

# Basel Accords versus Solvency II: Regulatory Adequacy and Consistency under the Postcrisis Capital Standards

Daniela Laas and Caroline Siegel\*†

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## Abstract

Over the past decade, European banking and insurance regulation has been subject to significant reforms. One of the declared goals of the authorities was the enhancement of market stability through adequate and consistent capital standards. This paper provides a critical analysis of the Basel II, III, and Solvency II capital standards for asset risks in light of these regulatory objectives. Our discussion begins with a detailed overview of the current standard approaches for market and credit risk. Based on a theoretical analysis and a numerical comparison of the capital charges our contribution is twofold: we reveal an inaccurate treatment of risk categories and severe inconsistencies between the capital standards for banks and insurers. Regarding the former, we are able to show that the models' inaccurate parameter settings do not reflect the specific risk-return characteristics of asset classes and unduly promote government bond holdings. This might lead to severe distortions to the financial institutions' investment decisions. With respect to the latter, the numerical part of our paper displays considerable differences in required capital for the same type and amount of asset risk, burdening insurers with almost twice as high capital requirements than banks. This not only contradicts the authorities' goal, but gives also rise to regulatory arbitrage opportunities across financial sectors.

**Keywords:** Banking, Basel Accords, Capital Standards, Insurance, Regulation, Solvency II

**JEL classification:** G11; G21; G22; G28; G32

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\*Daniela Laas (daniela.laas@unisg.ch) and Dr. Caroline Siegel (caroline.siegel@unisg.ch) are from the Institute of Insurance Economics, University of St. Gallen, Tannenstrasse 19, 9000 St. Gallen, Switzerland.

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# 1 Introduction

In the aftermath of two major financial crises, the European regulatory frameworks for the financial sector have undergone significant reforms. Within the banking sector, regulation has been enhanced from Basel II to Basel III. Similarly, over the past decade, insurance regulators have developed a new risk-based solvency framework, Solvency II, that is expected to come into force in 2016.

One of the primary goals of both regulatory regimes is to provide for financial market stability through adequate and consistent capital standards (see, e.g., BCBS, 2010e). The former aspect implies a model design that accurately accounts for the different risks a financial institution is exposed to, taking their interrelationships into consideration. This is especially relevant, as the capital charges are able to directly influence, for example, a financial institution's asset allocation.

Regulatory consistency, on the other hand, relates to the avoidance of arbitrage opportunities across the regulatory frameworks for financial institutions, by assigning equal capital charges for the same type and amount of risk. The rationale behind this is that a different regulatory treatment should be induced by discrepancies in their risk status and should not depend upon the regulatory regime they are subject to (see also Menezes, 2009). Although it is true that the level of market discipline and threat of systemic risk for the economy differ substantially between the banking and insurance industry (see, e.g., Gatzert and Wesker, 2012, and Eling, 2012), this is mainly due to the incomparable liability sides. However, they invest in part into the same asset classes such as stocks, government bonds, corporate bonds, real estate, private equity, and hedge funds. Therefore, the Joint Forum requires the Basel Committee, International Organization of Securities Commissions, and International Association of Insurance Supervisors to work together to “develop common cross-sectoral standards where appropriate so that similar rules and standards are applied to similar activities, thereby reducing opportunities for regulatory arbitrage and contributing to a more stable financial system.” (see BCBS, 2010e).

This paper evaluates whether the supervisory authorities' standard capital approaches are able to fulfill the goals of regulatory adequacy and consistency with respect to their treatment of asset risks. In other words, it examines if the regulators practice what they preach. In a first step, the standard approaches for market and credit risk under the Basel Accords II and III, as well as Solvency II are described in detail. Also, the proposals for two new standard market risk models, the so-called “partial risk factor approach” and the “fuller risk factor approach” of Basel III, are displayed. Based on the capital standards' design, we subsequently evaluate the accuracy of each framework from a theoretical perspective. Our contribution to the analysis of cross-sectoral consistency issues is two fold: To get an idea of the (in)comparability of capital charges for market and credit risks under the Basel Accords and Solvency II, we implement their standardized approaches and compare the resulting capital charges based on a stylized investment portfolio of a financial institution. To check the robustness of our results, we also assess the change in capital requirements that is due to an increase in the portfolio weight of each asset class. In order to explain the displayed differences in required capital for banks and insurers, we analyze, in a second step, the conceptual (in)consistencies of the capital standards for asset risks.

A considerable body of literature can be found on the topic of bank and insurance regulation. We will therefore focus on the two literature strings that are most important for our work: studies considering the standard approaches' adequacy and papers that deal with the regulatory goal of consistency.

The former, includes papers on the capital standards of Basel II, Basel III, and Solvency II, as well as comparisons among them. Regarding Pillar I of Basel II, several studies discuss the aggregation method for market and credit risk capital charges (see, e.g., Breuer et al., 2010, and Kretzschmar et al., 2010). Other work criticizes the calibration of risk weights under the two risk modules. For example, Resti and Sironi (2007) empirically show that the weighting scheme is not differentiated enough and that the preferential treatment of rated bank bonds compared to equally rated corporate loans is not justified. Furthermore, investigating historical default rates, Altman et al. (2002) reveal that incentives

for investments in risky assets are created as the regulatory risk weights for investment grade corporate loans are too high. Although Bliss (2002) identifies some shortcomings in the study of Altman et al. (2002), he concludes that their general result is valid. In addition, Rossignolo et al. (2013) show that the equity risk module does not provide enough protection in severe financial crises. In other studies, the reliance on external credit ratings for the calibration of regulatory models is criticized (see, e.g., Altman and Saunders, 2001, Cantor and Packer, 1997, King and Sinclair, 2003, and Moosa, 2010).

Since the Basel III framework was developed in recent years and the reform process is still ongoing, the number of studies on this topic is less extensive. Apart from the research initiated by the Basel Committee (see BCBS, 2010a, BCBS, 2010d, and MAG, 2010), several papers try to predict the impact of the new regulations on the economy and the financial system (see, e.g., Allen et al., 2012, and Yan et al., 2012). A new feature of Basel III that is discussed in several academic surveys is the countercyclical buffer. While the introduction of such capital cushions meets broad support (see, e.g., Shim, 2013, and Hanson et al., 2011), its reliance on the “credit-to-GDP gap” is controversial (see, e.g., Drehmann and Gambacorta, 2012, versus Repullo and Saurina, 2011).

Solvency II, as the flagship project of European insurance regulation, has received a lot of attention among the academic community. An overview on the development process and critical discussions are given, for example, by Ayadi (2007), Doff (2008), Eling et al. (2007), and Steffen (2008).

With regard to its standard formula and the adequacy of the solvency capital requirements, Devineau and Loisel (2009) and Braun et al. (2013) reveal large biases when compared to an internal model. Filipović (2009) focuses on the correlation matrices of the standard formula in comparison to internal models. Sandström (2007) as well as Pfeifer and Strassburger (2008) examine the accuracy of the formula for non-normally distributed risk positions and illustrate a miscapitalization of the insurer in these cases. Moreover, Floreani (2013) shows that the reliance on a total risk measure such as the value at risk can lead to increased systemic risks in the insurance sector. With respect to the market risk framework, Gatzert and Martin (2012) demonstrate that the exclusion of EEA government bonds from the spread risk module can cause significant underestimations of risk, especially in the case of non-investment grade rated countries. Furthermore, Mittnik (2011) shows that the calibration of the equity risk module exhibits severe deficiencies which might lead to incorrect capital requirements for equity risks.

The second string of literature on regulatory consistency is often discussed in the context of financial conglomerates, as they are the prime candidate to exploit sectoral differences in regulation (see, e.g., Darlap and Mayr, 2006, and Freixas et al., 2007). Moreover, several studies analyze the advantages and drawbacks of globally uniform capital standards (see, e.g., Acharya, 2003, Morrison and White, 2009, and Houston et al., 2012). However, the opinions about the need of harmonized regulatory frameworks differ significantly. On the one hand, regulatory inconsistency and arbitrage are often considered to have negative economic effects. Darlap and Mayr (2006), and Flamée and Windels (2009), for example, describe the importance of the regulatory efforts to achieve an equal treatment of the financial sectors. In line with this reasoning, Herring and Carmassi (2008), and Monkiewicz (2007) discuss the possibility of an “integrated supervisor”. On the other hand, Freixas et al. (2007) as well as Menezes (2009) argue that divergences and arbitrage opportunities, under certain conditions, are highly desirable.

Regarding our research objective, we are especially interested in publications that compare different capital standards in light of the central regulatory issues of capital adequacy and consistency. Although there are several studies that contrast the current insurance frameworks (see, e.g., Braun et al., 2013, Cummins and Phillips, 2009, Holzmüller, 2009, and Eling and Holzmüller, 2008), cross-sectoral analyses are rare. Furthermore, most of the papers that deal with the regulation of both sectors, such as Gatzert and Wesker (2012) and Al-Darwish et al. (2011), are limited to a qualitative comparison of Basel II/III and Solvency II.

The only study known to the authors that provides a qualitative and quantitative comparison is Herring and Schuermann (2005). Based on a stylized portfolio, they assess the capital charges for securities firms, banks, and insurance companies under the market and liquidity risk modules of Basel I, the U.S. RBC Model, and the Net Capital Approach (for U.S. securities companies). Therefore, by investi-

gating the capital standards for asset risks under the Basel Accords and Solvency II in a qualitative and quantitative way, our paper closes a major gap in the academic literature.

The rest of our study is structured as follows: Section 2 describes the standard approaches for market and credit risk of Basel II, III, and Solvency II. The principal part of the paper, Section 3, contains a two-fold contribution: Firstly, in Section 3.1, we critically examine the capital standards with regard to their regulatory adequacy. Secondly, regulatory consistency between the frameworks of the banking and the insurance industry is evaluated. We assess the resulting capital charges for market and credit risks based on a stylized and identical portfolio of assets. Furthermore, the displayed differences are explained by analyzing the conceptual inconsistencies (Section 3.2). Finally, the economic implications and our conclusion are stated in Section 4.

## 2 The Standard Approaches for Market and Credit Risks under the Basel Accords and Solvency II

### 2.1 Basel II

Basel II, the regulatory framework for the banking sector, was developed by the Basel Committee on Banking Supervision (BCBS) and replaces the Capital Accord of the year 1988. It was approved by the Committee in 2004 and supplemented in 2005 by an update of the Market Risk Amendment of 1996 (see BCBS, 2009). In the following years, the regulations were implemented in the European Union, in Switzerland, and in several other countries. The framework is divided into three pillars, which contain minimum capital requirements (Pillar I), rules for the supervisory process (Pillar II), and disclosure regulations to promote market discipline (Pillar III) (see BCBS, 2006). For our comparison of the standardized capital requirements, we will focus in the following on the risk modules in Pillar I that deal with asset risks: the market risk module and the credit risk module (for the following subsections, see BCBS, 2006).

#### 2.1.1 Market Risk Module

The Basel II market risk framework sets out the calculation of a capital charge ( $CR_{mkt}$ ) against the risk of losses due to changes in market prices. It only refers to the trading book that comprises assets “held either with trading intent or in order to hedge other elements of the trading book” (§ 685, BCBS, 2006).

Under Basel II, four categories of market risk are distinguished: interest rate risk, equity position risk, foreign exchange rate risk, and commodity risk. In the following, we will abstract from the latter two categories, as our stylized trading book only includes stocks and bonds and assumes a perfect hedge with respect to exchange rate risk. For the indices used in the paper, this implies refraining from converting them into one common currency.<sup>1</sup>

Both the interest rate risk and the equity position risk submodules are “building-block” approaches, meaning that the overall capital requirements are the sums of the capital charges for issuer-specific risks and general market risks. The specific risk capital charges are meant to cover losses resulting from negative price developments of a single asset. Consequently, for the calculation of the specific requirements, long and short positions in general must not be offset. On the contrary, longs and shorts may be subtracted to compute the general market risk capital charges. This is due to the fact that these parts of the regulatory capital shall protect financial institutions against unfavorable market movements.

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<sup>1</sup> As the market indices are denominated in different currencies, this is important in order to maintain the typical risk-return characteristics of each asset class (see also Braun et al., 2013).

**Interest Rate Risk** The interest rate risk submodule aims to protect financial institutions against losses from interest rate movements. In order to cover specific risks, banks must hold the capital charge:

$$CR_{mkt}^{int,sp} = \sum_{i=1}^{n_1} w_i \cdot |E_i|. \quad (1)$$

Here,  $n_1$  denotes the number of interest rate sensitive instruments in the trading book and  $E_1, \dots, E_{n_1}$  are the values of the single positions. These values are positive for long positions and negative for shorts. The factors  $w_i$  are issue-specific risk weights that depend on the issuer category (government, qualifying, or other), the rating, as well as the maturity of the security. The category “qualifying” contains bonds from public sector entities, multilateral development banks, as well as high-quality papers, such as investment grade bonds.

To calculate the general interest rate risk capital charge  $CR_{mkt}^{int,gen}$ , the financial institutions can choose between two similar approaches, the “maturity method” and the “duration method”. For reasons of comparability with respect to Solvency II, we will focus on the duration method. Under this method, in a first step, the banks have to calculate the modified durations  $D_1, \dots, D_{n_1}$  of their interest rate sensitive instruments. Moreover, they must determine the changes in the asset values  $\Delta A_i$  of their positions that are due to interest rate changes  $\Delta r_i$ :

$$\Delta A_i = -\Delta r_i \cdot D_i \cdot E_i, \quad i = 1, \dots, n_1. \quad (2)$$

In a second step, the financial institutions must calculate the general interest rate risk capital requirement  $CR_{mkt}^{int,gen}$ . It is the sum of the net price change  $|\sum_{i=1}^{n_1} \Delta A_i|$  and the capital charges for the basis and gap risks resulting from offsetting positions of different categories and with different maturities.

**Equity Position Risk** The term “equity position risk” refers to the risk of losses due to price changes of equity instruments (e.g., stocks) in the trading book. To cover general market risk, the Basel Committee demands a capital charge  $CR_{mkt}^{eq,gen}$  of 8% of a bank’s net position in the equity market, i.e., with  $w^{gen} = 8\%$ :

$$CR_{mkt}^{eq,gen} = w^{gen} \cdot \left| \sum_{i=1}^{n_2} E_i \right|. \quad (3)$$

Here,  $n_2$  denotes the number of equity positions in the trading portfolio and  $E_1, \dots, E_{n_2}$  the values of the instruments.

To be protected against specific risks, the bank must hold a buffer of 8% of the sum of the absolute values of all equity positions. Consequently, the specific capital charge  $CR_{mkt}^{eq,sp}$  amounts to:

$$CR_{mkt}^{eq,sp} = w^{sp} \cdot \left( \sum_{i=1}^{n_2} |E_i| \right), \quad (4)$$

with  $w^{sp} = 8\%$ . The weight  $w^{sp}$  can be reduced to 4% if the considered equity position portfolio is liquid and well diversified.

### 2.1.2 Credit Risk Module

According to the Basel II definition of credit risk, this module only refers to banking book positions (see BCBS, 2006). The capital charge is required to satisfy:

$$CR_{cr} = 0.08 \cdot RWA_{cr}, \quad (5)$$

with  $RWA_{cr}$ , the “risk-weighted assets” for credit risk (see, e.g., Van Roy, 2005):

$$RWA_{cr} = \sum_{i=1}^{n_3} v_i \cdot |E_i|. \quad (6)$$

The number of elements of the banking book is denoted by  $n_3$ ,  $E_i$  represents the value of asset  $i$ , and  $v_i$  is a specific risk weight according to security  $i$ ’s categorization and rating.

### 2.1.3 Total Capital Charge and Total Risk-Weighted Assets

The total capital requirement for market and credit risks ( $CR_{II}$ ) is the sum of the single charges  $CR_{mkt}$  and  $CR_{cr}$ . This sum corresponds to 8% of the “total risk-weighted assets” ( $TRWA$ ):

$$TRWA = 12.5 \cdot CR_{mkt} + 12.5 \cdot CR_{cr} = 12.5 \cdot CR_{mkt} + RWA_{cr}. \quad (7)$$

## 2.2 Innovations of Basel 2.5 and Basel III

The term “Basel 2.5” refers to the Revisions of the Basel II market risk framework from 2009 and 2011 (see BCBS, 2009 and BCBS, 2011c). They were considered necessary after the global financial crisis that led to losses in the trading book far beyond the capital cushions (see BCBS, 2009).

The revisions introduce significant new requirements for banks using an internal market risk model (for this paragraph, refer to BCBS, 2011c). However, the standardized approach was practically left unchanged for the asset categories considered in this paper. The sole modification is the elimination of the option to reduce the 8% charge in Formula (4) to 4%.

In the course of the financial crisis, further deficiencies of Basel II were revealed, such as a potential accumulation of excessive leverage, an underestimation of illiquidity risk, and a decrease in the quality and quantity of the capital base (see BCBS, 2011a). The Committee reacted by introducing Basel III, which is still undergoing a consultation phase, especially with regard to the market risk module.

The regulatory innovations relevant for our stylized asset portfolio include the determination of additional capital buffers as well as the development of new standard approaches to market risk (see BCBS, 2011a, BCBS, 2011b, and BCBS, 2012b). These will be described in detail in the following two sections.

### 2.2.1 The Capital Buffers of Basel III

The Basel III reform package introduces some additional overall capital charges, the “capital conservation buffer”  $CR_{CCB}$ , the “countercyclical buffer”  $CR_{CC}$ , and a charge  $CR_{GSIB}$  for global systemically important banks (GSIBs). They are calculated as a percentage of the total risk-weighted assets of the bank and are to be gradually built up until January 2019 (see BCBS, 2011a and BCBS, 2011b).

**Capital Conservation Buffer** This buffer is meant as a cushion in periods of financial distress (for the following two paragraphs, refer to BCBS, 2011a). It shall amount to a maximum of 2.5% of the total risk-weighted assets, i.e., with  $\gamma = 2.5$ :

$$CR_{CCB} = \gamma\% \cdot TRWA. \quad (8)$$

When a bank suffers high losses, it will be allowed to deplete the buffer. However, when reduced, the institution is forced to lower future dividends, staff bonus payments, etc.

**Countercyclical Buffer** As it is meant to counteract cyclical effects, this capital charge is an addition to the conservation buffer and required when an extreme credit expansion leads to an increase in system-wide risk (for further information on that magnitude, refer to BCBS, 2011a). It is calculated by:

$$CR_{CC} = \beta\% \cdot TRWA, \quad \text{with} \quad \beta = \sum_k c_k \beta_k. \quad (9)$$

Here,  $c_k$  is the percentage of private sector credit exposures of the bank issued in country  $k$ . The country-specific parameter  $\beta_k \in [0, 2.5]$  will be determined by the national authority in compliance with certain principles (see BCBS, 2010c).

**Buffer for GSIBs** The capital requirement for GSIBs is only mandatory to those financial institutions that are, from a global perspective, classified as “too big to fail”<sup>2</sup> (for the following remarks to the buffer for GSIBs, refer to BCBS, 2011b). The reason for this is, on the one hand, that the bankruptcy of one of these institutions may have disruptive effects on the entire financial system. On the other hand, they may cause deadweight losses through excessive risk-taking, due to the moral hazard problem of government bailouts.

To decide which banks are GSIBs, the Basel Committee has developed an approach based on different indicators (size, interconnectedness, complexity, global activity, and substitutability). The required buffer amounts to  $\alpha\%$  of their total risk-weighted assets, i.e.:

$$CR_{GSIB} = \alpha\% \cdot TRWA. \quad (10)$$

The value  $\alpha$  is specified according to the degree of global systemic importance of the GSIB.

### 2.2.2 The New Market Risk Proposals of Basel III

As mentioned above, the Committee is planning to reform also the market risk module (for the following section, refer to BCBS, 2012b). The most important enhancements include a switch from the value at risk measure to the expected shortfall and a modification of the trading book definition. Such a modification is necessary because the actual subjective “intent-to-trade” criterion gives incentives to assign assets to the book with the lower capital charge. To reduce these arbitrage possibilities, the Committee is discussing moving to a “trading evidence”-based boundary or to a “valuation-based” boundary (for details, see BCBS, 2012b).

As the standard market risk model of Basel II does not consider diversification benefits and the capital requirements can largely deviate from the charges determined by an internal approach, the Committee also intends to replace the Basel II standard approach. In its consultative document, the BCBS proposes two models, the partial risk factor approach (PRF approach) and the fuller risk factor approach (FRF approach).

**Partial Risk Factor Approach** The implementation of the PRF approach consists of three steps. In the first step, the positions of the trading book are divided into different risk buckets  $\mathcal{A}_1, \dots, \mathcal{A}_B$ , according to their risk similarity. The Committee is currently proposing 20 buckets for each risk category. Securities that are sensitive to  $k \geq 2$  risk factors have to be replaced by  $k$  instruments with the same market value that only depend on a single risk factor. Such a procedure is especially necessary in the case of “cross-cutting” risk factors, which influence a big part of the instruments (e.g., interest rate risk).

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<sup>2</sup> The Committee also requires a capital buffer for banks that are systemically important on the national level. It is the task of the national authorities to determine the systemic importance of their banks and the amount of capital requirements. However, the Committee established a set of principles as guidelines for the national regulators (see BCBS, 2012a).

In the second step, a capital charge  $K_b$  for each bucket  $\mathcal{A}_b, b = 1, \dots, B$ , is calculated by:

$$K_b = \sqrt{\sum_{i,j \in \mathcal{A}_b} \rho_{i,j} u_i E_i u_j E_j}. \quad (11)$$

Here,  $E_i$  and  $E_j$  are the market values of the instruments  $i$  and  $j$  in bucket  $\mathcal{A}_b$ , respectively,  $u_i$  and  $u_j$  their specific risk weights, and  $\rho_{i,j}$  is the correlation between the changes in value of the two positions  $i$  and  $j$ . Both the risk weights and the correlations will be calibrated empirically by the Committee in such a way that the resulting capital charge equals the 1% expected shortfall of the profit-and-loss distribution.

In the final step, the charges  $K_b$  are aggregated to the total capital requirement for market risk  $CR_{mkt}$ :

$$CR_{mkt} = \sqrt{\sum_{b=1}^B K_b^2 + \sum_{b=1}^B \sum_{c \neq b}^B \gamma_{b,c} S_b S_c}. \quad (12)$$

In this formula, for all  $b, c \in \{1, \dots, B\}$ , the parameter  $\gamma_{b,c}$  constitutes the correlation between the buckets  $\mathcal{A}_b$  and  $\mathcal{A}_c$  and will be given by the Committee. Furthermore,  $S_b$  denotes the sum  $S_b = \sum_{i \in \mathcal{A}_b} u_i E_i$  of the risk-weighted market values in bucket  $b \in \{1, \dots, B\}$ .

The Committee derives the Formulas (11) and (12), assuming a factor model for the return of each instrument with normally distributed factors. However, in the calibration procedure, it plans to drop the normality assumption.

**Fuller Risk Factor Approach** Under the FRF approach, banks are required to assign their trading book securities to common and individual risk factors. For this, the BCBS will specify  $r_l$  risk factors  $X_1^{(l)}, \dots, X_{r_l}^{(l)}$  for each risk class  $l \in \{1, 2, 3, 4, 5\}$  with 1 = “interest rate”, 2 = “equity”, 3 = “commodity”, 4 = “foreign exchange rate”, and 5 = “credit”. Except for credit risk, BAFIN (2012) proposes for all factors to assume independence and normal distributions with zero means. Each risk category has a special hierarchy, meaning that high-ranked risk factors influence more instruments than low-ranked risk factors. To capture individual risks, some factors are instrument specific.

Afterward, a net risk position  $E_k^{(l)}$  has to be calculated for each risk factor  $X_k^{(l)}, l \in \{1, \dots, 5\}, k \in \{1, \dots, r_l\}$  by:

$$E_k^{(l)} = \sum_{i=1}^{n_k^{(l)}} E_{k,i}^{(l)},$$

with  $n_k^{(l)}$ , the number of instruments influenced by factor  $X_k^{(l)}$ , and  $E_{k,i}^{(l)}$ , the gross risk position of the  $i^{th}$  position depending on  $X_k^{(l)}$ .  $E_{k,i}^{(l)}$  is defined as the change in the respective security due to prespecified shifts in the considered risk factor. The application of more than one shift is only necessary for nonlinear instruments (i.e., instruments that depend in a nonlinear form on the risk factor) and will have to be realized by means of the banks’ pricing models. Through the parameter setting of these models, correlation is introduced (see BAFIN, 2012).

Subsequently, the net risk positions  $E_k^{(l)}$  must be combined to a capital charge for each risk category. Given that all instruments are linear, this is done by calculating the standard deviation of the sum  $\sum_{k=1}^{r_l} E_k^{(l)} X_k^{(l)}$  and multiplying the result with a factor  $\nu^{(l)}$ . This scalar is determined in such a way that it reflects the tail characteristics of the distribution of risk factors, resulting in a capital charge that equals the 1% expected shortfall of the joint distribution. To keep calculations simple, the Committee assumes that for all  $l \in \{1, \dots, 5\}$ , the random variables  $X_1^{(l)}, \dots, X_{r_l}^{(l)}$  are stochastically independent. Thus, the



capital requirement  $CR_{mkt}^{(l)}$  for risk class  $l \in \{1, \dots, 5\}$  takes on the form:

$$CR_{mkt}^{(l)} = \nu^{(l)} \cdot \sqrt{\sum_{k=1}^{r_l} \left( |E_k^{(l)}| \cdot \sigma_k^{(l)} \right)^2},$$

with  $\sigma_k^{(l)}$  denoting the standard deviation of risk factor  $X_k^{(l)}$ .

In the case of nonlinear instruments, it is not sufficient to calculate the standard deviation of the sum  $\sum_{k=1}^{r_l} E_k^{(l)} X_k^{(l)}$ . Instead, more shifts have to be considered and aggregated by means of a formula not yet specified.

Finally, the charges  $CR_{mkt}^{(l)}$ , with  $l \in \{1, \dots, 5\}$  have to be combined to an overall capital charge for market risks. As of September 2013, the BCBS has not yet published a concrete aggregation formula nor specified the parameter values.

### 2.2.3 Total Capital Requirements under Basel III

The total capital charge  $CR_{III}$  under the Third Capital Accord is given by the sum:

$$CR_{III} = CR_{cr} + CR_{mkt} + CR_{CCB} + CR_{GSIB} + CR_{CC}. \quad (13)$$

As displayed above, the Committee intends to reform the standard calculation of  $CR_{mkt}$ . In the currently valid version of Basel III, however, the standard approaches for market and credit risk are unchanged compared to Basel II. Hence, the total capital requirements under Basel III at present are the sum of the Basel II charge and the additional buffers:

$$CR_{III} = CR_{II} + CR_{CCB} + CR_{GSIB} + CR_{CC} \quad (14)$$

$$= CR_{II} + (2.5\% + \alpha\% + \beta\%) \cdot 12.5 \cdot CR_{II}. \quad (15)$$

## 2.3 Solvency II

Solvency II, the new regulatory framework for the insurance sector, is the enhancement of the Solvency I Directive. Apart from the goals of policyholder protection and the prevention of disruptions to the entire financial system, the framework aims to unify and harmonize European insurance supervision (see CEIOPS, 2009). Similar to the Basel Accords, it is made up of three pillars, providing quantitative capital requirements (in Pillar I), qualitative corporate governance and risk management regulations (in Pillar II), as well as disclosure and transparency rules (in Pillar III).

Pillar I is structured according to different risk (sub)modules that are calibrated in accordance with a 0.5% value at risk of the “basic own funds (BOF)”, the difference between assets and liabilities (including subordinated debt) over a period of one year (see, e.g., EC, 2010). The resulting solvency capital requirements (SCRs) are aggregated to an “overall SCR”, taking correlation into account (see, e.g., EC, 2010).<sup>3</sup>

In order to calculate the SCRs associated with the risks of an insurance company investing in a portfolio of assets as shown in Section 3.2.1, we examine the standard approach’s market and counterparty default risk module as specified by the European Insurance and Occupational Pension Authority (EIOPA) (for the entire Section 2.3, refer to EIOPA, 2012b). Under both modules, the capital charges are defined as the change in BOF resulting from prespecified shocks to different market variables. However, as this paper focuses on the capital requirements resulting from asset portfolio risks, we will restrict the following analyses to the changes in the “asset value” (AV) that result from the preset shocks.

<sup>3</sup> Another key measure is the “minimum capital requirement” (MCR). However, as the MCR is calculated by applying a linear formula to the overall SCR, the paper focuses on the solvency capital requirements of the standard approach. For further information on the MCR, refer, for example, to EIOPA, 2012b.

### 2.3.1 Market Risk Module

Under Solvency II, market risk is defined as the volatility of market rates and prices of financial variables. The module comprises interest rate risks, equity risks, property risks, spread risks, concentration risks, currency risks, as well as illiquidity premium risks. As we use well-diversified capital market indices to proxy the asset portfolio of a life insurer (see Section 3.2.1), we find it legitimate to exclude concentration risks as well as illiquidity risks from the analyses. Similarly to the proceeding in Section 2.1.1, we assume that the insurance company is able to perfectly hedge exchange rate risks at negligible transaction costs.

**Interest Rate Risk** Interest rate risk, as defined by the Solvency II framework, involves all changes to the value of an asset ( $\Delta AV$ ) that are due to movements in the term structure and/or volatility of interest rates during one time period. The capital requirements for assets sensitive to interest rate movements  $CR_{int}$ , such as fixed income investments, include all scenarios where the interest rates are subject to an upward stress  $s^{int}$ :

$$CR_{int} = \sum_{i=1}^{n_{int}} \Delta AV_i | s_i^{int}, \quad (16)$$

with  $n_{int}$ , the number of interest rate sensitive instruments.

The framework assumes that the upward stress is an immediate shock to the interest rates:

$$r_i \cdot (1 + s_i^{int}).$$

Here,  $r_i$  is the current riskfree interest rate for investments with the same maturity and currency as instrument  $i$ .

Thus, the change in the asset value of security  $i$  can be specified as:

$$\Delta AV_i | s_i^{int} = r_i \cdot s_i^{int} \cdot AV_i \cdot MD_i, \quad (17)$$

the absolute change in asset  $i$ 's interest rate multiplied by its market value  $AV_i$  (according to the price achievable in an "arm's length transaction", see, e.g., EIOPA, 2012b) and its modified duration  $MD_i$ .

**Equity Risk** Under the standard approach, the measurement of equity risk is carried out in several steps. In a first step, all assets that are sensitive to the volatility of equity prices are divided into two categories: the category of "global equity", comprising all equities that are listed on organized capital markets in the EEA and OECD countries, and the category of "other equity", including nonlisted equities and alternative investments such as private equity, hedge funds, and commodities (see, e.g., EC, 2010). The assets are subjected to prespecified shocks  $s_i^{equ,j}$ , with  $j = 1, 2$ , a specific shock for instruments categorized under "global equity" and a separate shock for "other equity" investments:

$$\Delta AV_i | s_i^{equ,j} = s_i^{equ,j} \cdot AV_i. \quad (18)$$

In a second step, the capital requirement for the  $n_{equ,j}$  instruments of equity category  $j$  can be calculated by:

$$CR_{equ,j} = \sum_{i=1}^{n_{equ,j}} \Delta AV_i | s_i^{equ,j}. \quad (19)$$

In the last step, the overall capital requirement for equity risk is determined on the basis of a given

correlation coefficient  $CORR_{equ}$  between global and other equity:

$$CR_{equ} = \sqrt{CR_{equ,1}^2 + CR_{equ,2}^2 + 2 \cdot CORR_{equ} \cdot CR_{equ,1} \cdot CR_{equ,2}}. \quad (20)$$

**Property Risk** The capital requirement for property risk  $CR_{pro}$  is based on a predefined shock for assets sensitive toward real estate prices (see EC, 2010):

$$CR_{pro} = \sum_{i=1}^{n_{pro}} \Delta AV_i | s_i^{pro}, \quad (21)$$

with  $n_{pro}$ , the number of assets whose asset value is subject to a downward shock  $s_i^{pro}$ :

$$\Delta AV_i | s_i^{pro} = s_i^{pro} \cdot AV_i. \quad (22)$$

**Spread Risk** Spread risk can be defined as the variability of an asset's value due to changes in the credit spreads. This risk category comprises specifically corporate bonds, subordinated debt securities, and hybrid debt. In the following, the description of the calculation of the spread risk capital requirement will be limited to the capital charge for corporate bonds, since our reference portfolio in Section 3.2.1 is subject to spread risk only within this asset class. Under the standard approach, the capital requirement for corporate bonds and loans  $CR_{spr}$  that are exposed to spread risk is quantified by:

$$CR_{spr} = \sum_{i=1}^{n_{spr}} \Delta AV_i | s_i^{spr}, \quad (23)$$

with the assumed shocks  $s_i^{spr}$  for the  $n_{spr}$  credit spread sensitive instruments. To determine the change in the asset value, the instruments are sorted into different duration buckets (refer to the duration tables in EIOPA, 2012b). For assets with a duration  $D_i$  up to 10 years, the change in market value is specified as:

$$\Delta AV_i | s_i^{spr} = \begin{cases} s_i^{spr} \cdot D_i \cdot AV_i, & \text{if } 0 < D_i \leq 5, \\ \left[ s_i^{spr,0} + s_i^{spr,1} \cdot (D_i - 5) \right] \cdot AV_i, & \text{if } 5 < D_i \leq 10. \end{cases} \quad (24)$$

Thus, in the second case, the shock  $s_i^{spr}$  consists of two components  $s_i^{spr,0}$  and  $s_i^{spr,1}$ .

**Solvency Capital Requirement for Market Risk** Finally, the market subrisk modules are aggregated to an overall solvency capital requirement for market risk:

$$SCR_{mkt} = \sqrt{\sum_l CR_l^2 + \sum_l \sum_{m \neq l} CORR_{l,m}^{mkt} \cdot CR_l \cdot CR_m}, \quad (25)$$

with  $l, m \in \{int; equ; pro; spr\}$ , and the correlation coefficients for market risk  $CORR_{l,m}^{mkt}$ .

### 2.3.2 Counterparty Default Risk Module

The counterparty default risk module displays the risks of an unexpected insolvency or deterioration in the credit rating of debtors over one year. This includes exposures such as risk mitigation contracts, cash holdings, drawn on but unpaid obligations received by other (re)insurance companies, capital transfers and their deposits, as well as mortgage loans.

According to the standard approach's definition, the asset portfolio in Section 3.2.1 is subject to default risk within the category of "cash at bank". For the calculation of the solvency capital requirement, Solvency II requires the loss given default  $LGD_i$  of cash holding  $i$ , the variance of the loss distribution of cash holdings  $V$ , as well as the default probability  $PD_i$  of the asset according to its credit rating as input variables. For the variance of the loss distribution, we assume that all cash holdings have the same credit rating and thus the same default probability  $PD_i = PD$  for all  $i = 1, \dots, n$ :

$$V = \frac{1.5 \cdot PD \cdot (1 - PD)}{2.5 - PD} \cdot \sum_{i=1}^{n_{def}} LGD_i^2, \quad (26)$$

with  $n_{def}$ , the number of default risk positions.

Afterward, the solvency capital requirement for counterparty default risk can be determined by (see EIOPA, 2012a):

$$SCR_{def} = \begin{cases} 3 \cdot \sqrt{V}, & \text{if } \sqrt{V} \leq 7.05\% \cdot \sum_{i=1}^{n_{def}} LGD_i, \\ 5 \cdot \sqrt{V}, & \text{if } 7.05\% \cdot \sum_{i=1}^{n_{def}} LGD_i \leq \sqrt{V} \leq 20\% \cdot \sum_{i=1}^{n_{def}} LGD_i, \\ \sum_{i=1}^{n_{def}} LGD_i, & \text{if } 20\% \cdot \sum_{i=1}^{n_{def}} LGD_i \leq \sqrt{V}. \end{cases} \quad (27)$$

### 2.3.3 Aggregation of the Risk Modules

In a final step, the two categories of market risk and counterparty default risk have to be combined. The aggregated solvency capital requirement  $SCR_{agg}$  is determined as follows:

$$SCR_{agg} = \sqrt{SCR_{mkt}^2 + SCR_{def}^2 + 2 \cdot CORR_{agg} \cdot SCR_{mkt} \cdot SCR_{def}}, \quad (28)$$

with the correlation coefficient  $CORR_{agg}$ .

## 3 Assessing the Capital Standards' Adequacy and Consistency

### 3.1 Regulatory Adequacy

To evaluate the accuracy of the Basel and Solvency II capital standards for asset risks, it is focal to consider their model design, especially the treatment of individual risks and the recognition of diversification across risk classes, as well as the parameter calibration. These factors substantially influence the required capital and, through this, the attractiveness of an asset class for a financial institution.

The standard approaches for market and credit risk under Basel II and III calculate the central capital charges on the basis of static risk weights and fixed capital buffers. Due to the lack of dynamic risk magnitudes, the resulting capital charges might therefore become inadequate over time. Furthermore, as displayed in the last section, the models do not take diversification effects into account – a proceeding that is in sharp contrast to the empirical evidence (see, e.g., Braun et al., 2013).

Moreover, the calibration of risk weights seems particularly problematic as it is not rooted in empirical data and several risk weights are applied for a variety of vastly different asset classes (this is in line with the reasoning of several other studies such as Breuer et al., 2008, Resti and Sironi, 2007, and IOSCO, 2001). The excessive promotion of government bond holdings is another shortcoming, often discussed in the literature (see, e.g., Acharya and Steffen, 2013, Nouy, 2012, Al-Darwish et al., 2011, and Zähres, 2011).

This is mainly due to the low risk weights under the market and credit risk modules in comparison to those of corporate bonds of the same rating category (see Table 2 in the following sections).

Thus, the models display an inappropriate treatment of different risk categories. In turn, this may lead to a misestimation of risks and an underrepresentation of certain asset classes, that might cause severe distortions to a bank's asset allocation (see also Braun et al., 2013).

The partial risk factor proposal of Basel III might lead to more adequate capital charges for market risks, due to the refinement of the risk classification, the consideration of (imperfect) correlations between risks, as well as the calibration based on empirical data. Notwithstanding this positive development, the proposal in its current form ignores tail dependence. With regard to the incentive scheme for the banks' asset allocation, an appropriate parameter setting will be crucial.

The most sophisticated proposal for a market risk approach for the banking sector is provided by the fuller risk factor approach. It is able to differentiate between common and individual risk factors and can account for correlation as well as tail dependencies. That said, the current FRF proposal envisages to assume normally distributed risk factors with zero means. Norming the joint distribution function of risk factors to zero implies, however, that the individual risk-return profiles of asset classes are no longer identifiable. Thus, the sole focus on volatility inadequately promotes low risk asset classes (see also Braun et al., 2013), and may lead to severe biases in the investment incentive scheme. Nevertheless, depending on the concrete parameter specification, this is the most promising standardized capital adequacy model for the European banking system, so far.

The additional capital buffers under Basel III are calibrated empirically (see BCBS, 2010b, BCBS 2010c, and BCBS, 2011b). Moreover, the capital conservation buffer increases the banks' resistance in times of stress and the buffer for GSIBs permits the consideration of the degree of systemic relevance of the banks in the calculation. The countercyclical buffer also adds new flexibility to the framework as it varies with the credit growth. However, it remains unclear whether this buffer has the desired effect or instead increases the procyclicality of the capital requirements. In addition, as the buffers are directly related to the total risk weighted assets, the negative effects of the weaknesses of the standard approaches are increased.

Turning to Solvency II, the standard formula seems superior to the current capital standards of the Basel Accords. Correlation between different risks and risk categories is taken into account and the applied stress factors are based on empirical data. That said, room for criticism remains as the standard formula considers heavy tails only implicitly by means of extreme value analyses underlying its model calibration (see CEIOPS, 2010). The critique of a lack in a dynamic solvency assessment, mentioned in the context of the Basel Accords, applies also to the fixed stress factors and correlation matrices under the standard formula of Solvency II. Moreover, regarding the model calibration, the formula subsumes several asset classes under the same stress factor (see also Braun et al., 2013). As an example, the stress applied to "other equities" comprises all alternative investments, including private equity, hedge funds, commodities, and others, although the empirically deduced stress varies between these asset classes considerably (see CEIOPS, 2010). In addition, a perfect positive correlation between these asset classes is assumed, albeit this is not justifiable considering empirical data (see CEIOPS, 2010). With regard to the treatment of government bond holdings, Solvency II strongly favors securities issued by EEA governments, as they are excluded from the concentration and spread risk modules (see EIOPA, 2012b). In consequence, insurers might not diversify sufficiently within the category of government bonds. Furthermore, in light of the current debt crisis, this procedure is not only hardly justifiable, but evidently ignores central risk sources.

## 3.2 Regulatory Consistency

One declared goal of the financial supervisory authorities is to provide consistent regulatory frameworks in order to avoid regulatory arbitrage across financial sectors (see, e.g., EC, 2003; IAIS, 2009). Accord-

ing to the International Association of Insurance Supervisors’ Core Principles, regulatory arbitrage is the exploitation of different capital regulations by transferring assets within a group of business entities to those divisions with the lowest required capital (see IAIS, 2012). Regulatory consistency postulates a conceptual compatibility of regulatory rules between the banking and the insurance sector and, as a result of these rules, comparable capital requirements for the same risks (see EC, 2003).

In the context of capital standards for the financial industry, the overall required capital for asset and liability risks of a bank as opposed to an insurance company should obviously differ, as insurance risks are incomparable to the risks emerging from the core business of banks (see, e.g., Gatzert and Wesker, 2012). However, as the Basel Committee itself requires, “similar rules and standards should be applied to similar activities”. A consistent treatment of risks should therefore imply that the same capital requirements are imposed to the same categories of risk and the same magnitude of risk exposures. Considering the asset side of the balance sheets, the investment portfolios of banks and insurance companies contain in part the same asset classes. Although banks and insurance companies might hold different proportions of these asset classes in their investment portfolio, the capital charges for the same amount and type of asset risk should consequently be similar in order to fulfill the requirement of cross-sectoral consistency as demanded by the regulators.

In the following section, we evaluate the (in)consistencies between the current regulatory capital standards for banks and insurers in detail. In a first step, we calculate and compare the resulting capital charges under the standardized market and credit risk modules of Solvency II, Basel II and Basel III for an exemplified investment portfolio. We furthermore assess the change in capital charges when increasing the portfolio weight of each asset class, separately. The example gives a first impression of the degree of (dis)similarity of the regulatory capital requirements for asset risks. In a second step, we try to find the causes of the observed differences in required capital and analyze the conceptual (in)consistencies of the frameworks.

### 3.2.1 Implementing the Standard Approaches

**Stylized Asset Portfolio** As a basis for the calibration and implementation of the capital standards, we rely on empirical data to define a reference asset portfolio (see Table 1). In line with Braun et al. (2013), the total assets and the portfolio weights are based on financial statement information from 21 Swiss life insurance companies of the year 2011, available at the Swiss Financial Market Supervisory Authority’s “Insurer Report Portal” (see FINMA, 2011). In order to stylize the portfolio, we aggregate several positions and average the data over all 21 companies. Due to the unavailability of market values that are required by the Basel Accords and Solvency II, we consider this to be the most reliable solution to proxy the necessary parameters.

In the absence of information on the exact composition of the subportfolios, we use capital market indices of the latest decade to replicate the characteristics of each considered asset class. For this, we refer to common capital market indices that are also used by EIOPA to calibrate the parameter values of their standardized market risk approach (see CEIOPS, 2010, and EIOPA, 2012b). As a proxy for the stock portfolio, we thus use the MSCI Europe Total Return Equity Index. Within the class of government bonds, a portfolio composition of EU, U.S., and Swiss bonds with proportions of 0.5, 0.3, and 0.2 is assumed. The respective portfolios are represented by common country indices: the S&P EU Government Bond Total Return Index, the S&P U.S. Treasury Total Return Index, and the Swiss Government Bond Total Return Index. The Total Return Indices for U.S. Investment Grade (IG) and High-Yield (HY) Corporate Bonds as well as the modified duration as of December 31, 2011, for all bond indices are retrieved from Bloomberg. For corporate bonds, a relation of two-thirds IG Corporates and one-third HY Corporates is assumed.

Again, in accordance with the Calibration Paper of Solvency II (see CEIOPS, 2010), we use the UK

<b>Asset Portfolio</b>	Index Representing Asset Class	Value (in CU Million)	% of Total Assets	Duration (as of 12/31/2011)
<b>Stocks</b>	MSCI Europe Total Return Index	1,120	8%	–
<b>Bonds</b>	–	9,240	66%	–
<b>Government Bonds</b>	–	6,160	44%	–
EU Government Bonds	S&P EU Government Bond Total Return Index	3,080	22%	6.03
U.S. Government Bonds	S&P U.S. Treasury Total Return Index	1,848	13.2%	4.5
Swiss Government Bonds	Swiss Government Bond Total Return Index	1,232	8.8%	7.7
<b>Corporate Bonds</b>	–	3,080	22%	–
U.S. Investment Grade Corporate Bonds	Bloomberg FINRA Investment Grade U.S. Corporate Bond Total Return Index	2,053	14.67%	4.96
U.S. High Yield Corporate Bonds	Bloomberg FINRA High-Yield U.S. Corporate Bond Total Return Index	1,027	7.33%	3.71
<b>Real Estate</b>	Investment Property Databank UK Total Return Index	2,800	20%	–
<b>Alternative Investments</b>	–	280	2%	–
Hedge Funds	HFRX Global Hedge Fund Index	140	1%	–
Private Equity	LPX50 Listed Private Equity Index	140	1%	–
<b>Cash at Bank</b>	Swiss Three-Month Money Market Index	560	4%	–
<b>Total Assets</b>	–	14,000	100%	–

Table 1: Stylized Asset Portfolio

Total Return Index of the Investment Property Databank as a representative for the portfolio of real estate investments. The same reasoning applied, we resort to the HFRX Global Hedge Fund Index and the LPX50 Listed Private Equity Index to cover alternative investments. As for the percentage of cash holdings, we use the Swiss Three-Month Money Market Index.

The standardized approaches of the Basel Accords calculate separate capital charges for securities in the trading book and items in the banking book (see, e.g., BCBS, 2006). Averaging the proportions of assets in the trading book of the two largest Swiss banks at the end of the year 2011, we receive a proportion of assets held for trading of 20%. If we included the entire Swiss bank industry, that trading proportion would be considerably lower and would in turn lead to lower capital requirements within the banking sector. Therefore, the inclusion of the two largest banks represents an upper bound of the capital requirements. Moreover, assuming that the trading book consists of stocks and bonds only and with an average ratio of traded stocks of 29% for the two banks, we derive a percentage for traded stocks of 72.50 ( $= \frac{20 \cdot 29}{8}$ ) and a percentage of 21.52 ( $= \frac{20 \cdot 71}{66}$ ) for traded bonds.

**Basel II** In order to calculate the Basel II capital charge for the defined portfolio, we have to derive the parameters from the supervisory values, as displayed in BCBS (2006). Table 2 gives an overview of our chosen values.

The market risk weights  $w_i$  for the calculation of  $CR_{mkt}^{int,sp}$  depend on the type of the bond, its rating and in some categories also on the maturity. As government bond indices only contain investment grade bonds, we derive a specific weight of  $w_i = 0.48\%$  for the three government bond classes. This value corresponds to the average of the regulatory weights for the categories AAA to AA- and A+ to BBB- (in the second class we use the mean of the weights for the different maturities). Analogously, we average the three weights in the category “others” and receive the risk weight  $w_i = 9.33\%$  for HY corporate bonds. For investment grade corporate bonds,  $w_i = 0.95\%$ , the mean of the regulatory values for assets of the category “qualifying”, is chosen.

As our portfolio consists of long positions only, the capital requirement  $CR_{mkt}^{int,gen}$  equals the net price change of all bonds in our trading book. In order to calculate the changes  $\Delta A_i$  using Formula (2), the Committee has given a separate  $\Delta r_i$  for each duration band (see Table 2). We slot each bond index of Table 1 to the corresponding time band and separately calculate the change in the asset value.

The supervisory risk weights  $v_i$  for the calculation of  $RWA_{cr}$  are given within the credit risk module. For stocks, hedge funds, and private equity, the BCBS demands the weights 100%, 100%, and 150%, respectively. The weight for real estate did not change compared to the Basel I framework and amounts to 100% (see BCBS, 1988). Concerning the weights for bonds, the regulatory values depend on the credit rating of the issuer. In line with our proceeding in the market risk module, we derive the weight  $v_i = 23.33\%$  for government bonds by averaging the regulatory weights for the three highest rating categories. Similarly, our weights for IG and HY corporate bonds (56.67% and 116.67%) correspond to the averages of the weights for the first three and last three given rating categories, respectively. Finally, depending on the decision of the national authority, the risk weights for claims on banks have to be chosen with respect to the rating of either the banks themselves or of the countries in which they are incorporated. As we calibrate the portfolio weights in Section 3.2.1 from Swiss life insurance companies that are likely to own AAA-rated Swiss bank deposits, in both cases, we receive  $v_i = 20\%$  for cash at bank.

**Basel III** As mentioned in the theoretical part of the paper, as of the date of our simulation analyses (end of September 2013), the parameters of the PRF and FRF approach are yet to be calibrated by the Committee (see, e.g., BCBS, 2012b). As the parameter setting is essential for the calculation of capital charges, we have to refrain from considering these two proposals in our quantitative analyses and calculate  $CR_{III}$  with the current standard approaches for market and credit risks. These use the risk weights of the Second Basel Accord and it therefore only remains to choose the parameters for the capital buffers.



## Market Risk

Basel II/III Standard Model			Solvency II Standard Approach		
				Up	Down
<b>Interest Rate Risk</b>	$w_i$	$\Delta r_i$	<b>Interest Rate Risk</b>	$s_i^{int}$	
EU Government Bonds	0.48	0.65	EU Government Bonds	45.00	–
U.S. Government Bonds	0.48	0.70	U.S. Government Bonds	45.00	–
Swiss Government Bonds	0.48	0.60	Swiss Government Bonds	45.00	–
U.S. IG Corporate Bonds	0.95	0.70	U.S. IG Corporate Bonds	45.00	–
U.S. HY Corporate Bonds	9.33	0.75	U.S. HY Corporate Bonds	45.00	–
<b>Equity Risk</b>	$w^{sp}$	$w^{gen}$	<b>Global Equity Risk</b>		$s_i^{equ,1}$
Stocks	8.00	8.00	Stocks		32.00
			<b>Other Equity Risk</b>		$s_i^{equ,2}$
			Hedge Funds	–	42.00
			Private Equity	–	42.00
			<b>Property Risk</b>		$s_i^{prop}$
			Real Estate	–	25.00
			<b>Spread Risk</b>	$s_i^{spr}$	
			U.S. Government Bonds	0.63	–
			Swiss Government Bonds	3.13;0.32	–
			U.S. IG Corporate Bonds	1.48	–
			U.S. HY Corporate Bonds	5.63	–

## Credit Risk

Basel II/III Standard Model		Solvency II Standard Approach		
	$v_i$		PD	$\sum_i LGD_i$
Stocks	100.00	Cash at Bank	0.002	560
EU Government Bonds	23.33			
U.S. Government Bonds	23.33			
Swiss Government Bonds	23.33			
U.S. IG Corporate Bonds	56.67			
U.S. HY Corporate Bonds	116.67			
Real Estate	100.00			
Hedge Funds	100.00			
Private Equity	150.00			
Cash at Bank	20.00			

## Capital Buffers

Basel III Buffers		
	GSIB	Non-GSIB
Capital Conservation Buffer ( $\gamma$ )	2.5	2.5
Countercyclical Buffer ( $\beta$ )	0	0
Buffer for GSIBs ( $\alpha$ )	2.5	0

Table 2: Input Parameters for the Different Regulatory Approaches

This table summarizes the input parameters for the calculation of the capital requirements under the Basel Accords and Solvency II. The weights  $w_i$ ,  $w^{sp}$ ,  $w^{gen}$ , and  $v_i$  are given in percent and derived from BCBS (2006) and BCBS (1988).  $\Delta r_i$  constitutes the assumed yield changes in percentage points given by the Basel Committee (see BCBS, 2006). The values of  $\alpha$ ,  $\beta$ , and  $\gamma$  are absolute values and chosen in accordance with BCBS (2011b) and BCBS (2011a). The Solvency II shocks (given in percent), PD (given in percent), as well as the LGD (given in CU million) are based on EIOPA (2012b).

According to the BCBS, the capital conservation buffer has to amount to 2.5% of the total risk-weighted assets and may only be reduced in times of distress (see Section 2.2.1). Hence, in our example, we set  $\gamma = 2.5$ .

With regard to the countercyclical buffer, the Committee considers the credit-to-GDP gap (CGG) as a common starting point for the determination of the country-specific parameters  $\beta_k$  (for this paragraph, refer to BCBS, 2010c). The CGG is defined as the deviation of the ratio of aggregate private sector credits over domestic GDP from its long-term trend. Referring to several analyses, the BCBS recommends  $\beta_k = 0$  if the gap falls below 2, increasing values of  $\beta_k$  for gap values between 2 and 10, and  $\beta_k = 2.5$  for CGG values above 10. For our analysis, we set  $\beta = 0$ , since our stylized portfolio does not contain credit exposures.

Depending on the degree of global systemic importance of the banks, the new Basel framework demands a buffer  $CR_{GSIB}$  between 0 and 3.5% of  $TRWA$ . However, according to the latest categorization of the Financial Stability Board, currently no GSIB has to hold the maximal charge (see Financial Stability Board, 2013). In our example, we therefore use  $\alpha = 2.5$  for GSIBs and  $\alpha = 0$  for non-GSIBs.

**Solvency II** Our derivation of the parameters for the calculation of  $SCR_{agg}$  is based on the latest Solvency II Technical Specifications (see EIOPA, 2012b). Table 2 displays the values of the shocks under the market and counterparty default risk module with respect to the different asset classes.

Within the interest rate risk submodule, the Solvency II framework requires an upward shock to the asset values for each maturity of the term structure of interest rates (see CEIOPS, 2010). In line with Braun et al. (2013), we assume flat term structures for each currency zone (European Union, United States, and Switzerland) and choose the averages of the yield curves of AAA-rated zero bonds as the current riskfree interest rates. Thus we use  $r_i = 1.32\%$  (1.38%, 0.52%) for our bonds denoted in EUR (USD, CHF). In accordance with this procedure, we derive a single shock  $s_i^{int} = 45\%$  for each of our five bond categories by averaging the regulatory upward shocks for the different maturities. However, as these values imply absolute interest changes  $r_i \cdot s_i^{int}$  of less than one percentage point which is the required minimum by the regulators, we have to assume absolute yield shifts of one percentage point (see EIOPA, 2012a).

With respect to the equity risk module, EIOPA specifies a stress factor of 32% for “global equity” (such as stocks) and a shock of 42% for each class belonging to the category of “other equity”, i.e., in our case, for investments in hedge funds and private equity. For the aggregation of the charges of the two subcategories, a correlation coefficient  $CORR_{equ}$  of 0.75 is required.

The shock for real estate investments is given within the property risk submodule. It amounts to  $s_i^{pro} = 25\%$ .

Under the standard approach, the stress factors for spread risk of bonds depend on the types of the securities (government or corporate bond), their durations, as well as the issuers’ ratings. In order to receive the spread shocks for IG and HY corporate bonds, we calculate the means of the predefined stresses for the four highest rating categories (AAA to BBB) and the four lowest rating categories (BB to unrated) for the group of corporate bonds with a duration up to five years. This results in an IG spread shock of 1.48% and an HY spread shock of 5.63%. The stress factor  $s_i^{spr} = 0.63\%$  for U.S. government bonds is calculated similarly by averaging the shocks specified for government bonds with a duration less than five years and a rating of at least BBB. For the spread risk of Swiss government bonds, we have to consider the values for sovereign bonds with a duration between five and ten years. Using the same procedure as before, we derive  $s_i^{spr,0} = 3.13\%$  and  $s_i^{spr,1} = 0.32\%$ . In accordance with the Solvency II framework, we do not calculate a capital charge for the spread risk of EU government bonds.

As explained in above, for the aggregation of the risk categories within the market risk module, correlations ( $CORR_{l,m}^{mkt}$ ) are accounted. The respective correlation matrix that needs to be applied to Formula (25) can be found in Appendix A.

In order to calculate the SCR for counterparty default risk, the PD and LGD of “cash at bank” have to be determined. According to EIOPA, the loss given default has to correspond to the asset’s value, i.e. we have a LGD of 560 CU million. Moreover, as we assume that the deposits are held at AAA-rated banks, we choose a probability of default of 0.002%.

Finally, for the aggregation of the solvency capital requirements for market and counterparty default risk, we apply the supervisory correlation coefficient of  $CORR_{agg} = 0.25$ .

### 3.2.2 The Capital Requirements for Market and Credit Risks

Based on the supervisory authorities parameter setting explained above, this section assesses the capital charges for asset risks (in CU million) of the standardized approaches of Basel II, Basel III (for non-GSIBs and GSIBs with  $\alpha = 2.5$ ), as well as Solvency II. Table 3 shows our numerical results for the stylized asset portfolio in Table 1. Here, the second column displays the absolute values of capital requirements. One notices that the capital burden under Solvency II,  $SCR_{agg}$ , is twice as high as that under Basel II,  $CR_{II}$ . The required capital for market and credit risks under Basel III are higher than those under Basel II, but they still remain considerably below those of the standard formula of Solvency II. Even in the case of GSIBs with a high additional capital cushion  $CR_{GSIB}$ ,  $SCR_{agg}$  still exceeds  $CR_{III}$  by 23%. Furthermore, the last column displays the percentages of required capital in total assets. We observe that the required capital ranges from 5.41% of total assets (under the standardized approach of the Second Basel Accord) to 10.82% (under the standard formula of Solvency II).

Regulatory Approach	Capital Charge	in % of Total Assets
Basel II	757.37	5.41%
Basel III, $\alpha = 0$	994.04	7.10%
Basel III, $\alpha = 2.5$	1230.72	8.79%
Solvency II	1514.39	10.82%

Table 3: Capital Requirements for the Stylized Asset Portfolio

This table presents the capital requirements for market and credit risks under the standardized approaches of the Basel Accords II and III as well as Solvency II. The calculation is based on the stylized asset portfolio of Table 1. The second column displays the capital charges absolute values (in CU million), whereas the third column shows their percentage in total assets.

### 3.2.3 Changes in the Capital Requirements

In order to analyze the treatment of the different asset classes under the three standard approaches, we determine the change in the capital charges for asset risks that is due to an increase of the portfolio weight of one asset class. For each asset type, we successively increase the corresponding portfolio weight from 0% to 100% in 5% steps. As the weights of all securities must sum up to 100%, an increase of the portfolio weight of one asset class must be accompanied by a reduction in the portfolio weights of other asset categories. These “residual portfolio weights” are calculated such that the relative weights between pairs of asset classes remain the same (this method was introduced by Braun et al., 2011, and applied by Braun et al., 2013). For example, if the percentage of stocks is raised, the weight of cash at bank is reduced such that it remains twice the weight assigned to alternative investments. Concerning the trading book / banking book allocation, we assume that the percentages of stocks and of each bond category, assigned to the trading book, remain constant (at 72.50% and 21.52%, respectively).

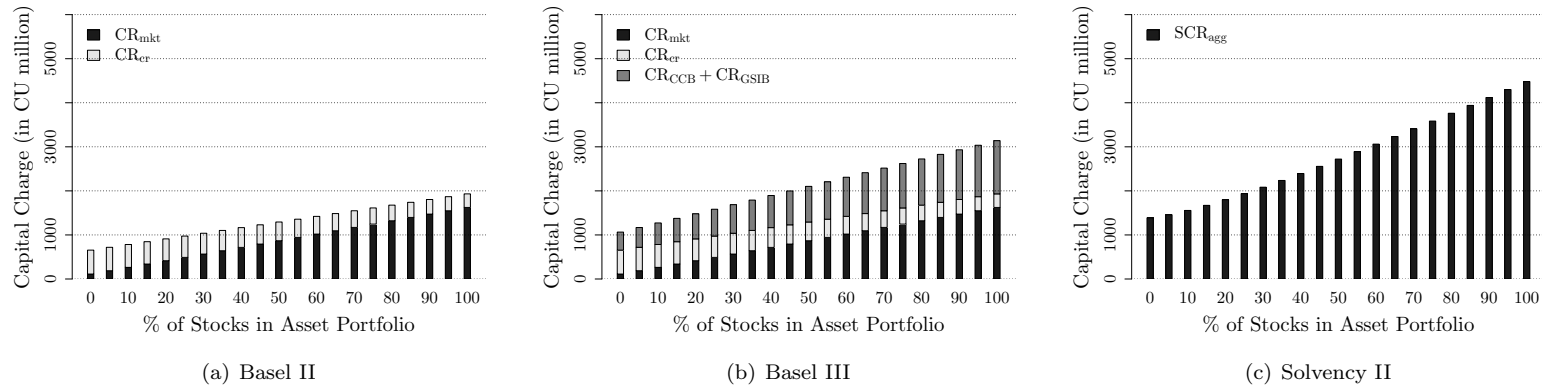


Figure 1: Capital Requirements for Different Percentages of Stocks in the Portfolio

This figure shows the capital charges with respect to different portfolio weights of stocks under Basel II (Subfigure (a)), Basel III for GSIBs with  $\alpha = 2.5$  (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges for the trading and banking book, respectively. The grey parts of the columns in Subfigure (b) represent the sum of the capital conservation buffer and the buffer for GSIBs.

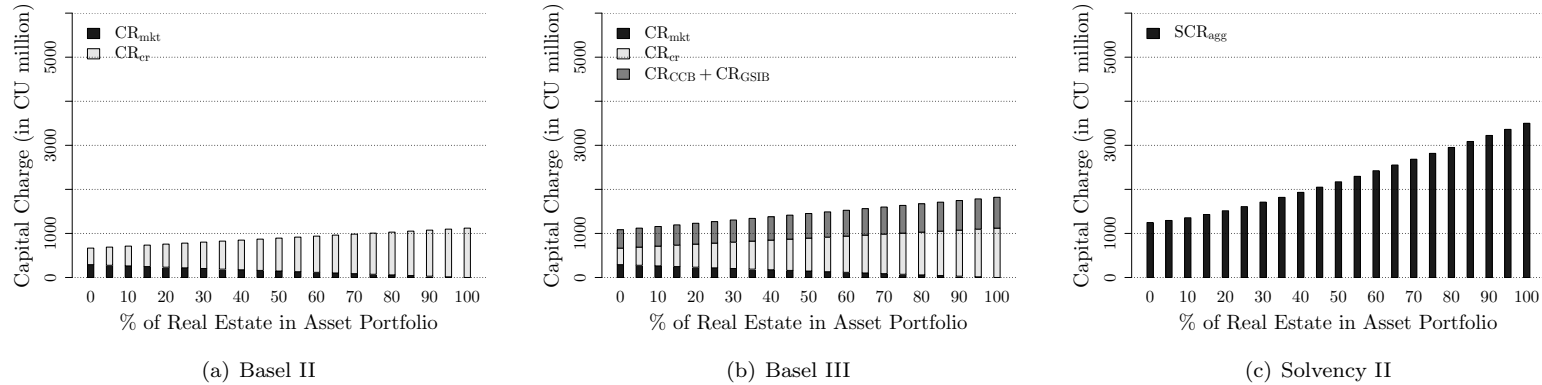
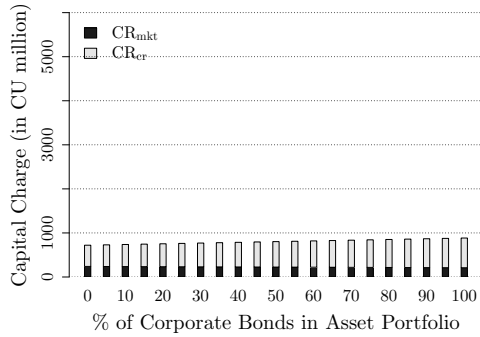
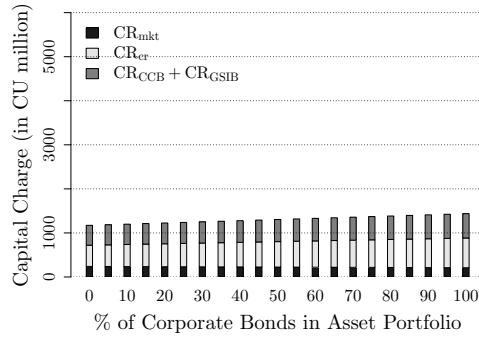


Figure 2: Capital Requirements for Different Percentages of Real Estate in the Portfolio

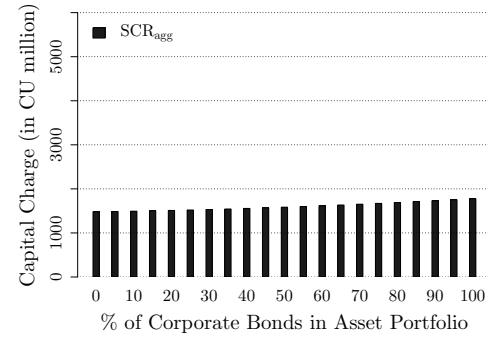
This figure shows the capital charges with respect to different portfolio weights of real estate investments under Basel II (Subfigure (a)), Basel III for GSIBs with  $\alpha = 2.5$  (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges for the trading and banking book, respectively. The grey parts of the columns in Subfigure (b) represent the sum of the capital conservation buffer and the buffer for GSIBs.



(a) Basel II



(b) Basel III

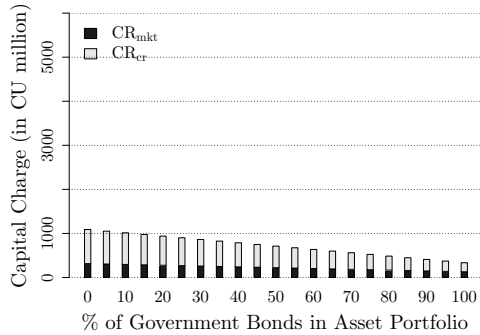


(c) Solvency II

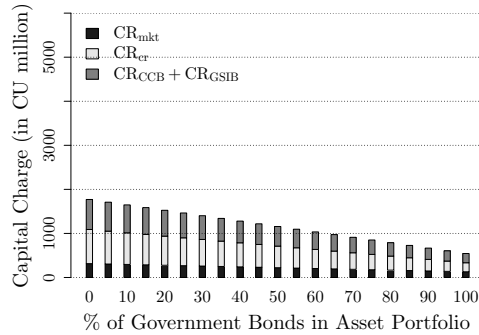
Figure 3: Capital Requirements for Different Percentages of Corporate Bonds in the Portfolio

This figure shows the capital charges with respect to different portfolio weights of corporate bonds under Basel II (Subfigure (a)), Basel III for GSIBs with  $\alpha = 2.5$  (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges for the trading and banking book, respectively. The grey parts of the columns in Subfigure (b) represent the sum of the capital conservation buffer and the buffer for GSIBs.

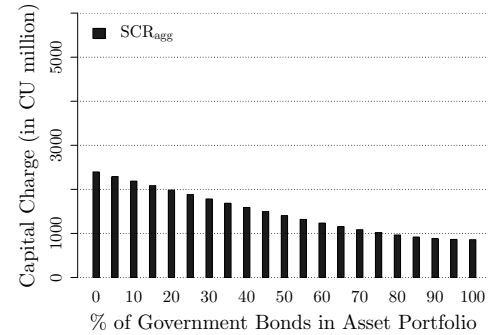
21



(a) Basel II



(b) Basel III



(c) Solvency II

Figure 4: Capital Requirements for Different Percentages of Government Bonds in the Portfolio

This figure shows the capital charges with respect to different portfolio weights of government bonds under Basel II (Subfigure (a)), Basel III for GSIBs with  $\alpha = 2.5$  (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges for the trading and banking book, respectively. The grey parts of the columns in Subfigure (b) represent the sum of the capital conservation buffer and the buffer for GSIBs.

Figures 1–4 illustrate the regulatory requirements for increasing portfolio weights of stocks, real estate investments, corporate bonds, and government bonds, respectively. As the results for alternative investments are relatively similar to those for investments in real estate, they are displayed in Appendix B.

The first figure contains the results for stocks ( $CR_{III}$  in Subfigure (b) is given for the case of a GSIB with  $\alpha = 2.5$ ). It shows that an increase of the proportion of stocks leads to a higher capital burden under all three regulatory frameworks. The reason for this is that additional portfolio weight is given to an asset class with relatively high stress factors and risk weights. Since, under the Basel Accords, this is valid for both the banking and trading book, in Subfigures 1(a) and (b), both  $CR_{mkt}$  and  $CR_{cr}$  rise. The increases are linear as the capital requirements under the Basel Accords constitute weighted sums of the asset values. Moreover, since the two Basel III capital buffers amount to 31.25% of the total capital charge for market and credit risk (see Formula (15)), they also rise, linearly.

A comparison of the three subfigures in Figure 1 reveals that the capital requirements of Solvency II significantly exceed those of Basel II. Depending on the proportion of stocks,  $SCR_{agg}$  is between 1.97 and 2.32 times as large as  $CR_{II}$ . Due to the capital buffers, the Basel III charge lies closer to the  $SCR_{agg}$ , but the differences are still substantial: for all percentages of stocks,  $SCR_{agg}$  is more than 21% higher than  $CR_{III}$ . Furthermore, as the required capital of the majority of banks does not include a GSIB buffer of 2.5% of  $TRWA$ , in most cases the differences are actually greater (see Financial Stability Board, 2013).

The results of our numerical analyses also show a somewhat more steep increase in capital charges under Solvency II than under the Basel Accords. On average, the  $SCR_{agg}$  rises by 6.04%, whereas the mean increase under Basel II and III amounts to 5.57%.

According to Figure 2, an expansion of the portfolio weight of real estate investments also leads to higher capital requirements under both Basel Accords and Solvency II. However, the average increases (2.63% and 5.30%) are smaller than in Figure 1. Concerning Basel II and III, this is due to two opposing effects: On the one hand, a higher portfolio weight of real estate investments leads to a reduction of  $CR_{mkt}$ , since real estate is not incorporated in the trading book and the amount of bonds and stocks decreases. On the other hand,  $CR_{cr}$  rises as a consequence of the high regulatory risk weight for real estate investments. The ascent of the Solvency II capital burden can again be attributed to a high stress factor of 25%. Similarly to the previous figure,  $SCR_{agg}$  always exceeds  $CR_{III}$  (and consequently also  $CR_{II}$ ). Moreover, due to the considerably stronger increase of the capital requirements under Solvency II compared to Basel III, the discrepancy between the charges rises substantially, from 15% in the portfolio without real estate investments to 97% in the case of solely real estate investments.

Turning to Figure 3, it can be observed that  $CR_{II}$ ,  $CR_{III}$ , as well as  $SCR_{agg}$  also move up with a growing proportion of corporate bonds in the portfolio. However, the average slopes (1.02% under the Basel Accords and 0.90% under Solvency II) are relatively small, as a rise in the amount of corporate bonds not only involves a reduction of low-charged government bonds but also a diminution of high-charged stocks, real estate investments, and alternatives. As in the afore discussed cases, the capital requirements for insurance undertakings are always higher than those for banks. The extent of exceedance of the SCR over the overall capital charges of Basel III lies between 21% and 26% and thus exhibits only little variation.

Finally, Figure 4 displays the results for government bonds. In contrast to all other asset classes considered, the overall capital charges under the Basel Accords constantly decrease with increasing portfolio weights of government bonds. The average decline amounts to 5.71% and can be attributed to the small risk weights for government bonds. The Solvency II capital requirements are also declining, but more slowly than  $CR_{II}$  and  $CR_{III}$  (on average by 4.95%). Consequently, the discrepancy between  $SCR_{agg}$  and  $CR_{III}$  ( $CR_{II}$ ) rises with the portfolio weight of government bonds, from 19% (93%) in a portfolio without this asset class to 58% (156%) in the case of exclusively government bonds.

In summary, our numerical results show that the capital charges under all three considered standard approaches rise with increasing percentages of stocks, real estate investments, alternatives, and corporate

bonds in the asset portfolio and decline when more weight is given to government bond investments. However, the maximum increase and the average slopes vary considerably across asset classes. The lowest capital charges are required for portfolios that consist solely of government bonds (2% of the total assets under Basel II, 4% under Basel III, and 6% under Solvency II). The highest regulatory capital is assigned to portfolios made up of equal shares of private equity and hedge fund investments under Solvency II as well as to stock portfolios under Basel II and III. Here, the ratio of regulatory capital to total assets amounts to 42%, 14%, and 22%, respectively.

The amount of required capital also varies considerably between the three standard approaches. While the Basel III capital charges constantly lie 63% above those of Basel II, the differences between the banks' required capital and the SCR for insurers fluctuate extensively. The numerical analyses reveal that the overall capital requirements of Solvency II always lie at least 15% and maximally 158% above those of Basel III. An even more severe gap in the capital burdens can be found between the standard approaches of Solvency II and Basel II: here, the differences range from 87% to 320%.

The results presented above are all based on the assumption of a percentage of traded stocks (bonds) of 72.50 (21.52). This is in practice a relatively large percentage of "traded securities", since most smaller and middle-sized banks are more conservative. As the capital requirements for assets in the trading book are considerably higher than those for assets belonging to the banking book, there is a positive relation between the proportion of traded securities and  $CR_{III}$  as illustrated in Figure 6 of Appendix 4. Thus, in most cases, the discrepancies between the capital charges under the Basel Accords and Solvency II are going to be even larger than our calculated values. Notwithstanding this fact, our results show that even if all stocks and bonds are held for trading, the Basel III capital requirements (1495.75 CU million) are still lower than the  $SCR_{agg}$  (1514.39 CU million) for insurance companies.

Finally, we have to note that in our calculations we do not take into account the liability side, which influences the capital requirements especially under Solvency II. However, due to the large differences between  $SCR_{agg}$  and  $CR_{III}$  (even in the case of a GSIB and a high portion of traded assets), we suppose that in many cases insurers are subject to higher regulatory capital charges than banks.

### 3.2.4 Conceptual Inconsistencies between the Basel Accords and Solvency II

Our empirically based analyses of the last sections indicate the existence of large differences between the capital charges assigned to the same asset class under Solvency II and the Basel Accords. This implies that the regulatory authorities' assessment of the riskiness of a considered asset category must differ substantially. In this section, we examine the conceptual inconsistencies between the frameworks from a theoretical perspective, applying the same criteria as in Section 3.1. Thus, we evaluate the model setup of each capital standard for market and credit risks, especially its risk categorization, risk measure, the recognition of diversification effects, the definition of capital charges, and the parameter setting. As the parameters of the two new market risk proposals of the Basel Committee are not yet calibrated, we again focus on the current Basel frameworks and Solvency II.

The first criterion examined in this context is the risk categorization of the standardized approaches. The current capital models under Basel II and III include within the market risk module the categories of interest rate, equity position, foreign exchange, and commodities risks. Within these categories liquidity risks and spread risks are also accounted for, implicitly. The credit risk module differentiates between thirteen asset classes or "claims" to assign risk weights, comprising among others, claims on: sovereign bonds, corporate bonds, securities firms, residential property, and commercial real estate. By contrast, the Solvency II standard formula uses a different categorization subsuming interest rate risks, equity risks, property risks, currency risks, spread risks, and concentration risks under the market risk module, leaving the credit risk module with the pure counterparty default risks. This module relates only to certain asset

classes (see Section 2.3.2), excluding all securities which are subject to the spread risk module (e.g. bond holdings). It is particularly noticeable, that the risk category of concentration risk under Solvency II is not accounted for under the first Pillar of the Basel Accords, leading to higher capital requirements for insurance companies.

The second important factor examined is the risk measure based on which the parameters are calibrated. As one can deduce from the statements of the Basel Committee regarding internal models, the standardized models under Basel II and III use a 1% value at risk for market risk and a 0.1% value at risk for credit risk (see also Gatzert and Wesker, 2012). The standard formula under Solvency II uses the same risk measure as Basel. However, the quantile differs slightly, as all capital charges are calibrated so as to correspond to a 0.5% value at risk.

As mentioned in Section 3.1, the recognition of diversification effects is another aspect of conceptual difference between frameworks: Solvency II is able to account for different correlations between different risk classes whereas the current Basel Accords always assume perfect correlation.

The two most central and determining factors that influence the capital requirements are the calculation methods and their parameter setting.

Starting with the definition and general formulas to calculate the capital charges under the standardized approaches, we find that equity risks and property risks are calculated similarly under Basel II/III and Solvency II by multiplying the value of risk positions with fixed predefined percentages (so called risk weights under Basel or stress factors under Solvency II). However, the Basel Accords differentiate within the market risk module between a specific and general capital requirement for equity risk.

In contrast to that, the requirement for interest rate risk represents several conceptual differences: First, the Basel Accords' market risk modules again distinguish between a specific and general capital charge. Second, while the Basel II/III market risk module defines the general capital requirement as the product of the value of the risk position, its duration, and a fixed yield change, Solvency II calculates in a first step the change in the current interest rate as a result of a predefined term dependent shock. In a second step, this value is multiplied by the modified duration and the value of the risk position. And third, under the Basel Accords, interest rate risk for bonds in the banking book is not taken account for under Pillar I (see BCBS, 2006). Instead, these bonds are only subject to a charge for their default risk which does not depend on their durations.

As mentioned above, while Basel II and III implicitly account for spread risks and liquidity risks within the other risk categories, Solvency II defines them as individual risk sub-modules. This separate calculation implies an additional capital charge for insurers.

Furthermore, the credit risk modules between frameworks differ, fundamentally. While the standardized model of Basel II/III defines fixed risk weights to be multiplied with the value of the different risk positions as the capital charge, Solvency II uses a complex formula that incorporates the default probability and the loss given default for each risk position to determine the solvency capital requirement.

Finally, the overall requirements for asset risks are on the one hand calculated by means of square root formulas under Solvency II, while on the other hand, the Basel Accords simply sum up the weighted risk positions to derive  $CR_{II}$  and  $CR_{III}$ . Moreover, under Basel III, the buffers for capital conservation, counter-cyclicality and GSIBs are added, a procedure that has no match within Solvency II.

Turning to the last criterion, the parameter setting, we need to go back to Table 2 to evaluate the calibration of risk weights and shocks by the Basel Committee and EIOPA. The Basel risk weights for stocks sum up to 16.00% for securities in the trading book and 8.00% in the banking book as opposed to a shock of 32.00% under the standard formula of Solvency II. A very low charge of 8.00% is applied to real estate and hedge fund investments under the Basel Accords' banking book regulation, whereas  $s_i^{prop}$  for insurers is equal to 25.00% and the shock for hedge funds amounts to 42.00%. The difference with regard to private equity is slightly reduced in comparison to that of hedge funds, with a percentage



of 12.00% under Basel II/III and 42.00% under Solvency II. As mentioned before, spread risks are not separately considered under the Basel Accords' standardized approach. In consequence, the separate shocks under Solvency II increase the relative difference in capital requirements in full. Concerning the requirements for bond holdings, it is not sufficient to contrast only the risk weights and stress factors, as the formulas for the capital charges vary between the frameworks (see above). Moreover, comparisons for bonds can only be made for concrete portfolios, as the durations and - under Solvency II - the current riskfree interest rate must be taken into account. In our case, the Basel charges for government bonds amount to 1.87% for banking book positions and 4.39%, 3.63%, 5.10%, respectively for the three classes of government bonds in the trading book. The corresponding charges for insurers lie all above those for banks with 6.03%, 4.50%, and 7.70%<sup>4</sup>. Similarly, the category of investment grade corporate bonds in our stylized asset portfolio is charged less under the Basel standard model with 4.53% (4.42%) in the banking book (trading book) in comparison to 4.96% under Solvency II. On contrary, the requirements for our class of high-yield bonds are higher under Basel II/III (9.33% / 12.12% in the banking book / trading book) than under the interest rate risk module of Solvency II (3.71%). The same applies to cash at bank, which is subject to a relative charge of 1.60% under the Basel Accords and of 1.04% under Solvency II.

To sum up, a detailed comparison of the standard approaches for market and credit risks reveals large differences between the regulatory frameworks for the banking and insurance sector. As demonstrated in our example, these discrepancies can lead to huge deviations in the capital requirements. Moreover, the theoretical analysis of the parameter setting and risk categorization confirms our conclusion at the end of the previous section, as it identifies higher capital charges for most asset classes and the use of more risk categories under Solvency II compared to the Basel Accords.

Concerning the goal of regulatory consistency between the capital standards for asset risks for banks and insurers, we can therefore conclude that this objective is clearly not achieved. This in turn implies considerable arbitrage incentives that might be exploited, for example, by financial conglomerates that are able to transfer assets to the entities with the lowest required capital (see, e.g., BCBS, 2012c).

A reform of the Basel III standard market risk approach could reduce the inconsistencies in some way. Especially the calculation methods under the PRF-approach are similar to the Solvency II formulas. However, the scope of application of the market risk module will remain fundamentally different under the regulatory frameworks for the banking and insurance industry. Furthermore, if the BCBS implements its plan to move to an expected shortfall methodology, a new source of inconsistency arises through the use of different risk measures. In the end, the Committee's calibration of the new approach will be crucial with respect to the (in)consistency of the future standard approaches.

## 4 Implications and Conclusion

In order to learn from the consequences of the last financial crisis and to enhance the stability of the financial system, regulators, financial institutions, and policymakers alike need a comprehensive understanding of the implications of the revised capital standards. With this paper, we aim to critically analyze the latest regulatory developments and to emphasize their potential consequences for the financial sector. It constitutes a comparative assessment of the standard approaches for asset risks under the Basel Accords and Solvency II with respect to their capital charges' accuracy and regulatory consistency.

As large banks and insurers are expected to use the IRB approach or internal solvency models, respectively (see, e.g., Hannoun, 2011), one might argue that the standard approaches could be regarded as a minimum basis and are therefore not required to consider individual aspects of the institutions' risk situation. However, when the supervisory authorities require internal solvency models to fulfill certain

<sup>4</sup>These values correspond to the charges required per unit of asset value. Thus, e.g.,  $1.87\% = 0.08 \cdot v_i$ ,  $4.39\% = w_i + \Delta r_i \cdot MD_i$ , and  $6.03\% = 1\% \cdot MD_i$ .

principles, such as an adequate treatment of risks and consistency across financial sectors, we argue that their own proposed capital models should comply with these principles, as well. Moreover, the standardized approaches are generally applicable for all banks and insurance companies, respectively, and might be used as a reference for the internal models (see, e.g., BCBS, 2012b)

Our discussion begins with a thorough description of the standard capital models of Basel II, Basel III (including the latest proposals of a partial risk factor and fuller risk factor approach), and Solvency II. In this context, we focus on the risk modules that are relevant for a financial institution's asset side, the market, and credit / counterparty default risk modules. The first regulatory goal, adequacy, is analyzed from a theoretical perspective. The evaluation of the second goal, cross-sectoral consistency between the banking and the insurance industry, is evaluated on a quantitative and qualitative basis. With an exemplary calculation of the capital charges for an empirically-based investment portfolio of a financial institution, a first indication of the dissimilarity of regulatory capital is reached. The analysis of the standardized approaches model design, risk recognition, and calibration reveals the conceptual inconsistencies that lead to the observed differences in capital charges.

A critical analysis of the standard approaches' mechanics displays severe deficiencies regarding the adequacy of the capital charges. The current standardized assessment of regulatory capital depends on crude risk weights or stress factors that are not able to reflect the risk-return characteristics of individual asset classes. Under Basel II, diversification effects between different risk categories are ignored, whereas Solvency II uses static correlation matrices that are only roughly based on empirical evidence. Some of these issues are accounted for under the new risk factor proposals of Basel III. However, as the parameter calibration is not published yet, an evaluation of their enhancements is limited to the general formulas to calculate the capital charges. Thus, in contrast to dynamic modeling techniques, the current capital standards for European banks and insurance companies cannot provide for new market information or economic changes, nor can they account for tail dependencies. The most problematic tendency is, however, their biased treatment of government bond holdings. As an asset class with a large portfolio weight in both banks' and insurers' asset portfolios, the fact that it is not considered within central risk modules is hardly justifiable. This incentive structure has the potential to cause severe moral hazard as it contributes to the increasing interlinkages between national governments, banks, and insurance companies, turning the latter two into the prime financiers of the former.

To improve the accuracy of the current model frameworks, regulators should first and foremost recognize the individual risk-return profiles of asset classes within the calculation of capital requirements. This would simultaneously address the problem of the unduly promotion of government bonds. Instead of a "one risk weight (shock) fits all" approach, they could ground their calibration procedure in empirical data and develop dynamic capital standards. Considering the latter aspect, the solvency model of the Swiss Solvency Test for insurance companies represents a solid example of adapting the model parameters to economic changes (see, e.g., Braun et al., 2013).

Concerning the authorities' goal of regulatory consistency across financial sectors, the example reveals huge differences in the required capital for the same asset portfolio. With regard to the standardized approaches of Basel II and Solvency II, the capital charges for insurance companies are often more than twice as high. The additional capital buffers introduced by Basel III increase the capital charges for the banking industry, but the requirements for insurers remain considerably larger. Although we do not take into account the liability sides, these results indicate the existence of stronger rules for the insurance sector. This conclusion is confirmed by our theoretical analysis of the conceptual differences between frameworks, which identifies higher stress factors and more risk categories under Solvency II compared to the Basel Accords.

An alignment of the capital standards of the banking and insurance sector could be realized by agreeing on one common risk measure and a similar magnitude of the risk weights and stress factors that are

applied to the individual asset classes.

Furthermore, in future papers, some of the limitations to our study could be approached. For example, in order to hold the analyses consistent, we refrain from including certain risk modules such as the currency and illiquidity premium risk modules. In addition, as mentioned before, we focus on the asset side of the financial institutions' balance sheet as their liability sides are incomparable due to different business models. That is the asset-liability matching, which is particularly relevant for insurance companies, is not taken into account. Also, the results of our example are subject to basis risk as we use an empirically grounded but stylized asset portfolio and broad capital market indices to calibrate the models. Therefore, in order to deduce any conclusions from our results to a specific financial institution, it is necessary to include its respective investment holdings.

All in all, our paper is able to reveal huge deficiencies within the European regulatory frameworks regarding the supervisory goals of capital adequacy and consistency. But in the end, policymakers and supervisory authorities will need to decide whether they regard the possible distortions to the financial institutions' asset portfolios and the arising arbitrage opportunities as severe enough to justify a reassessment of the incentive schemes immanent in their capital standards.

## Appendix A

$CORR_{mkt}$	Equity	Interest	Property	Spread
Equity	1.00	0.00	0.00	0.00
Interest	0.00	1.00	0.75	0.75
Property	0.00	0.75	1.00	0.50
Spread	0.00	0.75	0.50	1.00

Table 4: Correlation Coefficients for the Calculation of  $SCR_{mkt}$  in Formula 25 under Solvency II (see EIOPA, 2012b).

## Appendix B

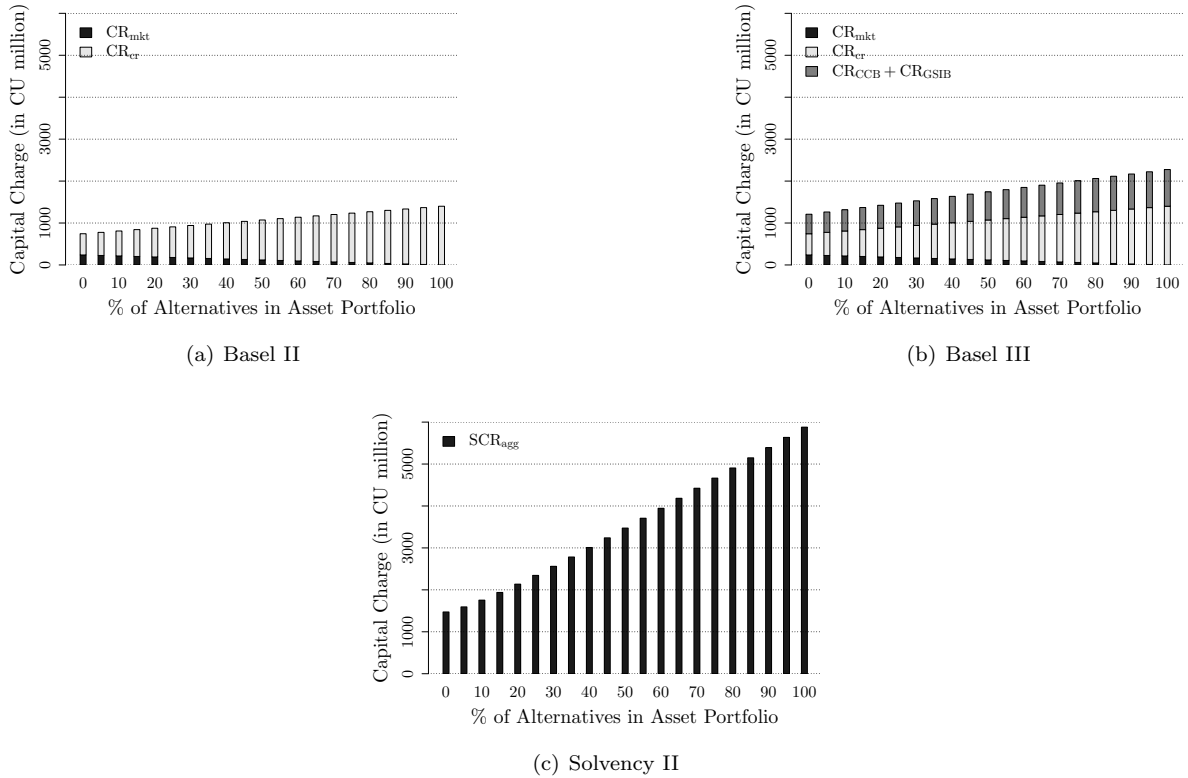


Figure 5: Capital Requirements for Different Percentages of Alternative Investments in the Portfolio

This figure shows the capital charges with respect to different portfolio weights of investments in private equity and hedge funds under Basel II (Subfigure (a)), Basel III for GSIBs with  $\alpha = 2.5$  (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges for the trading and banking book, respectively. The grey parts of the columns in Subfigure (b) represent the sum of the capital conservation buffer and the buffer for GSIBs.

## Appendix C

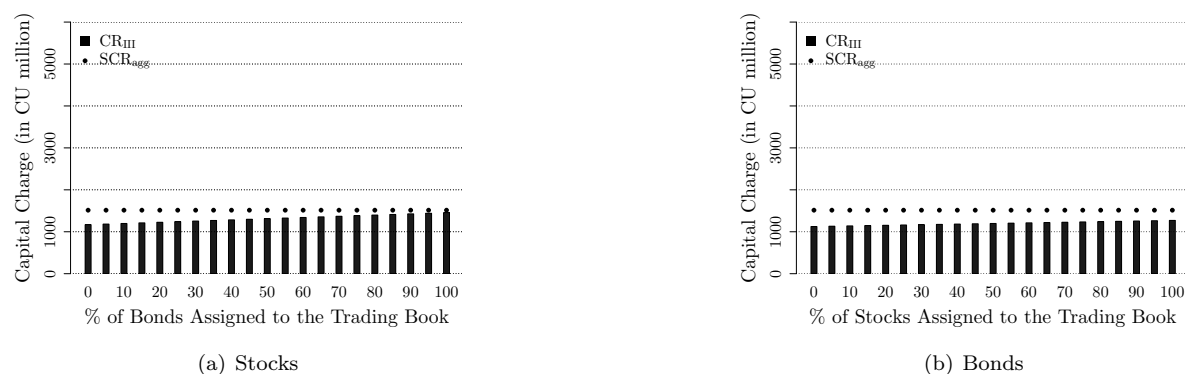


Figure 6: Alteration of the Trading Book / Banking Book Allocation

This figure shows the capital charges under Basel III (bars) and Solvency II (bullets) for the stylized asset portfolio (see Table 1) and increasing proportions of stocks and bonds assigned to the trading book. In Subfigure (a), the share of stocks assigned to the trading book is altered while the proportion of trading book bonds remains unchanged at 21.52%. Subfigure (b) shows the capital requirements if the proportion of trading book bonds is varied and the share of stocks remains at 72.50%.

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