exhibit 8. The exhibit illustrates that because of the diversification effect between portfolio segments, risk as assessed by the portfolio analysis happens to be lower than capital requirements implied by all types of IRB approaches. The modified aggregation rule for capital requirements partially captures the diversification effect. Note further that the modified IRB approach offers incentives over the standardized approach even for realistic values of LGD.

5.2. Portfolio B

Portfolio B consists only of the corporate segment comprising 12,000 clients. Default probabilities range from 0.05% to 4%. 2.8% of clients hold 50% of portfolio value. Clients stem from 10 sectors with correlations of clients in the same sector of 50% and correlations of clients in different sectors of 20%.

Albeit the fact that the credit quality of portfolio B is significantly higher, the results of the portfolio analysis are similar to the results for portfolio A and are summed up in Exhibit 9.
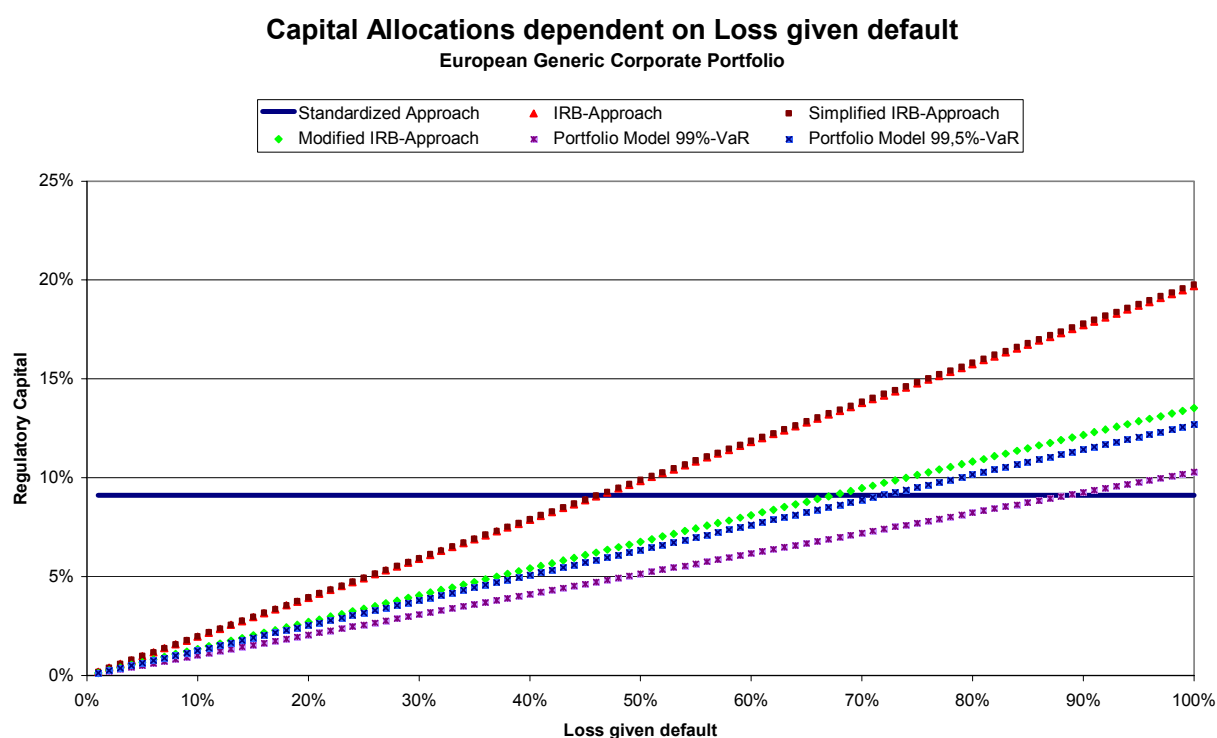
Capital Allocations dependent on Loss given default
European Generic Corporate Portfolio

Exhibit 9: Capital Allocations dependent on Loss given default: European Generic Corporate Portfolio

Portfolio B confirms the observations derived for portfolio A. Again, the Committee's current IRB approach only leads to lower capital requirements than the standardized approach for low values of LGD. However, in this portfolio an average LGD of less than 46% is sufficient for the IRB approach to outperform the standardized approach. Moreover, the existing IRB approach and its simplified version lead to equivalent results. The modified IRB approach leads to a closer, but still conservative approximation of capital requirements implied by a full portfolio analysis even if the 99.5 percentile is

considered. Finally, the modified IRB approach offers an incentive for abandoning the standardized approach for realistic values of LGD.

5.3. Summary

Although the simulation exercise neither provides formal nor econometric proof, it reinforces our suggestions to make the IRB approach lean, to include the granularity adjustment into the risk weight formula, and to modify the aggregation rule. Moreover, comparing the lean and modified IRB approach with the risk capital derived from a portfolio risk model suggests that the latter is a better proxy of the true portfolio risk. Finally, there is ample support to advocate the use of the modified aggregation rule, regardless of which IRB approach is used.

6. Regulatory Design

6.1. Banking Regulation and the Transition Problem

In this paper we cannot give a thorough account of the costs and benefits of capital requirements and we accept the mainstream view that capital requirements are welfare enhancing. Moreover, we start from the premise that it is desirable to achieve a certain confidence level (the 99.5 percentile or another percentile standard) for all banks.

Starting from the 99.5 percentile standard, the current IRB approach will on average tend to increase capital requirements for banks, particularly in the corporate sector. If the modified IRB approach and the modified aggregation rule are used or if full-fledged credit portfolio models are employed, capital requirements for the corporate sector are lower than under the current IRB approach, but may still be higher than today. However, there is considerable uncertainty regarding the latter and it is presently not known whether capital requirements will on average ultimately increase.

Given this uncertainty, the critical question then is how regulatory design can induce a smooth transition of the banking industry towards better capital adequacy standards, which will be addressed in the next section.

6.2.   Transition Rules

The uncertainty surrounding the impact of the IRB approach on capital requirements led to the proposal that "during the first two years following the implementation, the Committee is proposing a floor on the advanced IRB approach equal to 90% of the capital requirements which would result under (a simplified calculation of) the foundation IRB approach"[15]. Moreover, the Committee has expressed the desire that the new rules should neither produce a net increase or a net decrease – on average – in minimum regulatory capital, after accounting for operational risks.

While such an approach makes sense because of the current lack of a complete understanding of the risk inherent in credit risk portfolios, it is doubtful that such regulatory design will ensure that the ultimate goal of an overall level of regulatory capital generated sufficient to address the underlying credit risk will be achieved. In particular, if capital requirements should increase on average, at some point new rules must produce an average net increase of minimum regulatory capital. Therefore, the regulatory design must contain transition rules to solve two main problems.

The first main problem is that banks which are ready to move to the IRB approach may face have higher capital requirements than under the modified standard approach. As a consequence, they will not want to make the transition.[16] Only those banks with portfolios skewed towards high-rated firms will adopt the IRB approach. Thus, exactly those banks for whom the IRB approach would make a large difference will stick with the modified standard approach. Ultimately the incentives to adopt the IRB approach will depend on the risk weights and the aggregation rule employed.

The second main problem is that forcing banks to adopt the IRB approach would have negative feedback on the economy.[17]

We therefore suggest a different approach that takes into account both the ultimate goal, as well as the need for a smooth transition. The proposal for transition rules rests on two pillars:

---

[15] See *The Basel Capital Accord* § 132.

[16]   However, sophisticated banks might be induced to adopting the IRB approach, because of the desire to be assessed by rating agencies. In turn, sophisticated banks might be induced to selling their lower quality assets to other banks that operate under the standardized approach. Such endogenous reactions would increase the two-tier problem in the banking industry.

[17] Since banks could not raise equity on a large scale, they would either need to rely on retained earnings, which would require less intensive competition with larger intermediation margins which would depress the demand for loans or banks could reduce loans creating the risk of a credit crunch.

- Feedback from the advanced IRB approach back to the modified standard approach;

- Increasing the feedback according to the share of banks that have adopted the advanced IRB approach.

The feedback would amount to adjustments of risk weights of the (modified) standard approach so that average regulatory capital under the modified standard approach moves closer - on average - to the average capital of the same banks under the implemented IRB framework. The speed of adjustment should depend on the share of banks that have already adopted the IRB advanced approach.

These two transition rules would ensure that ultimately the average capital requirements under the modified standard approach and the implemented IRB approach are identical reducing disincentives for banks to adopt the IRB approach and allowing to make the IRB approach mandatory.

The above transition design could be further refined. Since banks with portfolios skewed towards low-rated firms may still have too little incentives to adopt the IRB approach, the modified standard approach could be increased over time so that remaining banks that will likely have below average portfolios will adopt the IRB approach.

Note that if it ultimately turned out that capital requirements on average do not increase under the IRB approach, transition rules would leave the risk weights in the standard approach unchanged. However, since it is not known ex ante whether and how much capital requirements would increase, transition rules would nevertheless improve incentives for banks to improve risk management practices and to adopt the IRB approach in order to hedge against future regulatory requirements. This would be strengthened by the refinement of the transition rule where the modified standard approach requires above average capital compared to the IRB approach.

However, a feedback from the advanced IRB approach to the standardized approach may also generate negative side effects. First, it makes the whole approach more complex and requires aggregate data about capital requirements under the IRB approach. Second, such a feedback would increase uncertainty in the banking sector about future capital requirements which might also hamper proper calculations of risk premiums. On balance, however, some form of feedback from the IRB approach to the standardized approach appears to be necessary. Following our lean perspective, one could envision a single adjustment of the standardized

approach at a fixed point in time and an associated period of time for the adjustment of banks still operating under the standardized approach.

7. Conclusions

In this paper we have suggested that the three main problems of the current IRB approach may be alleviated. The IRB approach as described in the Consultative Paper can be considerably simplified by a lean IRB approach without distorting the resulting capital requirements. Aggregation rules can be modified to account for risk diversification across segments. The modified IRB approach and modified aggregation rule better proxy the true portfolio risk. We have suggested specific transition rules to facilitate the adoption of the IRB approach. Naturally, we have omitted a variety of issues in determining regulatory capital for banks. Nevertheless, the suggestions in the paper may be of importance in reconsidering the current IRB framework.

References:

Altman, E.I. and A. Saunders (2001), „An analysis and critique of the BIS proposal on capital adequacy and ratings", *Journal of Banking and Finance*, 25, 1, pp. 25-46.

Bhattacharya, S., A.W.A. Boot, and A.V. Thakor, 1998, „The Economics of Bank Regulation", *Journal of Money, Credit and Banking* 30, 4, 745-770.

Blum, J. and M. Hellwig, (1995): „The Macroeconomic Implications of Capital Adequacy Requirements", *European Economic Review*, 39, 733-749.

Crouhy, M., D. Galai, and R. Mark (2000): „A Comparative Analysis of Current Credit Risk Models", *Journal of Banking and Finance*, 24, 59-117.

Crouhy, M., D. Galai and R. Mark (2001), „Prototype risk rating system", *Journal of Banking and Finance*, 25, 1, pp. 47-95.

Dewatripont, M. and J. Tirole (1994), "The Prudential Regulation of Banks", *MIT Press*.

Erlenmaier, U. (2001), "Models of Joint Default in Credit Risk Management", Working Paper, *University of Heidelberg*.

Gersbach, H. (2001), "The Optimal Capital Structure of an Economy". *Discussion Paper, University of Heidelberg*.

Gersbach, H. and Wehrspohn, U. (2001), "Die Risikogewichte der IRB-Ansätze: Basel II und schlanke Alternativen", risknews.

Goodhart, C., P. Hartmann, D. Llewellyn, L. Rojas-Suárez, and S. Weisbrod, 1998, „Financial Regulation: Why, how and where now?", New York: Routledge.

Gordy, M.B., 2000, „A Comparative Anatomy of Credit Risk Models", *Journal of Banking and Finance*", 24, 119-149.

Hellwig, M.F. (1995): „Systemic Aspects of Risk Management in Banking and Finance", *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, Vol. 131, 723-737.

Holmström, B. and J. Tirole (1997): „Financial Intermediation, Loanable Funds, and the Real Sector", *Quarterly Journal of Economics*, Vol. 112, No. 3, 328-345.

Linnell, I. (2001), „A critical review of the new capital adequacy framework paper issued by the Basle Committee on Banking Supervision and its implications for the rating agency industry", *Journal of Banking and Finance*, 25, 1, 187-196.

Kaufman, G. G. and K. E. Scott, „Does Bank Regulation Retard or Contribute to Systemic Risk?, *John M. Olin Program in Law and Economics*, Working Paper No. 211, 2000, Stanford Law School.

Krahnen, J.P. and M. Weber (2001), „Generally accepted rating principles: A primer", *Journal of Banking and Finance*, 25, 1, pp. 3-23.

Nickell, P., W. Parraudin, and S. Varotto (1999): „Ratings- versus Equity-Based Credit Risk Modeling: An Empirical Analysis", *Bank of England*, Working Paper.

Santos, J. C. (2001), „Bank Capital Regulation in Contemporary Banking Theory: A Review of the Literature", SSRN-Discussion paper.

Risk Weight Functions for the Corporate Portfolio

Loss given default = 50%, maturity = 3 years
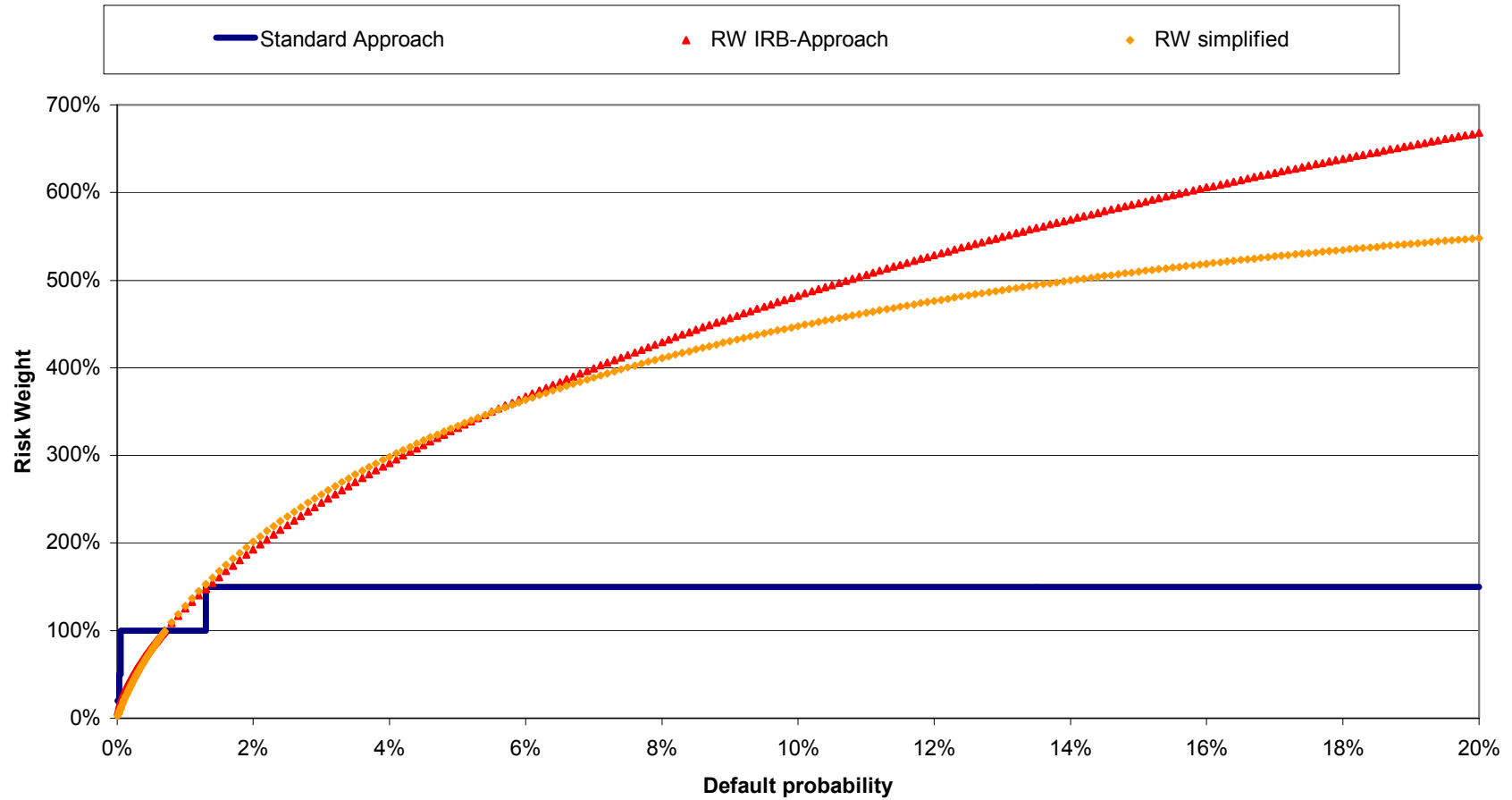
Exhibit 10: Risk Weight Functions for the Corporate Portfolio

Risk Weight Functions for the Retail Portfolio

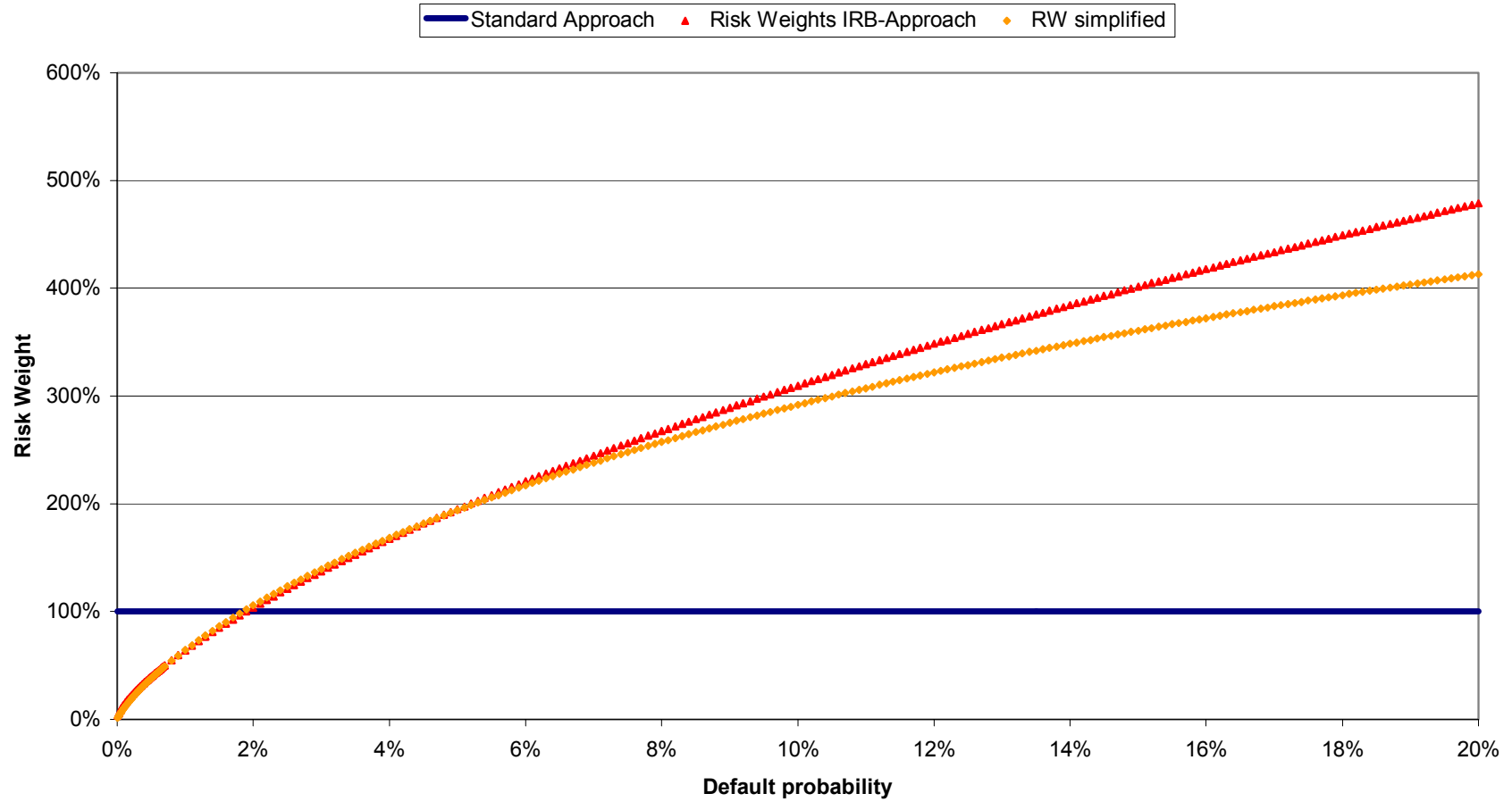**Loss given default = 50%**

Exhibit 11: Risk Weight Functions for the Retail Portfolio

Risk Weight Functions for the Corporate Portfolio

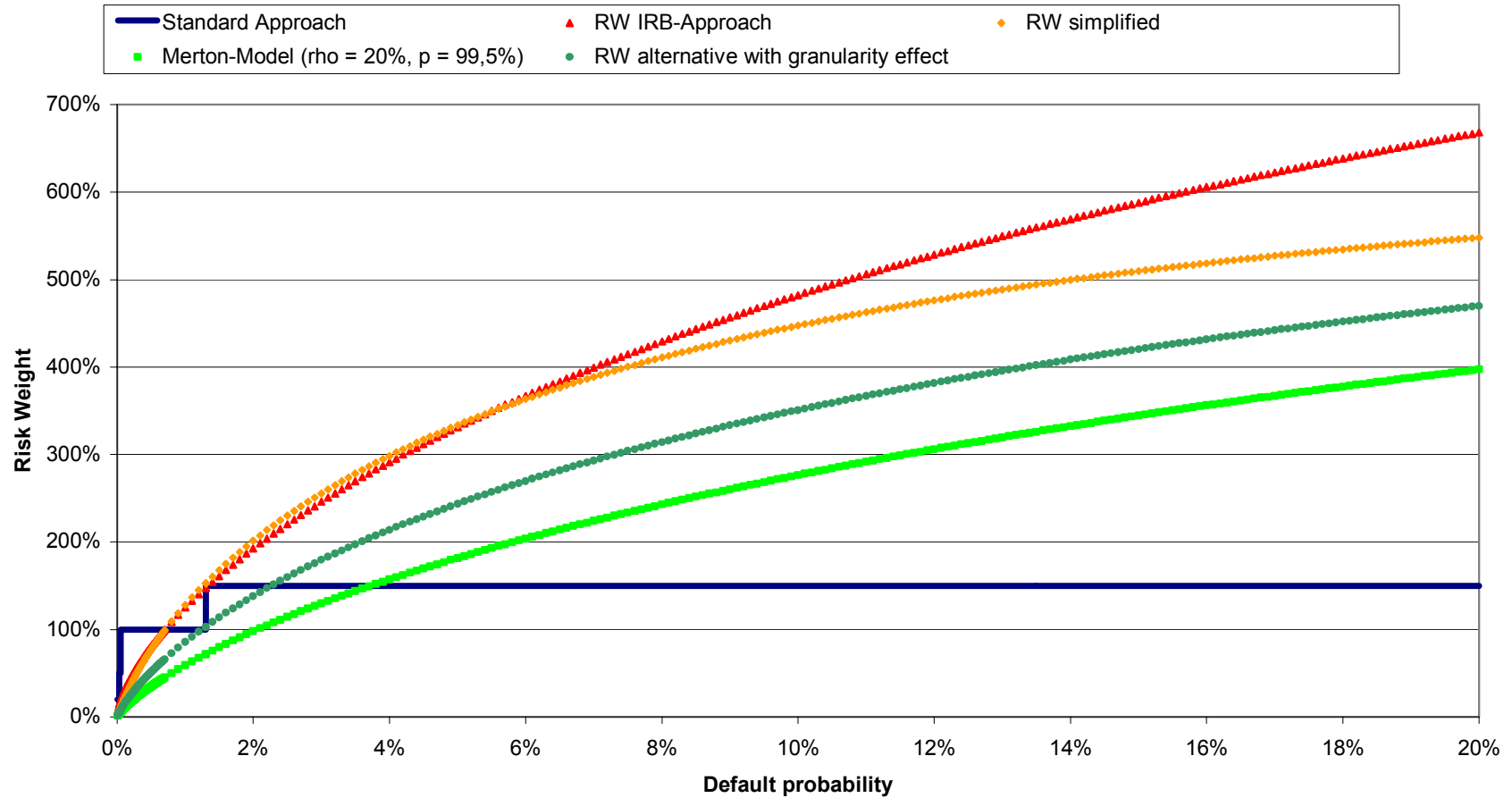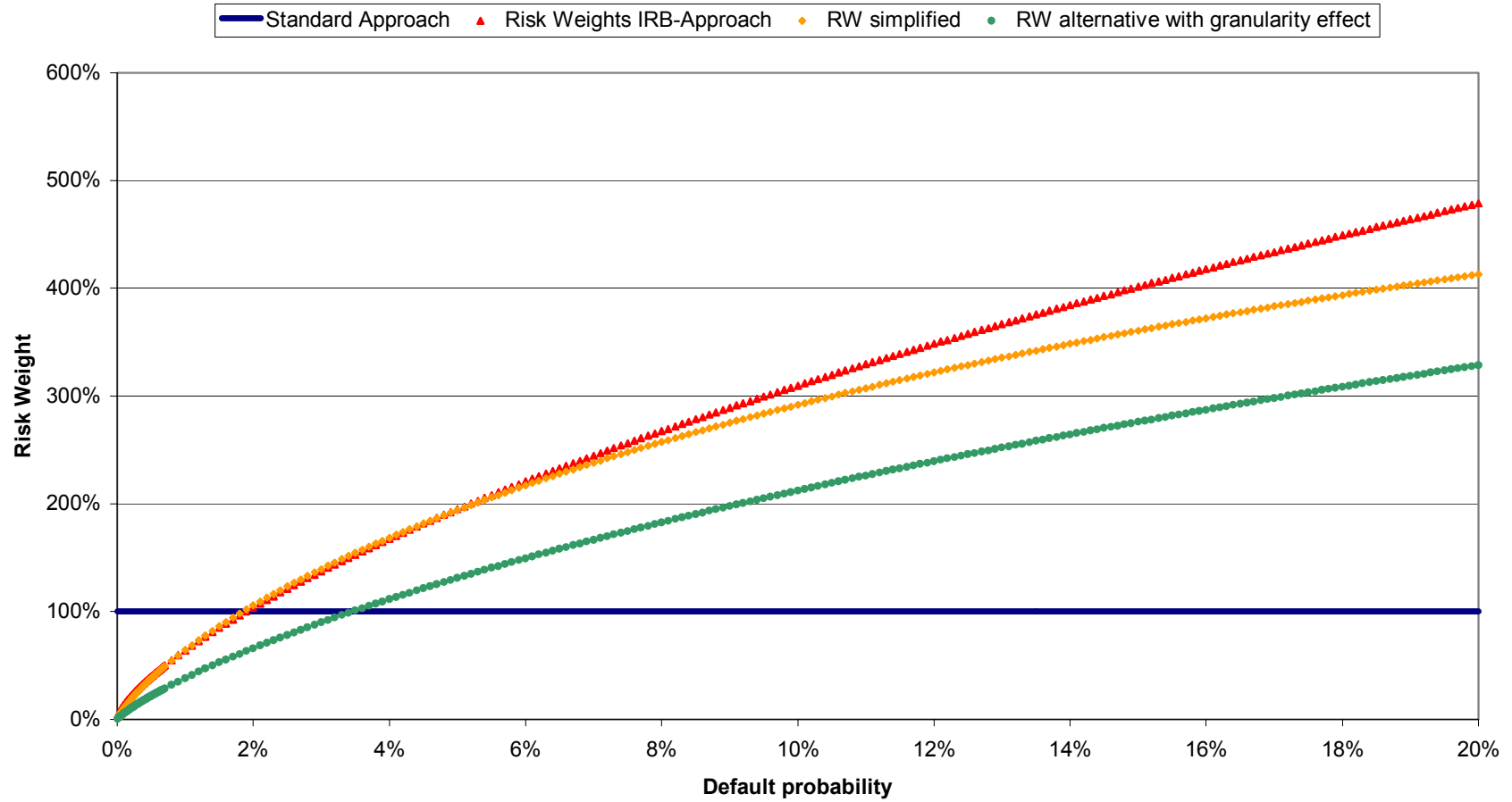## Loss given default = 50%, maturity = 3 years

Exhibit 12: Modified Risk Weight Functions for the Corporate Portfolio

Risk Weight Functions for the Retail Portfolio

Loss given default = 50%

Exhibit 13: Modified Risk Weight Functions for the Retail Portfolio

Capital Allocations dependent on Loss given default
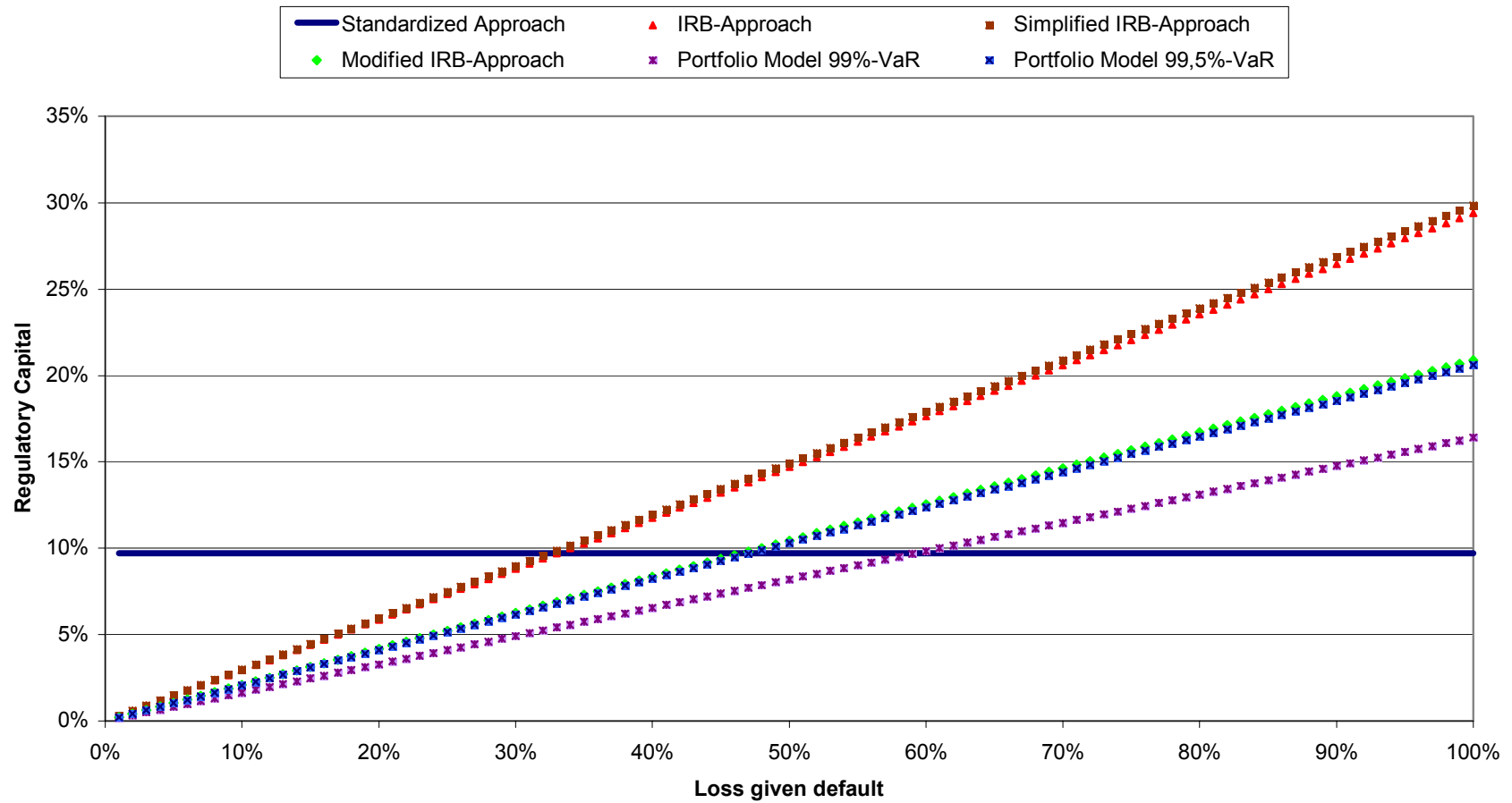
German Regional Bank Corporate Portfolio

Exhibit 14: Capital Allocations dependent on Loss given Default: German Regional Bank Corporate Portfolio

Capital Allocations dependent on Loss given default
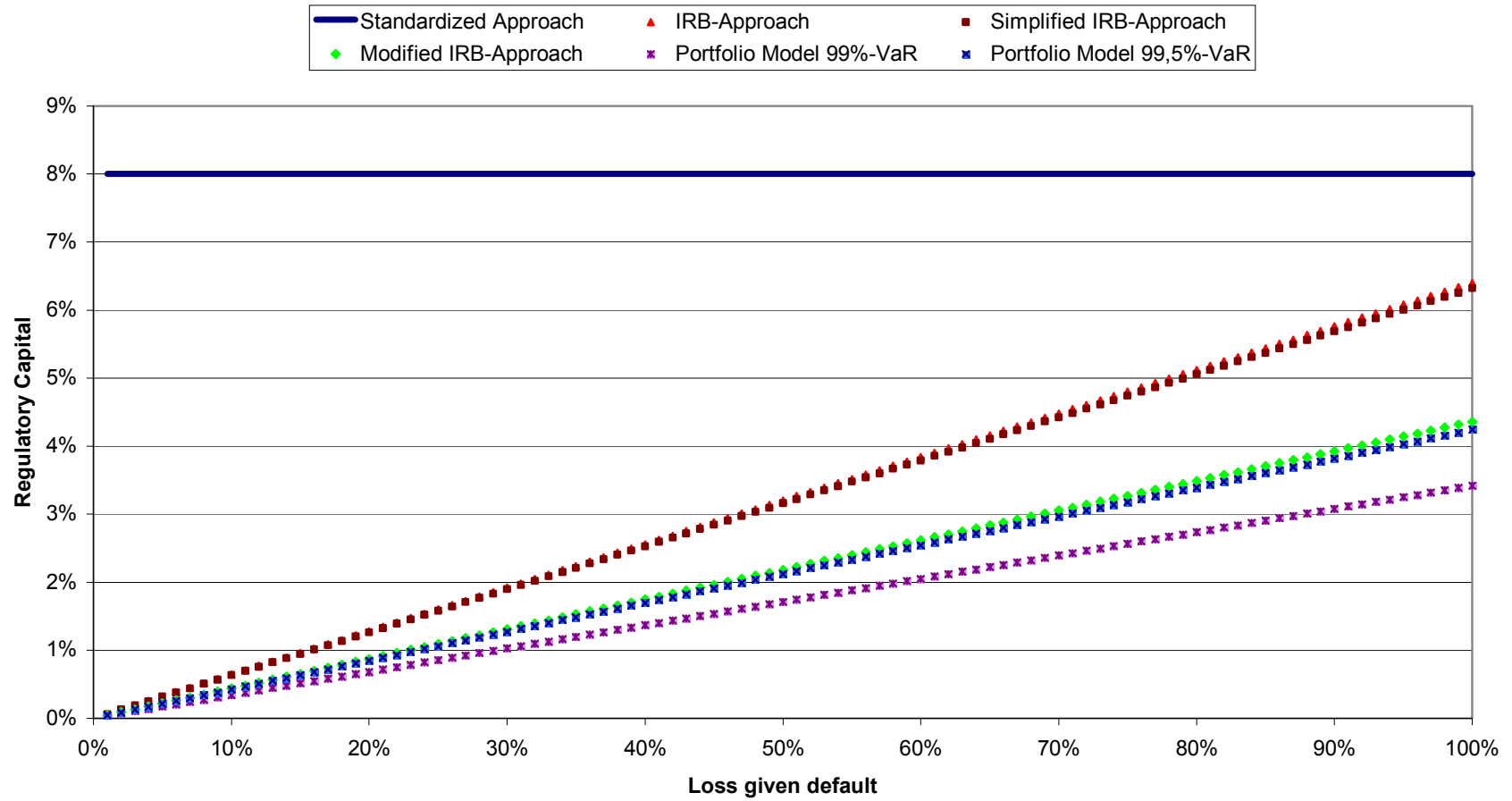
German Regional Bank Retail Portfolio

Exhibit 15: Capital Allocations dependent on Loss given default: German Regional Bank Retail Portfolio

Capital Allocations dependent on Loss given default

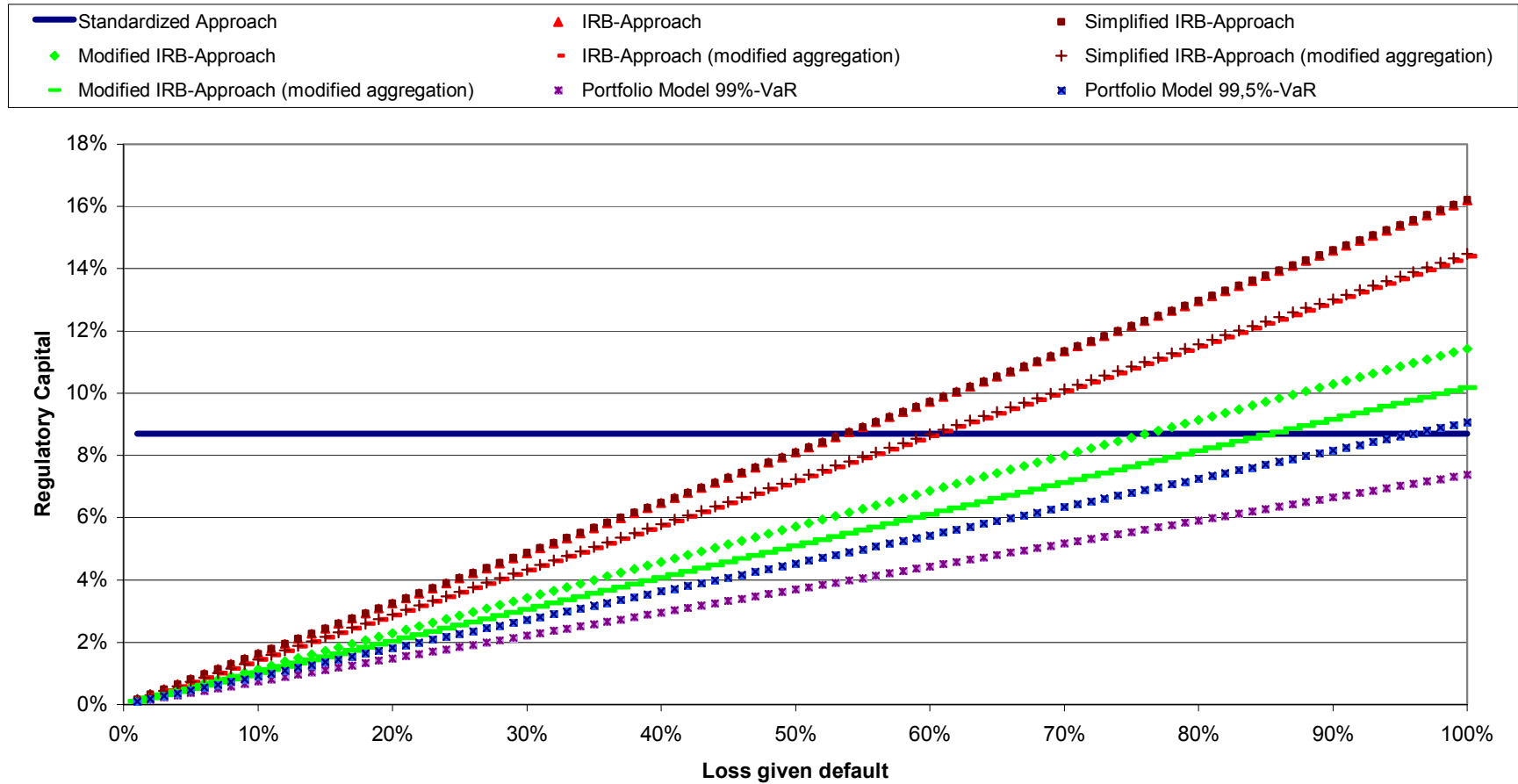**German Regional Bank: Total Portfolio**

Exhibit 16: Capital Allocations dependent on Loss given default: German Regional Bank: Total Bank Portfolio

Capital Allocations dependent on Loss given default
European Generic Corporate Portfolio

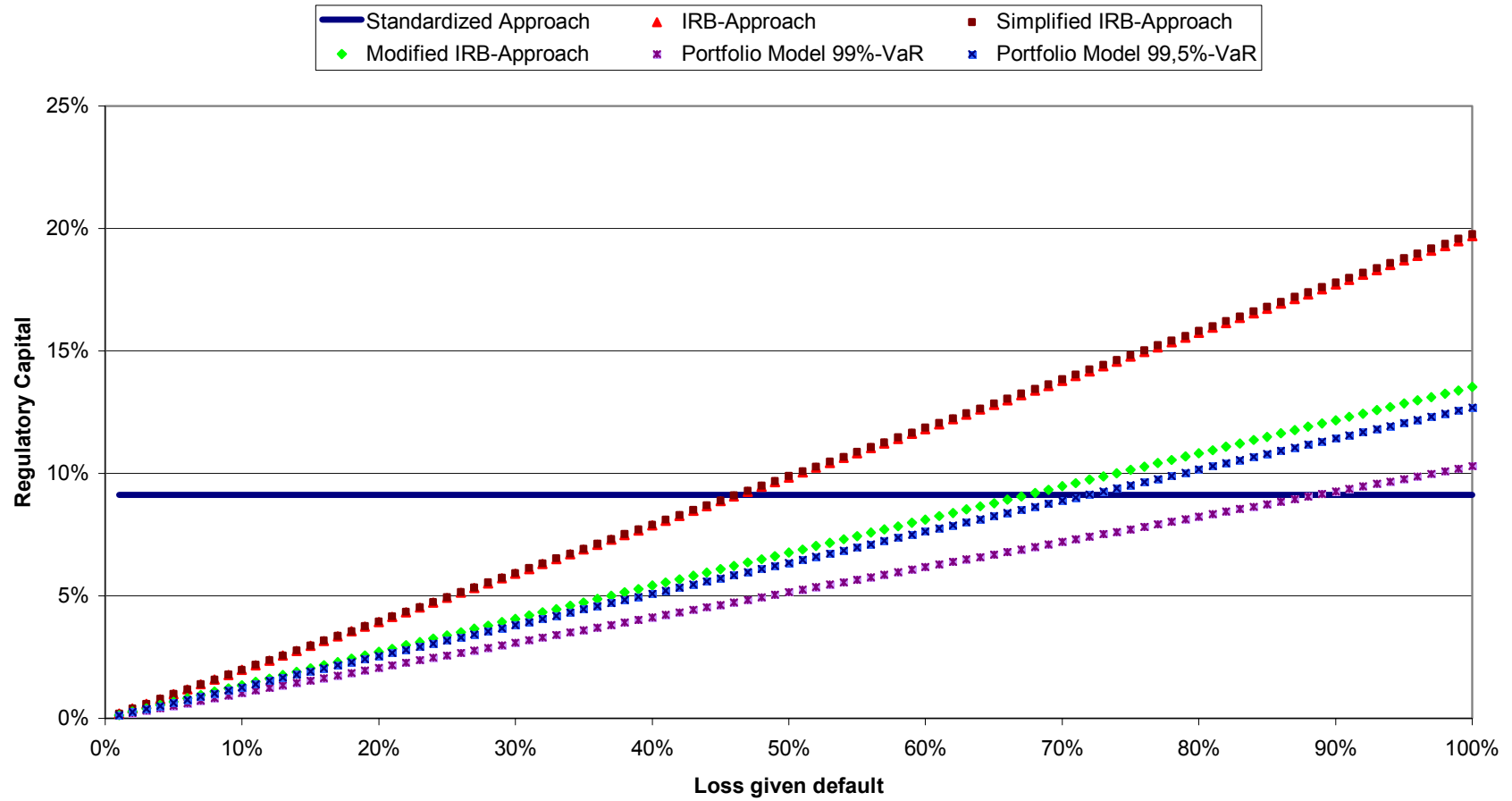|		
—— Standardized Approach	▲ IRB-Approach	■ Simplified IRB-Approach
◆ Modified IRB-Approach	✳ Portfolio Model 99%-VaR	✖ Portfolio Model 99,5%-VaR

Exhibit 17: Capital Allocations dependent on Loss given default: European Generic Corporate Portfolio