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

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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 this regulatory objective. Our discussion begins with a detailed overview of the current standard approaches for market and credit risk. Furthermore, we describe the two new capital adequacy proposals under Basel III – the partial and fuller risk factor approach. Based on a theoretical analysis and a numerical comparison of the capital charges, our paper reveals an inaccurate treatment of risk categories and severe inconsistencies between the capital standards for banks and insurers. While the latter could lead to an exploitation of regulatory arbitrage opportunities across industries, the former might result in severe distortions to the financial institutions' investment decisions. The unduly promotion of government bond holdings under all three frameworks is able to further deteriorate the postcrisis issue of moral hazard in the financial industry.

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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 and Kupiec and Nickerson, 2005). 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), 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 European Commission argues that in order to ensure cross-sectoral consistency, the general concept of the regulatory systems for banks and insurers should be compatible: "Products containing similar risks should, in principle, be supervised in the same way and be subject to the same capital adequacy or solvency requirements" (see EC, 2003).

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 whether 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. In order to examine the capital standards cross-sectoral consistency, we calculate in a second step the capital charges for market and credit risks for an identical portfolio of certain assets under both standardized capital approaches. For each asset class, the change in the capital requirements that is due to an increase in its portfolio weight is assessed. Finally, we try to explain the displayed differences in required capital for banks and insurers by analyzing 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. 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.

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 investigating 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: First, we critically examine the capital standards with regard to their regulatory adequacy in Section 3.1. Secondly, regulatory consistency between the frameworks of the banking and the insurance industry is evaluated by assessing the resulting capital charges for asset risks and 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.[1]

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.

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:

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

[1] 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).

Here, n_1 denotes the number of interest rate sensitive instruments in the trading book and $E_1, ..., E_{n_1}$ 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 $D_1, ..., D_{n_1}$ of their interest rate sensitive instruments. Moreover, they must determine the changes in the asset values ΔA_i of their positions that are due to interest rate changes Δr_i:

$$\Delta A_i = -\Delta r_i \cdot D_i \cdot E_i, \qquad i = 1, ..., n_1. \tag{2}$$

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 $w^{gen} = 8\%$:

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

Here, n_2 denotes the number of equity positions in the trading portfolio and $E_1, ..., E_{n_2}$ 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:

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

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:

$$CR_{cr} = 0.08 \cdot RWA_{cr}, \tag{5}$$

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

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

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*):

$$TRWA = 12.5 \cdot CR_{mkt} + 12.5 \cdot CR_{cr} = 12.5 \cdot CR_{mkt} + RWA_{cr}. \tag{7}$$

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 $\gamma = 2.5$:

$$CR_{CCB} = \gamma\% \cdot TRWA. \tag{8}$$

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 add-on 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:

$$CR_{CC} = \beta\% \cdot TRWA, \qquad \text{with} \qquad \beta = \sum_k c_k \beta_k. \tag{9}$$

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"[2] (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.:

$$CR_{GSIB} = \alpha\% \cdot TRWA. \tag{10}$$

The value α 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 $\mathscr{A}_1, ..., \mathscr{A}_B$, 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).

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

$$K_b = \sqrt{\sum_{i,j \in \mathscr{A}_b} \rho_{i,j} u_i E_i u_j E_j}. \tag{11}$$

Here, E_i and E_j are the market values of the instruments i and j in bucket $\mathscr{A}_b$, 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

[2] 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).

i and j. Both the risk weights and the correlations will be calibrated 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}:

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

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

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 $X_1^{(l)}, ..., X_{r_l}^{(l)}$ 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 $X_k^{(l)}$, $l \in \{1, ..., 5\}$, $k \in \{1, ..., r_l\}$ 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 $l \in \{1, ..., 5\}$, the random variables $X_1^{(l)}, ..., X_{r_l}^{(l)}$ are stochastically independent. Thus, the capital requirement $CR_{mkt}^{(l)}$ for risk class $l \in \{1, ..., 5\}$ 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 $l \in \{1, ..., 5\}$ have to be combined to an overall capital charge for market risks. However, the BCBS has neither published a concrete aggregation formula nor specified the parameter values, yet.

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:

$$CR_{III} = CR_{cr} + CR_{mkt} + CR_{CCB} + CR_{GSIB} + CR_{CC}. \tag{13}$$

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:

$$\begin{aligned} CR_{III} &= CR_{II} + CR_{CCB} + CR_{GSIB} + CR_{CC} \quad (14)\\ &= CR_{II} + (2.5\% + \alpha\% + \beta\%) \cdot 12.5 \cdot CR_{II}. \quad (15)\end{aligned}$$

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).

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 for market risk and counterparty default risk as specified by the European Insurance and Occupational Pension Authority (EIOPA) (for the entire Section 2.3, refer to EIOPA, 2012b).[3]

The market risk module and the counterparty default risk module use prespecified shocks to different market variables. The capital charges are defined as the change in the BOF, the change in the difference between assets and liabilities, resulting from the shocks considered. 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.

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

[3] 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.

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 (ΔAV) 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}:

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

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:

$$r \cdot (1 + s_i^{int}),$$

with the current interest rate r.
Thus, the change in the asset value of security i can be specified as:

$$\Delta AV_i | s_i^{int} = r \cdot s_i^{int} \cdot AV_i \cdot MD_i, \tag{17}$$

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:

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

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

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

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:

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

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):

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

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

$$\Delta AV_i | s_i^{pro} = s_i^{pro} \cdot AV_i. \tag{22}$$

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:

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

with the assumed shock for the n_{spr} credit spread sensitive instruments s_i^{spr}. To determine the change in the asset value, the instruments are sorted into different duration buckets (refer to the duration table in EIOPA, 2012b). For assets with a modified duration MD_i up to five years, the change in market value can be specified as:

$$\Delta AV_i | s_i^{spr} = s_i^{spr} \cdot AV_i \cdot MD_i. \tag{24}$$

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

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

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 $i = 1, ..., n$:

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

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):

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

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:

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

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 dependencies 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. As displayed in the last section, the models do not take risk dependencies into account – a proceeding that is in sharp contrast to the empirical evidence (see, e.g., Braun et al., 2013). Furthermore, due to the lack of dynamic risk magnitudes, the resulting capital charges might become inadequate over time.

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). For example, there is no differentiation within the category of unrated bonds and the same risk weight is applied to investments in real estate, hedge funds, and stocks, assuming therefore a correlation coefficient of +1 between them. The excessive promotion of government bond holdings is another shortcoming, often discussed in the literature (see, e.g., 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 and the consideration of correlations between risks. 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.

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 cannot account for fat-tailed risk distributions. 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). Also, this implies the assumption of a perfect positive correlation between these asset classes that is not justifiable considering empirical data (see CEIOPS, 2010). With regard to the treatment of government bond holdings, Solvency II refrains from considering them in the concentration and counterparty default risk module (see EIOPA, 2012b). 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). According 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 (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 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, 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 be similar in order to fulfill the requirement of cross-sectoral consistency as required by the European Commission (as explained above). Thus, for our stylized portfolio of assets in Table 1, the capital requirements for banks and insurance companies should be of similar magnitude.

In the following section, we therefore evaluate the (in)consistencies between the current regulatory capital standards for banks and insurers by implementing the standard approaches for market and credit risks to calculate the capital requirements for an empirically-based stylized asset portfolio. We furthermore assess the change in capital requirements when increasing the portfolio weight of each asset class, separately.

3.2.1 Implementing the Standard Approaches

Stylized Asset Portfolio As a basis for the calibration 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. Here, we rely on the calibration techniques of EIOPA for the Solvency II standard approach for market risk (see CEIOPS, 2010 and EIOPA, 2012b).[4] 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 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). The proportion of assets held for trading of 13% is calculated from balance sheet data of the UBS group of the year 2011. Assuming that the trading book consists of stocks and bonds only and with an empirical ratio for traded stocks of 26%, we derive a percentage for traded stocks of 42.25 ($\frac{13 \cdot 26}{8}$) and a percentage of 14.58 for traded bonds ($\frac{13 \cdot 74}{66}$).

Basel II The parameters of the market and credit risk module of Basel II, as displayed in BCBS (2006), are not derived from empirical market data.

The market risk weights w_i for the calculation of $CR_{mkt}^{int,sp}$ were chosen by the Committee in such a way that the capital requirements $w_i \cdot |E_i|$ for the individual risks in the trading book resemble the charges $8\% \cdot v_i \cdot |E_i|$ for the same positions in the banking book (see BCBS, 2005b). From the supervisory weights, we derive $w_i = 0.80\%$ 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- (we replace the term to maturity

[4] As there is no information available on how the different risk weights of the Basel Accords are calibrated, we focus on the Solvency II Calibration Paper for the parameter settings of the asset portfolio.

Asset Portfolio	Index Representing Asset Class	Value (in CU Million)	% of Total Assets	Duration (as of 12/31/2011)
Stocks	MSCI Europe Total Return Index	1,120	8%	–
Bonds	–	9,240	66%	–
Government Bonds	–	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
Corporate Bonds	–	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
Real Estate	Investment Property Databank UK Total Return Index	2,800	20%	–
Alternative Investments	–	280	2%	–
Hedge Funds	HFRX Global Hedge Fund Index	140	1%	–
Private Equity	LPX50 Listed Private Equity Index	140	1%	–
Cash at Bank	Swiss Three-Month Money Market Index	560	4%	–
Total Assets	–	14,000	100%	–

Table 1: Stylized Asset Portfolio

Market Risk

Basel II/III Standard Model			Solvency II Standard Approach		
				Up	Down
Interest Rate Risk	w_i	Δr_i	**Interest Rate Risk**	s_i^{int}	
EU Government Bonds	0.80	0.65	EU Government Bonds	42.00	–
U.S. Government Bonds	0.80	0.70	U.S. Government Bonds	42.00	–
Swiss Government Bonds	0.80	0.60	Swiss Government Bonds	42.00	–
U.S. IG Corporate Bonds	1.60	0.70	U.S. IG Corporate Bonds	42.00	–
U.S. HY Corporate Bonds	9.33	0.75	U.S. HY Corporate Bonds	42.00	–
Equity Risk	w^{sp}	w^{gen}	**Global Equity Risk**		$s_i^{equ,1}$
Stocks	8.00	8.00	Stocks		32.00
			Other Equity Risk		$s_i^{equ,2}$
			Hedge Funds	–	42.00
			Private Equity	–	42.00
			Property Risk		s_i^{prop}
			Real Estate	–	25.00
			Spread Risk	s_i^{spr}	
			U.S. IG Corporate Bonds	1.25	–
			U.S. HY Corporate Bonds	6.00	–

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	4.00
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 (γ)	2.5	2.5
Countercyclical Buffer (β)	0	0
Buffer for GSIBs (α)	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). Δr_i constitutes the assumed yield changes in percentage points given by the Basel Committee (see BCBS, 2006). The values of α, β, and γ are absolute values and chosen in accordance with BCBS (2011b) and BCBS (2011a). The Solvency II parameters (given in percent) are based on EIOPA (2012b).

by the duration of the indices). Analogously, we average the three weights in the category "others" and receive the risk weight $w_i = 9.33\%$ for HY corporate bonds. For the investment grade corporates, $w_i = 1.60\%$, the regulatory value for assets of the category "qualifying" with a time to maturity of more than two years, 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 ΔA_i using Formula (2), the Committee has given a separate Δr_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} constitute a refinement of the weights of the 1988 Capital Accord and were finally determined by the Committee after several quantitative impact studies and consultations with the banking industry (see, e.g., BCBS, 2002). 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. As government bond indices only contain investment grade bonds, we derive the weight $v_i = 23.33\%$ for government bonds by averaging the regulatory weights from 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 of 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 set $v_i = 20\%$ for cash at bank.

Basel III The calibration process for Basel III comprises the determination of the capital buffers and, if CR_{mkt} is not calculated by means of the Basel II standard market risk approach, the specification of the input variables for the PRF or FRF approach. The parameters for the buffers are presented at the bottom of Table 2.

As pointed out in Section 2.2.1, the capital conservation buffer is intended to be set to 2.5% of the total risk-weighted assets. According to the Committee, the percentage of 2.5% was determined based on the results of stress tests in eight countries as well as several empirical investigations (see BCBS, 2010b).

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 β_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 β_k for gap values between 2 and 10, and $\beta_k = 2.5$ for CGG values above 10. For the analysis, we set $\beta = 0$, since our stylized portfolio does not contain credit exposures.

For the determination of the maximum size of CR_{GSIB}, the Basel Committee carried out three different analyses (for the remarks on this buffer, refer to BCBS, 2011b). The two main approaches consist of an examination of the costs and benefits of the additional capital requirement as well as an estimation of the charge needed to equalize the expected impact of defaults of GSIBs and non-GSIBs. According to the BCBS, the calculated capital cushions range from 1% to 8% of *TRWA*, but mainly lie between 2% and 4% of *TRWA*. On the basis of these results, the supervisors opted for a maximum capital buffer for GSIBs of 3.5% of *TRWA*. However, currently no GSIB has to hold the maximal charge (see Financial Stability Board, 2012). In our analysis, we therefore choose $\alpha = 2.5$ for GSIBs and $\alpha = 0$ for non-GSIBs.

As mentioned in the theoretical part of the paper, 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 (see Section 3.2.2).

Solvency II The description of the parameter calibration in the following section will be 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 Calibration Paper requires an upward shock to the asset values for each maturity of the term structure of interest rates (see CEIOPS, 2010). According to EIOPA, these shocks are calibrated from a principal component analysis with data from European and British government zero coupon bond term structures and European and British libor and swap rates (see CEIOPS, 2010). In order to calculate the stresses on the representative asset portfolio of Table 1, we assume flat term structures for each currency zone (European Union, United States, and Switzerland)[5]. Taking the median of the predefined upward stress factors to the yield curves for each maturity, we derive a single shock of 42%.

For the "global equity" shock, EIOPA employs return time series such as the MSCI Europe Total Return Index to derive a stress factor of 32%. For alternatives and nonlisted equities, the stress factor relies on historical time series from the LPX50 Total Return Index, the S&P GSCI Total Return Index, the HFRX Global Hedge Fund Index, and the MSCI Emerging Markets BRIC (see CEIOPS, 2010). On this basis, EIOPA determines the 0.5% values at risk for each subcategory, separately. Although they display noticeable heterogeneity, EIOPA derives a common shock for "other equity" of 42%. Furthermore, a correlation coefficient of 0.75 between the risk categories of "global equity" and "other equity" is specified.

The calibration of the property risk stress factor relies on the Investment Property Databank for UK Total Return Index data (see CEIOPS, 2010). This results in a property shock of 25%.

According to EIOPA, the determination of the spread risk module is carried out using Merrill Lynch Corporate Bond Indices and subindices of EMU Corporate Bonds that cover different maturity buckets. Furthermore, times series of daily yield spreads from Datastream and Bloomberg are applied (see CEIOPS, 2010). In order to receive a spread shock for IG corporate bonds and HY corporates, we divide the standard parameter values with a duration up to five years into two groups and calculate their respective medians (for a detailed overview of the parameter values, refer to the corresponding table in EIOPA, 2012b). Under the investment grade group, we subsume all corporate bonds with a rating between AAA and BBB. The rest of the corporates are considered high yield. This results in an IG spread shock of 1.25% and an HY spread shock of 6.00%.

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 2.3.1 can be found in Appendix A.

As explained by the regulator, the predefined probabilities of default are calibrated based on exponentially smoothed and linearly correlated data from two public reports on global corporate defaults, as well as default and recovery rates of corporate bond issuers by Standard & Poors and Moody's (see CEIOPS, 2007).

Finally, the solvency capital requirements for market and counterparty default risk are aggregated applying a correlation coefficient of $CORR_{agg} = 0.25$. The correlation coefficients used to display the dependencies between submodules of the market risk module and between the market and the default risk module were, according to CEIOPS (2010), set in line with a qualitative analysis after the financial crisis of 2007-2009. After several concerned remarks from insurance stakeholders, the values where retroactively justified by further statistical analyses but remain only roughly based on empirical market data.

[5] This is in line with the proceeding of Braun et al. (2013).

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 more than 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 41%. Furthermore, the last column displays the percentages of required capital in total assets. One notices that the required capital ranges from 5.16% of total assets (under the standardized approach of the Second Basel Accord) to 11.85% (under the standard formula of Solvency II).

Regulatory Approach	Capital Charge	in % of Total Assets
Basel II	722.89	5.16%
Basel III, $\alpha = 0$	948.79	6.78%
Basel III, $\alpha = 2.5$	1174.69	8.39%
Solvency II	1659.47	11.85%

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 42.25% and 14.58%, respectively).

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 2.24 and 2.81 times larger than 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 38% higher than CR_{III}. Furthermore, as the required capital of most banks does not include a GSIB buffer of 2.5% of *TRWA*, the differences are actually greater (see Financial Stability Board, 2012).

The results of our numerical analyses also show a more steep increase in capital charges under Solvency II than under the Basel Accords. On average, the SCR_{agg} rises by 5.31%, whereas the mean increase under Basel II and III amounts to 4.61%.

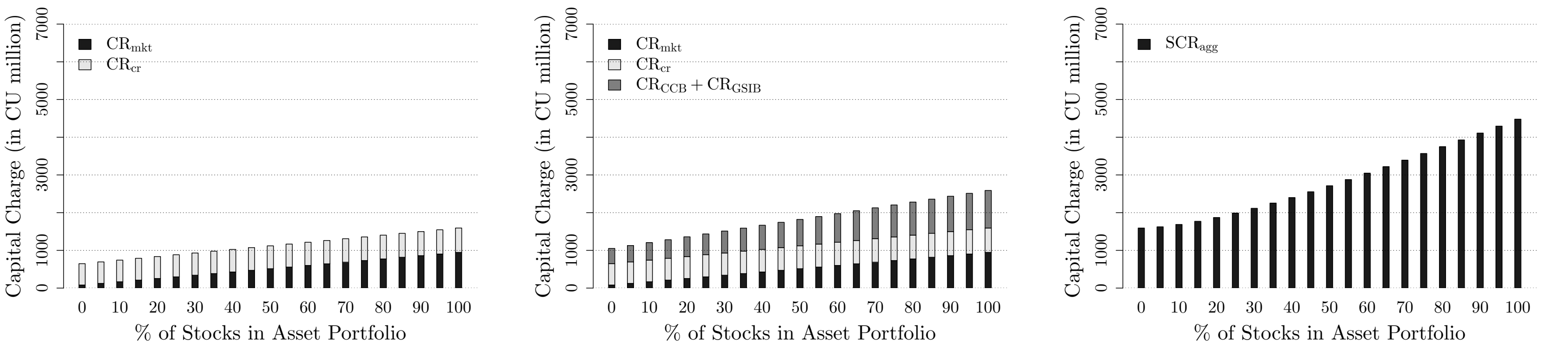
According to Figure 2, an expansion of the portfolio weight of real estate investments also leads to higher capital requirements under both Basel Accords and Solvency II. However, the average increases (2.97% and 4.11%) are smaller than in Figure 1. Concerning Basel II and III, this is due to two opposing 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_{II} and CR_{III}. For all portfolio weights, the relative differences between the charges for banks and insurance firms are even slightly larger than in Figure 1.

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 (1.35% under the Basel Accords and 2.23% 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 38% and 65% and is thus similar to that in Figure 1.

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 5.74% and can be attributed to the small risk weights for government bonds. The Solvency II capital requirements are also declining to a portfolio weight of 85%, but more slowly than CR_{II} and CR_{III}.

For higher proportions of government bonds, the SCR_{agg} slightly rises in consequence of a reduction of diversification effects that overcompensates the effect of the low stress factors. Because of the faster decrease of CR_{II} and CR_{III} compared to SCR_{agg} and the increase of the Solvency II charge for very high portfolio weights of government bonds, the discrepancy between the burden for banks and insurance firms considerably rises for high proportions of that asset class in the portfolio.

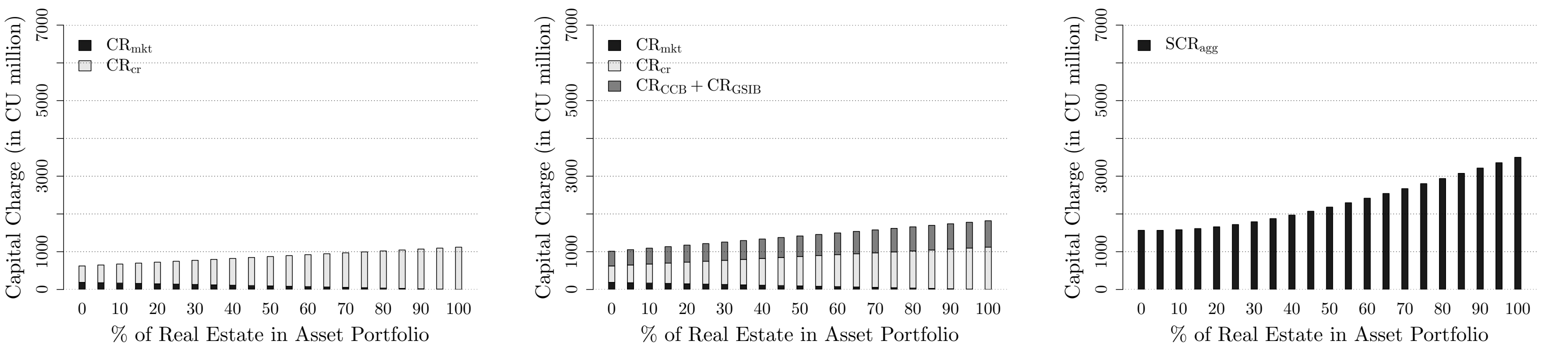
In summary, our numerical results show that the capital charges under all three considered standard approaches rise with increasing percentages of stocks, real estate investments, alternatives, and corporate bonds in the asset portfolio and decline when more weight is given to government bond investments. 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 10% 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%, 11%, and 18%, respectively.



(a) Basel II (b) Basel III (c) Solvency II

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

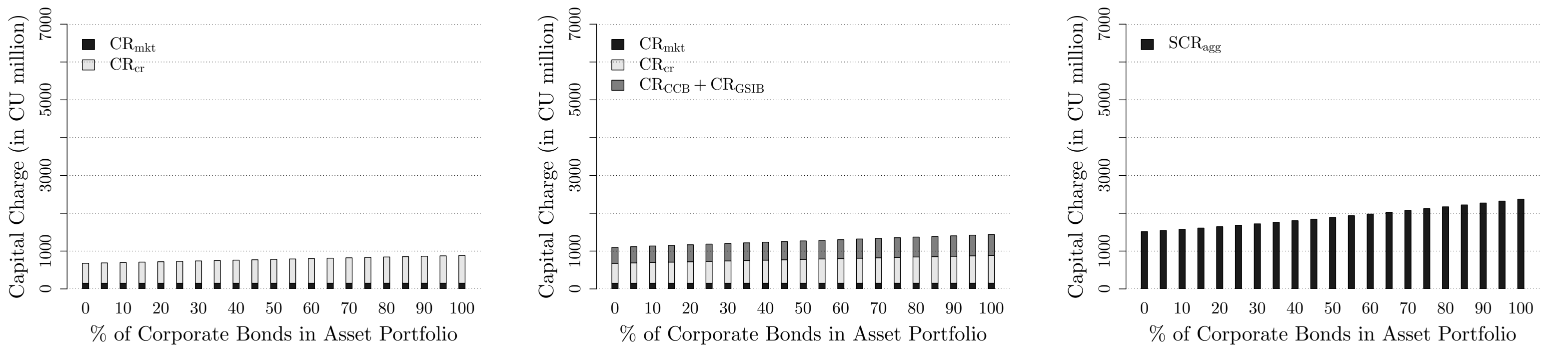
This figure shows the capital charges with respect to different portfolio weights of stocks under Basel II (Subfigure (a)), Basel III for GSIBs with $\alpha = 2.5$ (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate the charges 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.



(a) Basel II (b) Basel III (c) Solvency II

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

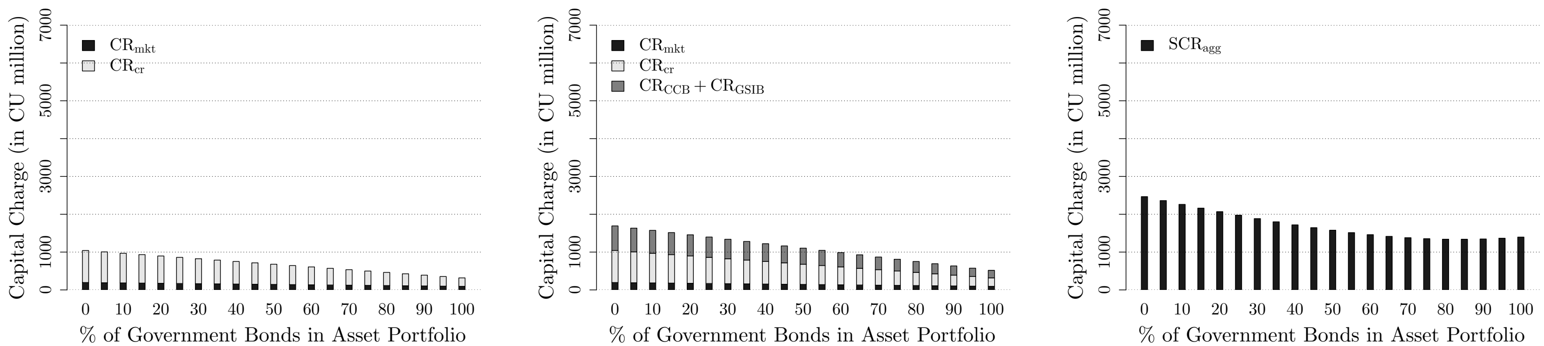
This figure shows the capital charges with respect to different portfolio weights of real estate investments under Basel II (Subfigure (a)), Basel III for GSIBs with $\alpha = 2.5$ (Subfigure (b)), and Solvency II (Subfigure (c)). In Subfigures (a) and (b), the black and the white parts of the bars illustrate 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.



(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.

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 38% and maximally 171% 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 124% to 340%.

3.3 Conceptual Inconsistencies between the Basel Accords and Solvency II

Our empirically based analyses of the last sections reveal vastly different capital charges assigned to the same asset class. This implies that the regulatory authorities' assessment of the riskiness of a considered asset category must differ substantially. More importantly, with respect to the sensitivity analyses for one particular asset class, we find overall capital charges for insurance companies that are often more than doubled in comparison to those for banks subject to Basel II, and remain considerably above those of Basel III.

In order to explain these huge cross-sectoral differences, this section evaluates the conceptual inconsistency between frameworks, applying the same criteria as in Section 3.1. We evaluate the model setup of each capital standard for market and credit risks, especially its risk categorization, risk measure, the recognition of risk dependencies, 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 risk, equity position risk, foreign exchange risk, and commodities risk. 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, for example, sovereign bond holdings. It is particularly noticeable, that the risk category of concentration risk under Solvency II is not accounted for under 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. 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 risk dependencies is another aspect of conceptual difference between frameworks: Solvency II is able to account for correlations between different risk classes whereas the current Basel Accords ignore such risk dependencies, completely.

The two most central and determining factors that influence the required capital, that is the quantitative capital requirements, for banks and insurance companies are the calculation of capital charges 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 a fixed pre-defined percentage (a so called risk weight under Basel or shock 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 again distinguish between a specific and general capital charge. Second, while the standard Basel model within the market risk module defines the general capital requirement as the product of the value of the risk position, its duration, and a fixed percentage representing the risk weight, Solvency II calculates in a first step the increase or decrease in the current interest rate as a result to a pre-defined shock. In a second step, this value is multiplied by the modified duration and the value of the risk position. And third, the capital charge for interest rate risk positions within the banking book are calculated without taking their duration or maturity into account.

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 of capital requirements is another cause of higher capital charges 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 within 13 categories of claims as the capital requirement, Solvency II uses a complex formula that incorporates the default probability and the loss given default for each risk position to calculate the solvency capital requirement.

Finally, the overall requirements for asset risks are on the one hand a simple summation of weighted risk positions under the Basel Accords, while on the other hand, Solvency II draws on square root formulas to calculate the solvency capital requirement for the market and credit risk module.

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. Even more prominent is the difference for real estate and hedge fund investments: A very low charge of 8.00% is applied to each of these asset classes 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 and 42.00% under Solvency II. As mentioned before, spread risks are not separately accounted for under the Basel Accords' standardized approach, so that the separate shocks under Solvency II increase the relative difference in capital requirements in full. The Basel charges for interest rate risks of government bonds amount to 1.87% for banking book positions and 4.72%, 3.95%, 5.42%, respectively for the three classes of government bonds in the trading book. The corrsponding charges for insurers lie all above those for banks with 10.20%, 8.15%, and 12.15%. Similarly, the category of corporate bonds in our stylized asset portfolio is charged less under the Basel standard model with 4.53% and 9.33% (5.07% and 12.12%) in the banking book (trading book) in comparison to 11.51% and 14.23% under Solvency II. The only capital charge that is more strict under the standardized approach for banks is that for cash at bank, with 1.60%, as opposed to 1.04% under Solvency II. Additionally, the capital buffers for capital conservation, counter-cyclicality, and GSIBs under Basel III amount to 5% for GSIBs but have no match within Solvency II.

All in all, a considerable part of the differences in capital requirements between the Basel Accords and Solvency II is certainly rooted in their parameter settings. Our analysis has been able to show that the standard formula of Solvency II involves considerably higher charges than the standardized approaches of Basel II and III. Also the additional risk categories within the insurance model are likely to contribute to the observed difference in capital requirements.

Our conclusion for regulatory consistency between the capital standards for asset risks for banks and insurers is therefore, that this supervisory goal 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).

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 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.

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. In a first step, we assess the regulatory adequacy from a theoretical perspective. In a second step, cross-sectoral consistency between the banking and the insurance industry is evaluated by means of a comparison of the capital charges for an empirically-based portfolio of assets. Moreover, we assess the changes in regulatory capital that are due to an increase in the portfolio weight of each individual asset class. In order to explain the differences in the amount of required capital, we examine the conceptual inconsistencies between the Basel Accords' standardized models and the standard formula of Solvency II.

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, dependencies 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 account for tail-dependencies, nor can they provide for new market information or economic changes. 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.

Concerning the authorities' goal of regulatory consistency across financial sectors, the paper reveals huge differences in the required capital for the same amount and type of asset risk. In consideration of the standardized approaches of Basel II and Solvency II, the capital charges for insurance companies are often more than twice as high. Although the additional capital buffers introduced by Basel III increase the capital charges for asset risks, the requirements for insurers remain considerably larger. On the basis of a theoretical analysis of the conceptual differences between frameworks, the lower risk weights and fewer risk categories under the Basel Accords' standard model can be identified as the main causes for the inconsistency between the considered capital standards.

The recent regulatory developments might lead to improvements, especially within the Basel Accords. However, we conclude that the current status of the standard approaches for asset risks are clearly neither adequate nor consistent.

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).

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 shocks that are applied to the individual asset classes.

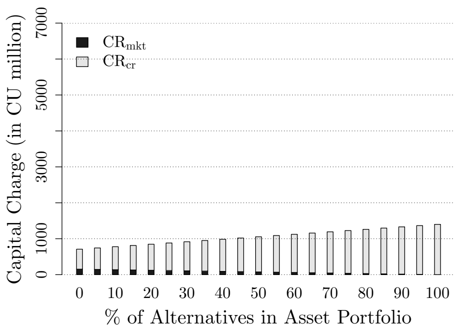
In the end, policymakers and supervisory authorities will need to decide whether they regard the possible distortions to the financial institutions' asset portfolios and the arising arbitrage opportunities as severe enough to justify a reassessment of the incentive schemes immanent in their capital standards.

Appendix A

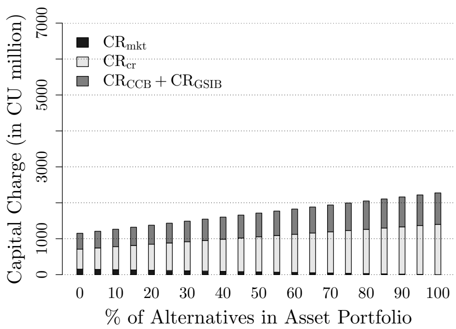
$CORR_{mkt}$	Equity	Interest	Property	Spread
Equity	1.00	0.00	0.00	0.00
Interest	0.00	1.00	0.75	0.75
Property	0.00	0.75	1.00	0.50
Spread	0.00	0.75	0.50	1.00

Table 4: Correlation Coefficients for the Calculation of SCR_{mkt} in Formula 2.3.1 under Solvency II (see EIOPA, 2012b).

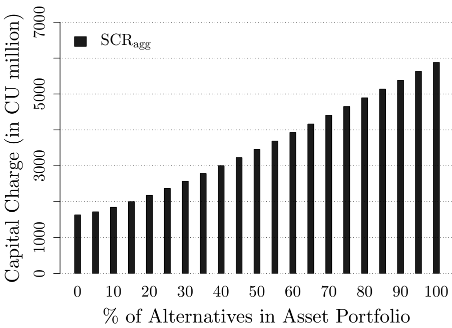
Appendix B



(a) Basel II



(b) Basel III



(c) Solvency II

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.

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