Institute of Insurance Economics
University of St.Gallen

Basel III Versus Solvency II: An Analysis of Regulatory Consistency under the New Capital Standards

Daniela Laas
Caroline Franziska Siegel

Working Papers on Risk Management and Insurance No. 132

Edited by Hato Schmeiser

Chair for Risk Management and Insurance

April 2016

Basel III versus Solvency II: An Analysis of Regulatory Consistency under the New Capital Standards

Daniela Laas and Caroline Franziska Siegel

This version: April 4th 2016

Abstract

This paper provides a critical analysis of the consistency of the standard approaches for market and credit risks under Solvency II and the current and forthcoming Basel III standards. The comparability is assessed both theoretically via a detailed comparison of the capital standards and in a numerical analysis that contrasts the capital charges for a stylized portfolio. Our examination reveals substantial discrepancies in the design of the frameworks. These lead to vastly differing capital requirements for the same risks. Moreover, the analysis indicates higher charges for banks than insurers, especially under the proposed new Basel III standard approaches.

Keywords: Basel III, Solvency II, Capital Requirements, Regulatory Arbitrage, Regulatory Consistency

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 strengthened from Basel II to Basel III. Similarly, over the past decade insurance regulators have developed a new risk-based solvency framework, Solvency II, which came into force in January 2016.

One of the primary goals of the supervisory authorities is to increase the stability of financial markets through consistent capital standards (see, e.g., BCBS, 2010c, and EC, 2014b). Cross-sectoral regulatory consistency postulates a conceptual compatibility of regulatory rules between the banking and insurance sectors and, as a result, comparable capital requirements for the same risks (see EC, 2003). Although regulatory consistency has several advantages such as lower efforts for multi-sector concerns and regulators (see Menezes, 2009), the main argument in favor of cross-sectoral consistency is the avoidance of regulatory arbitrage (see, e.g., BCBS, 2010c, and EC, 2014b). For example, 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, 2010c, p. 12). In the context of financial sector regulation, regulatory arbitrage can be described as the exploitation of different capital regulations by reallocating assets within a group of business entities to those units with the lowest capital charges (see, e.g., Freixas et al., 2007, and IAIS, 2012). These transfers reflect the profit-maximizing behavior of financial conglomerates which try to reduce the costs imposed by the regulatory requirements (see Nabilou, 2013).

Due to differences in their core business activities, banks and insurance companies are subject to different types of risks and their overall risk situations differ (see, e.g., Al-Darwish et al., 2011, and Gatzert and Wesker, 2012). Consequently, the regulators' goal does not imply comparability of the overall capital charges. However, both industries invest in part into the same asset classes and are therefore exposed to market and credit risks. For these risks similar rules are necessary in order to prevent financial conglomerates from circumventing parts of the regulation.

Motivated by the regulatory authorities' goal, this paper evaluates whether the Basel III and Solvency II standard approaches for market and credit risks are consistent. As well as the current Basel III rules, our analysis covers the proposals for the forthcoming Basel III market and credit risks frameworks (see BCBS, 2014c, and BCBS, 2014d). Based on a comprehensive description of the capital standards' design in the next section, we investigate the consistency theoretically and quantitatively. The numerical analysis implements the standard approaches for a European financial institution's stylized balance sheet and compares the resulting capital requirements. We also contrast the changes in the regulatory capital charges due to portfolio reallocations or the investment of newly raised capital.

A considerable body of literature can be found on Basel III, Solvency II, and the topic of bank and insurance regulation in general. We therefore focus on the two literature strings that are most important for our work: papers that deal with the regulatory goal of consistency and comparisons of regulatory frameworks. The concept of regulatory consistency is often discussed in the context of financial conglomerates, as they are the prime candidates for exploiting sectoral differences in regulation (see, e.g., Mälkönen, 2004, Darlap and Mayr, 2006, Freixas et al., 2007). Moreover, several studies analyse the advantages and drawbacks of globally uniform capital standards (see, Acharya, 2003, Morrison and White, 2009, Houston et al., 2012, among others). Opinions about the need for 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 equal treatment of financial sectors. In line with this reasoning, Monkiewicz (2007) and Herring and Carmassi (2008) discuss the possibility of an "integrated supervisor". On the other hand, Mälkönen (2004), Kupiec and Nickerson (2005), and Freixas et al. (2007), among others, argue that divergences and arbitrage opportunities, under certain conditions, can increase efficiency and social welfare.

When comparing different regulatory regimes, the majority of publications examine the current insurance frameworks (see, e.g., Eling and Holzmüller, 2008, Cummins and Phillips, 2009, Holzmüller, 2009, Höring, 2013, Braun et al., 2014). Cross-sectoral comparisons are rare. Furthermore, most papers that deal with the regulation of both sectors, such as Al-Darwish et al. (2011) and Gatzert and Wesker (2012), are limited to a qualitative comparison of the Basel Accords and Solvency II. A qualitative and quantitative cross-sectoral comparison is provided by Herring and Schuermann (2005), but they consider the First Basel Accord, the U.S. RBC Model, and the Net Capital Approach (for U.S. securities companies).[1]

Our paper contributes to the existing literature in several ways. First, in contrast to previous work, we focus on the standard approaches for market and credit risks. Thus we can address the consistency of methods and formulas for the calculation of the capital charges in more detail. Second, we also take into account the proposals for the forthcoming Basel III rules for market and credit risks. And third, the numerical analysis permits a quantification of the effects of the inconsistencies on the final capital charges.

The rest of our study is structured as follows: As a basis for the subsequent analyses, the next section describes the standard approaches for market and credit risks under Basel III and Solvency II. In the principal part of the paper (Section 3), we asses the cross-sectoral consistency from a theoretical perspective (Section 3.1) and in a comprehensive numerical analysis (Section 3.2). The last section provides our conclusion.

2 The Standard Approaches for Market and Credit Risks

2.1 Current Basel III Framework

The main Basel III Accord (see BCBS, 2010a, and BCBS, 2011a), was introduced at the end of 2010 and adopted in the European Union in 2013 (see EC, 2013a, and EC, 2013b). With regard to the Pillar 1 capital requirements for market and credit risks, the framework merely changes the standard approaches (for the asset classes considered in this paper, see Table 1), but introduces three new capital buffers (see BCBS, 2009, BCBS, 2011a, BCBS, 2011c).

[1] After the publication of the first version of our paper, Thibeault and Wambeke (2014) published a study that also contains a quantitative comparison of Basel III and Solvency II. However, in contrast to our work, their study seems to be oriented toward practitioners, and they do not contrast the detailed calculation methods. In addition, they neither consider the current Basel III market risk module nor the forthcoming Basel III standard approaches for market and credit risks.

Market Risks The capital requirements for market risks (CR_{mkt}) cover all assets in the trading book and are the sum of charges for interest rate risks, equity risks, foreign exchange rate risks, and commodity risks (for this subsection, refer to BCBS, 2006). We abstract from the latter two risk categories, as our stylized trading book only includes stocks and bonds, and we assume a perfect hedge with respect to exchange rate risk (this is in line with Braun et al., 2011). The requirements for interest rate and equity risks are composed of capital charges for issuer-specific risks based on the instruments' market values E_i and risk weights w_i

$$CR_{int,sp} = \sum_{i \in M} w_i \cdot |E_i| \qquad \text{and} \qquad CR_{equ,sp} = 0.08 \cdot \sum_{i \in M} |E_i| \tag{1}$$

and general market risks (M denotes the subset of instruments covered by the respective risk module). If the portfolio consists of long positions only and the maturity method is chosen for interest rate risks, the requirements for general market risks are given by:

$$CR_{int,gen} = \sum_{i \in M} \Delta r_i \cdot D_i \cdot E_i \qquad \text{and} \qquad CR_{equ,gen} = 0.08 \cdot \sum_{i \in M} E_i. \tag{2}$$

In the left equation, Δr_i is a predefined yield change for instrument i and D_i the asset's modified duration.

Credit Risks The charge CR_{cr} for credit risks is defined as 8% of the risk-weighted sum (with risk weights v_i) of the balance sheet values E_i (see EC, 2006) of all banking book positions (see, e.g., Van Roy, 2005):

$$CR_{cr} = 0.08 \cdot \sum_{i \in M} v_i \cdot E_i. \tag{3}$$

Capital Buffers The newly introduced capital conservation buffer (a buffer for periods of financial distress, see BCBS, 2011a), countercyclical buffer (required when an extreme credit expansion leads to an increase in system-wide risk, see BCBS, 2010b, and BCBS, 2011a), and buffer for so-called global systemically important banks GSIBs (see BCBS, 2011b) are certain percentages $\alpha^{CCB}, \alpha^{CC}, \alpha^{GSIB} \in [0, 2.5]$ of a bank's total risk-weighted assets $TRWA = 12.5 \cdot (CR_{mkt} + CR_{cr})$ (see BCBS, 2006).

Total Basel III Charge The final Basel III charge CR_{III} equals the sum of CR_{mkt}, CR_{cr}, and the three buffers, or, equivalently (see BCBS, 2006, and BCBS, 2011a):

$$CR_{III} = (8\% + \alpha^{CCB}\% + \alpha^{CC}\% + \alpha^{GSIB}\%) \cdot TRWA. \tag{4}$$

2.2 Forthcoming Basel III* Rules

The Basel Committee is planning to also renew the standard approaches. While the reform of the credit risk framework only entails a recalibration of the risk weights v_i in formula (3) (see BCBS, 2014d), a new sensitivity based approach (SBA) will be introduced for the calculation of CR_{mkt} (see BCBS, 2014c). In the following, the Basel Accord with these new approaches is referred to as Basel III*.

Under the SBA, CR_{mkt} is the sum of the requirements for seven risk types (for the SBA, refer to BCBS, 2014c): General interest rate risk, credit spread risk, equity risk, commodity risk, foreign exchange risk, default risk, and options-non-delta risk.[2] Except under the default risk module, the module specific capital charges are calculated as follows: In the first step, all securities are assigned to so-called risk buckets or a residual bucket. In the second step, the assets' sensitivities with respect to a set of predefined risk factors are computed. The third step is the calculation of a bucket-specific charge K_b for each bucket $\mathcal{B}_b, b \in \{1, ..., B, res\}$. For this, the net sensitivity S_k with respect to risk factor k is multiplied by a risk weight u_k.[3] The resulting risk-weighted sensitivities $WS_k = u_k S_k$ are then aggregated, taking correlations $\rho_{k,l}$ into account:

$$K_b = \sqrt{\sum_k WS_k^2 + \sum_k \sum_{l \neq k} \rho_{k,l} WS_k WS_l}. \tag{5}$$

In the final step, the capital charge CR_M for risk module M is derived by means of the following formula:

$$CR_M = \sqrt{\sum_{b=1}^{B} K_b^2 + \sum_{b=1}^{B} \sum_{c=1, c \neq b}^{B} \gamma_{b,c} S_b S_c} + K_{res}. \tag{6}$$

Here, $\gamma_{b,c}$ denotes the correlation between the buckets $\mathcal{B}_b$ and $\mathcal{B}_c$ and S_b the sum $S_b = \sum_k WS_k$.

Within the general interest rate risk and credit spread risk modules, the risk factors are the risk-free interest rates r_t and spreads cs_t at various tenors (or vertices) V_t. An instrument's sensitivity with respect to r_t (or cs_t) is defined as the change in the asset's present value due to an increase in r_t (cs_t) by 1 basis point (bp), divided by 1bp. For equity risks, each equity price corresponds to a separate risk factor and the sensitivity of an asset with respect to a risk factor is specified as the change in the asset's value in consequence of a decline in the equity price by 1 percent, divided by 1 percent.

The default risk module M^{def} covers a wide range of assets in the trading book, such as bonds, equity instruments, credit default swaps, and securitisations. Provided the portfolio only comprises long positions, the charge for default risks CR_{def} is defined as the risk-weighted sum (with risk weights u_i) of the jump-to-default (JTD) amounts of all instruments (for the calculation of the JTD, see BCBS, 2014c, and ISDA, 2014).

2.3 Solvency II

The Solvency II framework introduces a new risk-based capital regulation for the European insurance sector (for the entire section, refer to EC, 2014a, and EIOPA, 2014b). The target capital requirements (called SCR) are calibrated in accordance with a 99.5% value at risk of the "basic own funds " (BOF), the difference between assets (A) and liabilities (L) (excluding subordinated debt), over a period of one year.[4]

As a basis for the SCR calculation, the Solvency II rules require an economic valuation of the company's balance sheet positions. For this, assets and "other" liabilities (i.e., liabilities that are not technical provisions) have to be accounted in line with the fair valuation principle using mark-to-market or mark-to-model techniques. Technical provisions have to be valued according to the price the insurer would

[2]In line with the procedure in the previous section, we abstract from foreign exchange risks. Furthermore, in view of the asset classes included in our stylized asset portfolio, we do not give details for commodity and options-non-delta risks and consider the case of a portfolio of only long positions.

[3]In the case of our portfolio, the net sensitivity corresponds to the sum of all sensitivities with respect to r_t in the interest rate risk module and to the individual sensitivities in the credit spread and equity risk modules.

[4]The Solvency II framework also requires the calculation of so-called "minimum capital requirements" (MCR). As insurers have to fulfill the SCR requirement in order to not be subject to regulatory sanctions, we focus on the SCR.

have to pay to transfer the contract to another company. Thus, the value has to correspond to the sum of a best estimate and a risk margin (for details see, e.g., EIOPA, 2014b).

The calculation of the capital charges is split into various modules (including the modules for market and counterparty default risks) and submodules. In order to account for diversification effects, the requirements for different modules or submodules are aggregated by means of the general square-root formula:

$$SCR_{agg} = \sqrt{\sum_{L} SCR_L^2 + \sum_{L} \sum_{M \neq L} CORR_{L,M} \cdot SCR_L \cdot SCR_M}. \tag{7}$$

Here, SCR_L and SCR_M denote the charges for the different modules (or submodules) that have to be aggregated and $CORR_{L,M}$ the assumed correlation between the risks in (sub-)modules M and L.

Market Risk Module The Solvency II market risk module comprises interest rate risks, equity risks, property risks, spread risks, concentration risks, and currency risks.[5] The capital charges under the six submodules are calculated using a scenario-based approach and aggregated to SCR_{mkt} by means of a formula of type (7). Under the scenario-based approach, the assets A_i and liabilities L_j covered by submodule M are subject to specific shocks (stresses) s^M and the required capital SCR_M (before diversification) is defined as the resulting loss in BOF (see also Gatzert and Martin, 2012):

$$\begin{aligned} SCR_M &= \max\left\{\Delta(A-L)|s^M; 0\right\} \\ &= \max\left\{(A-L)-((A-L)|s^M); 0\right\} \\ &= \max\left\{\sum_{i\in M} \Delta A_i|s^M - \sum_{j\in M} \Delta L_j|s^M; 0\right\}. \end{aligned} \tag{8}$$

Under the equity risk, property risk, and spread risk modules the liabilities are not affected by the respective shocks. For property risks, the framework defines one single downward shock $s^{prop} < 0$ and $\Delta A_i|s^{prop} = -s^{prop} \cdot A_i$.[6] The equity risk module requires the calculation of two separate capital charges for "type 1 equities" (equities that are listed on organized capital markets in EEA and OECD countries) and "type 2 equities" (non-listed equities and alternative investments) by means of (8) and a subsequent aggregation using formula (7). For each equity type $k = 1, 2$, a specific downward stress $s^{equ,k} < 0$ has to be applied and $\Delta A_i|s^{equ,k} = -s^{equ,k} \cdot A_i$. Both shocks are the sum of base level stresses and symmetric adjustments based on the current value and long term average of the equity index (see EC, 2009, and CEIOPS, 2010). The spread shocks depend on the instrument i (e.g., the issuer's credit quality) and consist of two components $s_i^{spr,0} \geq 0$ and $s_i^{spr,1} > 0$. For bonds with a modified duration MD_i in the range $(5k; 5(k+1)]$, $k \in \{0, 1, 2, 3, 4\}$, the individual losses are defined as $\Delta A_i|s_i^{spr} = s_i^{spr,0} + s_i^{spr,1} \cdot (MD_i - 5 \cdot k)$.

The interest rate risk module requires the consideration of two scenarios: An upward shock $s^{int,up} > 0$ which increases the risk-free interest rate r_t at each maturity t by a factor $(1 + s_t^{int,up})$, and a downward stress $s^{int,down} < 0$ that reduces the interest rates r_t by $(1 + s_t^{int,down})$. Under each scenario $k \in \{up, down\}$, the changes $\Delta A_i|s^{int,k}$ and $\Delta L_j|s^{int,k}$ equal the changes in the assets' and liabilities' present

[5] Besides the currency risk module, we do not consider the concentration risk submodule. The latter does not require any capital for government bonds issued by EU or AAA to AA rated countries. In addition, we assume that the composition of the remaining asset classes in our stylized balance sheet (see Table 1) can be replicated by well-diversified capital market indices.

[6] In EC (2014a), the property shock is a positive value. For consistency reasons, in this paper upward stresses are defined as being positive and downward stresses as being negative. The formulas are adapted accordingly.

values due to the change in the interest rates (see also Gatzert and Martin, 2012). The company has to calculate the loss in BOF for both scenarios using (8) and the final charge for interest risks is the maximum of the two losses.

Counterparty Default Risk Module The counterparty default risk module covers the credit risk of several asset classes that are not contained in the spread risk module. The framework specifies separate capital charges for two types of exposures which are subsequently combined to SCR_{def} by means of a formula of type (7). The capital charge $SCR_{def,1}$ for the set of so-called type 1 exposures (including, among others, cash holdings), is given by:

$$SCR_{def,1} = \begin{cases} 3 \cdot \sqrt{V}, & \text{if } \sqrt{V} \leq 7\% \cdot LGD^{(1)}, \\ 5 \cdot \sqrt{V}, & \text{if } 7\% \cdot LGD^{(1)} \leq \sqrt{V} \leq 20\% \cdot LGD^{(1)}, \\ LGD^{(1)}, & \text{else.} \end{cases} \tag{9}$$

Here, $LGD^{(1)}$ denotes the sum of the loss given defaults LGD_i of all type 1 instruments and V the variance of the loss distribution of this group of assets. The latter depends on the loss-given-defaults LGD_i and probabilities of default PD_i of the single positions and is specified in the EIOPA (2014b, pp. 180/181).

The capital requirement $SCR_{def,2}$ for type 2 securities such as residential mortgage loans is defined as:

$$SCR_{def,2} = 0.9 \cdot \sum_{i \in M^{def,2,>3m}} LGD_i + 0.15 \cdot \sum_{i \in M^{def,2,\leq 3m}} LGD_i, \tag{10}$$

with $M^{def,2,>3m}$ ($M^{def,2,\leq 3m}$) indicating the subset of type 2 receivables from debtors that have been outstanding for more than three months (not more than three months). For a residential mortgage loan with market value A_i and risk-adjusted value M_i^{adj} (see EIOPA, 2014b, pp. 192/193), the LGD is calculated by:

$$LGD_i = \max\{A_i - 0.8 \cdot M_i^{adj}; 0\}. \tag{11}$$

Final SCR After calculating the capital charges for all risk modules (i.e., also those modules that are not considered in our paper), the final SCR has to be determined.[7] For this, the module-specific charges are aggregated to the Basis Solvency Capital Requirement (BSCR) by means of formula (7) and an addition of the charge for intangible asset risks (not considered here). Subsequently, the charge SCR_{op} for operational risks (not considered here) and adjustments $Adj_{TP} < 0$ and $Adj_{DT} < 0$ for the loss absorbing capacity of technical provisions and deferred taxes (see EIOPA, 2014b) are added to the BSCR:

$$SCR = BSCR + Adj_{TP} + Adj_{DT} + SCR_{op}. \tag{12}$$

[7] Although we focus on the capital standards for market and counterparty default risks, we have to consider these steps in part, as these lead to a substantial reduction of the capital requirements. For example, based on the QIS 5 results (see EIOPA, 2011), Höring (2013) derives a reduction of the market risk charge by around 18% due to the diversification effect between the different risk modules.

3 Regulatory Consistency of Basel III/III* and Solvency II

3.1 Theoretical Assessment

3.1.1 Current Basel III versus Solvency II

We start our analysis of regulatory consistency with a comparison of the general structure of the capital standards for market and credit risks (for this section, refer to BCBS, 2006, BCBS, 2011a, EIOPA, 2014b). Under the Basel Accords, the capital requirements exclusively refer to the asset side, i.e., liability risks are not taken into account under Pillar I (see also Al-Darwish et al., 2011, and Gatzert and Wesker, 2012). The market risk module covers all assets in the trading book and currently comprises interest rate, equity position, foreign exchange, and commodities risks. The credit risk framework applies to all assets in the banking book and the standard approach differentiates between thirteen asset classes or "claims" to assign risk weights. In contrast, Solvency II considers all balance sheet positions (i.e., assets and liabilities, see also Al-Darwish et al., 2011, and Gatzert and Wesker, 2012). Moreover, under Solvency II, the large majority of assets are subjected to the market risk module, whereas the credit (i.e., the counterparty default) risk module only refers to a small part of the positions on the asset side.[8] The Solvency II market risk module also consists of two more submodules (the spread and concentration risk submodules) than the Basel III market risk framework (see also Gatzert and Wesker, 2012).

To calibrate parameters, the two frameworks both use the value at risk, but rely on different quantile levels. The Basel III framework seeks a 99% value at risk for market risks and a 99.9% value at risk for credit risks (see Gatzert and Wesker, 2012). In contrast, Solvency II considers the company as a whole and requires a 99.5% value at risk of BOF (see also Gatzert and Wesker, 2012).

The capital charges for equity risks of stocks are calculated similarly under the current Basel III and Solvency II market risk frameworks, by multiplying the market values with certain percentages. However, while the size of the Solvency II equity shocks depends on the development of the equity index (due to the symmetric adjustment mechanism), the risk weights for equity investments under Basel III are fixed. Moreover, the Basel Accords require separate charges for issuer-specific and general market risks.

The requirements for interest rate risk represent several conceptual differences: First, the Basel Accord's market risk module again distinguishes between a specific and general capital charge. Second, while Basel III defines the general capital requirement for a bond as the product of the bond's market value, its duration, and a fixed absolute yield change, Solvency II calculates the change in an asset's present value due to a shock to the whole risk-free interest rate curve. Thus, the Solvency II capital standards do not assume flat yield curves (as is implicitly done under Basel III). As Solvency II only fixes the relative yield changes, the absolute increases or decreases further depend on the current risk-free rates. Third, Solvency II accounts for the liabilities' interest rate sensitivity and defines the total requirement for interest rate risk as the net loss in asset and liabilities due to the stress scenario. Finally, under the Basel Accords, interest rate risk for bonds in the banking book is not taken into account under Pillar I.

As mentioned before, the Basel III framework does not define a separate charge for spread risks. Instead, spread risks are implicitly taken into account by means of issuer- and rating-dependent specific

[8]According to Höring (2013), around 75% of the assets on the QIS 5 balance sheet (see EIOPA, 2011, p. 36) are subsumed under the market risk module and around 15% under the credit risk module (10% are "other assets").

risk weights in the interest rate module. Conversely, the Solvency II framework specifies a separate charge for this risk type and the spread shock linearly depends on the bond's maturity.

With respect to the credit risk module, the standardized model of Basel III defines capital charges as the product of fixed risk weights and the securities' values. The Solvency II regime, in contrast, uses complex formulas that incorporate the loss given default, among others. Thus, the calculation of the capital requirements for asset classes that are subjected to the credit risk modules under both frameworks differs fundamentally (e.g., for residential mortgage loans, see also Thibeault and Wambeke, 2014).

The comparability of the calculation of the capital requirements for assets that are covered by the market risk module under Solvency II and the credit risk framework under Basel III varies. Stocks, alternative investments, and real estate investments receive a similar treatment, as the capital charges are defined as the product of a position's value and a given risk weight or stress factor. Conversely, the structure of the Basel III charge for a bank's bonds in the banking book (risk weight times amortized cost or fair value) is completely different from the structure of the SCR for bond holdings under (the interest rate and spread risk modules of) Solvency II.

Under Basel III, the capital charges for market and credit risks are supplemented by three additional capital buffers. The Solvency II framework does not contain comparable rules. Instead, the capital requirements are reduced by the loss-absorbing capacity of technical provisions and deferred taxes.[9]

The aggregation method for individual charges and thereby the recognition of diversification effects is another conceptual difference (see also Gatzert and Wesker, 2012). On the one hand, the Basel standard approach simply totals the risk-weighted positions. Thus, perfect correlation is assumed at each stage of the calculation. On the other hand, Solvency II aggregates the capital charges at the different levels by means of square-root formulas using (imperfect) correlations. In doing so, diversification between different risks and risk categories is taken into account.

A comparison of the parameter settings is difficult, as the Solvency II BSCR, i.e., the capital charge after consideration of all diversification effects, is considerably lower than the sum of the individual charges (see EIOPA, 2011, and EC, 2014b). However, a few conclusions are possible, in particular with respect to the asset classes' rank orders as implied by the stand-alone capital requirements. If the capital standards are consistent, these should be similar under both frameworks (see EC, 2014b).

On the whole, the ranking of security types is comparable under Solvency II and Basel III, as the lowest amount of capital is required for highly-rated government bonds, relatively low capital must be held for corporate bonds with investment grade rating, medium charges are necessary for property holdings, and high risk weights and stress factors are assigned to equities and alternative investments. A detailed analysis further shows that the two frameworks agree in requiring no charge for credit / spread risks of government bonds with rating AAA or AA. Thus, apart from interest rate risks, these bonds are considered risk-free by the regulatory authorities of both sectors.

[9] At the request of the G20 countries, the Financial Stability Board (especially the IAIS) is developing a framework with enhanced qualitative and quantitative requirements for global systemically important insurers (GSIIs) (see, e.g., Financial Stability Board, 2013, and IAIS, 2013). However, while the buffer for GSIBs is an integral part of Basel III, the new measures for GSIIs are separate from Solvency II.

In addition to these similarities, some discrepancies can also be found. For example, while the capital requirements for hedge funds and private equity exceed those for stocks under Solvency II, more capital is necessary for traded stocks (in total 16%) than for alternative investments (12%) under Basel III. Moreover, for some rating categories, the Basel Accords define lower risk weights for bonds issued by banks compared to bonds from non-financial companies. This preferential treatment of claims on banks does not exist under the capital regime for the European insurance industry.

Identical calculation formulas and parameters can only lead to equal capital charges if the same accounting principles are applied to determine the assets' values. On the one hand, the Basel Accords use both fair values (for assets in the trading book and some in the banking book) and amortized costs (for a part of the securities in the banking book) (see Al-Darwish et al., 2011). On the other hand, the Solvency II capital charges are exclusively based on economic values. These are to a large extent calculated by means of the IFRS rules for fair valuation, but there are also some deviations (see Al-Darwish et al., 2011). Thus, differences arise for some instruments that are evaluated at market value under both frameworks and for assets that are carried at amortized cost under Basel III.

3.1.2 Forthcoming Basel III* versus Solvency II

The reform of the Basel Accord's standard approaches for market and credit risks might lead to some alignment in the capital regulation for banks and insurance companies. However, some substantial discrepancies will persist and new inconsistencies are introduced (for this section, refer to BCBS, 2014c, BCBS, 2014d, EIOPA, 2014b).[10]

An improvement in the specification of the boundary between the trading and banking book might lead to some changes in the trading book - banking book allocation, but the general scopes of the market and credit risk frameworks will persist. Thus, the scope of application of the market risk module will remain fundamentally different under Basel III* and Solvency II. Some harmonization of the risk classification schemes of the standard approaches for market risks will result through the introduction of a separate risk module for spread risks under the SBA approach. However, unlike the Solvency II framework, the SBA approach also takes spread risks of sovereign bonds from EEA countries with non-zero credit spreads into account. Moreover, the future Basel III* market risk framework will also comprise a separate submodule for default risks (which does not exist under Solvency II), but no concentration risk module.

The reform does not lead to an alignment of the applied risk metrics. While the Basel III* market risk framework relies on the 97.5%-expected shortfall, a 99.5%-value at risk is used under Solvency II. The impact of this inconsistency on capital charges depends on the underlying distribution. For light-tailed distributions such as the normal distribution, the Basel III* risk measure should lead to lower capital requirements.[11] If the underlying distribution has very heavy tails, the 97.5%-expected shortfall may exceed the 99.5%-value at risk. As the new Basel III* credit risk weights are calibrated so as to increase their consistency with the IRB weights, a 99.9%-value at risk is targeted by the new proposals.

With the introduction of the new Basel III* rules for the trading book, the standard approaches for market risks will be consistent insofar as the stand-alone capital charges are derived from the securities'

[10]In this subsection, we only address those elements of the frameworks that will be changed under Basel III*.

[11]For the normal distribution, the 97.5%-expected shortfall approximately corresponds to the 99%-value at risk (see also BCBS, 2013).

losses in value due to predefined shocks. Nevertheless, the specific methods differ. On the one hand, the SBA approach defines for each submodule (except the default risk module) one single shock that equally applies to all risk factors. For each position, the bank has to determine the induced loss in value and the capital charge results from weighting this loss by means of a specific risk weight. This risk weight depends on the characteristics of the underlying instrument, such as the credit quality and sector of the issuer in the spread risk module. On the other hand, the Solvency II framework specifies several shocks for each risk module (e.g., issuer-type- and issuer-rating-dependent shocks in the spread risk framework). These shocks are applied to the instruments and the capital charges are defined as the resulting losses. Thus, the instrument-specific characteristics are incorporated into the stress factors and no risk-weighting applies after the calculation of the value changes.

For equity risks of stocks, these differences are not substantial and the undiversified capital charge equals the product of the position's market value and the SBA risk weight / Solvency II stress. By contrast, the calculation of the requirements for interest rate and spread risks exhibits marked differences. Under Solvency II, the risk-free yield curve is stressed at all maturity points simultaneously and a position's stand-alone capital charge for interest rate risks is defined as the resulting loss in present value. The new Basel III* interest rate risk module chooses a different approach, as the yield curve is shocked at each maturity point separately (for a given set of maturity points). Thus, a series of changes in present value has to be determined and subsequently aggregated. For spread risks, the Solvency II capital charges for a bond investment correspond to the product of the market value and a stress factor, which is a function of the bond's rating and modified duration, whereas the SBA approach is similar to that for interest rate risks.

The Basel III* credit risk module will maintain the current definition of capital charges as the product of risk-weight and balance sheet value. Therefore, the (in)consistencies between the formulas for the capital charges for asset classes covered by the credit risk module under the Basel Accords will persist.

At first glance, the methods for the aggregation of the individual charges under the SBA approach and the Solvency II market risk module seem quite similar: Both frameworks take diversification effects into account and use similar square-root aggregation formulas. However, these aggregation approaches are applied at different levels. Under Basel III*, the square-root formula is used within the market risk submodules in order to merge the charges for individual instruments and the bucket-specific charges. The requirements of the various submodules as well as the charges for market, credit, and operational risks are then added up, i.e., imperfect correlations are neglected at this stage. In contrast, under Solvency II, the individual charges within the submodules are simply added up and the square-root formula is applied for the aggregation of the capital requirements for the different submodules and modules.

Finally, the parameter setting implies a comparable rank order of asset classes under the two frameworks, but a considerably stronger risk differentiation under Basel III*. For example, the SBA equity risk submodule distinguishes 10 risk categories (buckets) in order to assign the risk weights, in contrast to one single shock for all listed equities under Solvency II.

3.1.3 Eligible Capital

The capital requirements are only one side of the coin. The rules for determining a company's capital that can be used to fulfill the regulatory capital requirements (so-called eligible capital) are equally important. For example, 20% higher capital charges for banks could be compensated if the amount of capital according to Basel III/III* exceeded the capital calculated under Solvency II by 20%. Furthermore, as the costs of capital depend on the type of capital instrument, the requirements surrounding the quality of a company's capital items are relevant (see Al-Darwish et al., 2011).[12]

The calculation of a company's capital differs substantially between the frameworks. Under Solvency II, capital (called own funds) is defined as the sum of basic own funds (= assets - liabilities + subordinated debt) and ancillary own funds (see, e.g., Lord, 2014). The latter are certain off-balance sheet capital instruments that can be called-up to compensate losses (see, e.g., Al-Darwish et al., 2011). Thus, the main part of an insurer's capital (the BOF) is derived indirectly from the economic balance sheet (see Schwarze, 2011). In contrast, a bank's amount of capital is determined by directly adding up the value of the various types of capital that meet the criteria to be included into Tier 1 or Tier 2 (see below) (see Schwarze, 2011).

As the capacity to absorb losses varies between different types of capital (see Al-Darwish et al., 2011), the frameworks classify capital instruments into different tiers and specify concrete limits for the consideration of low-quality capital items (for the descriptions of the tiers, refer to BCBS, 2011a, and EIOPA, 2014b). Under both Basel III/III* and Solvency II, Tier 1 capital comprises capital of the highest quality (e.g., common shares), and similar criteria are used to define eligible instruments. Moreover, both regulatory regimes distinguish two comparable sub-categories of Tier 1 Capital (see also Al-Darwish et al., 2011): Common Equity Tier 1 (Basel) or unrestricted Tier 1 capital instruments (Solvency), which are not limited, and Additional Tier 1 (Basel) or restricted Tier 1 items (Solvency), which can only be used to cover the required capital charge to a certain extent. However, an in-depth comparison reveals several differences in the details (see also Al-Darwish et al., 2011). For example, in contrast to the Third Basel Accord, Solvency II allows the inclusion of paid-in subordinated liabilities in Tier 1. The Solvency II framework also does not require called-up instruments to be replaced by capital items of the same or higher quality - a precondition for repayments of Additional Tier 1 instruments under Basel III/III*.

Substantial discrepancies exist with regard to the remaining tiers (see also Al-Darwish et al., 2011). In particular, while the regulatory regime for the banking sector only takes one additional tier into account, the framework for European insurers considers two more tiers of capital. Furthermore, unlike Basel III/III*, Solvency II accepts both the inclusion of called-up but not paid-in instruments (if the payments are made within three months), and the consideration of uncalled off-balance sheet instruments (Ancillary Own Funds).

As shown in detail by Al-Darwish et al. (2011), the Basel III/III* and Solvency II rules also require different adjustments in the calculation of eligible capital. Among others, under the Basel Capital Accord, Common Equity Tier 1 (CET1) capital has to be reduced by the amount of deferred tax assets that are based on a financial institution's future profitability. According to the Basel III monitoring report from September 2014, this has led to a decrease in CET1 capital of "group 1" banks (i.e., internationally active banks with CET1 capital above EUR 3 billion) of 2.4% (see BCBS, 2014a). In contrast, deferred tax

[12] For a detailed comparison of eligible capital under Basel III/III* and Solvency II, see also Al-Darwish et al. (2011). However, some details in the Solvency II rules have changed in the meantime.

assets may be considered under Tier 3 of Solvency II. In total, the Basel Accord's regulatory adjustments result in a reduction of CET1 capital by 20% (see BCBS, 2014a). Without the deduction of goodwill, CET1 is reduced by 8.8% and the sum of Tier 1 and Tier 2 capital by around 7.6%.[13,14] This decrease substantially exceeds the relative reductions under Solvency II (3% of BOF without adjustments in QIS 5, see EIOPA, 2011).

The Third Basel Accord also requires substantially higher proportions of Tier 1 capital than Solvency II. According to BCBS (2011a), banks have to hold Tier 1 capital of at least $(6\%+\alpha^{CCB}\%+\alpha^{CC}\%+\alpha^{GSIB}\%)$ of TRWA (see BCBS, 2011a). Typically, $\alpha^{CCB} = 2.5$. Thus, depending on the size of the countercyclical buffer and degree of systemic importance ($\alpha^{CC}, \alpha^{GSIB} \in [0, 2.5]$), between 81% and 87% of the Basel capital requirements must be covered by Tier 1 instruments (see equation (4)). The remaining part of the capital charge can be held in the form of Tier 2 capital. Under Solvency II, only 50% of the SCR has to be made up of items belonging to Tier 1 (see EIOPA, 2014b). The remaining proportion of the SCR can consist of Tier 2 and Tier 3 items, with Tier 3 instruments amounting to 15% or less of total SCR (see EIOPA, 2014b).

Our quantitative analysis in the following section focuses on the comparability of the amounts of required capital. However, we again emphasize that the calculation of eligible capital and accounting rules are also very important. Assume, for example, that a decline in credit spreads causes an increase in market value of some corporate bonds that are held at amortized costs in the bank's banking book. In this case, the Basel III/III* capital charges remain unchanged and the bank builds up undisclosed reserves, which may not be included in its Tier 1 capital (see BCBS, 2011a). Moreover, the Third Basel Accord does not include measures that are comparable to the Solvency II volatility adjustment (see below) and that cause a change in the value of liabilities. Under Solvency II, in contrast, the decline in credit spreads would lead to an increase in the value of total assets on the insurer's economic balance sheet. In addition, the economic value of liabilities may increase due to a reduction in the volatility adjustment.[15] If the rise in the value of assets exceeds the increase in the value of liabilities, the insurance company's BOF will increase. As reconciliation reserves are accepted as Tier 1 capital under Solvency II (see EIOPA, 2014b), the insurer has more Tier 1 capital to meet the regulatory capital requirements. These also change, as the capital charges for interest rate and spread risks are calculated based on increased asset and liability values.

3.2 Numerical Evaluation

3.2.1 Stylized Balance Sheet

As a basis for the implementation and numerical comparison of the capital standards, we first define the economic balance sheet of a stylized European life insurer (see Table 1).

[13] The report by BCBS (2014a) shows a deduction for goodwill of 11.2%. This proportion is not taken into account, as Solvency II assigns no value to goodwill, implying that there is no need for reductions of basic own funds for goodwill (see Al-Darwish et al., 2011).

[14] This percentage is calculated as follows: According to BCBS (2014a), CET1 capital and total capital on average amount to 10.2% and 11.9% of TRWA, respectively (for group 1 banks). Assuming a ratio of CET1 capital to total capital of $0.86 \approx 10.2/11.9$, a reduction of CET1 by 8.8% implies a reduction in total capital of around 7.6%.

[15] The volatility adjustment is an add-on to the risk-free rates used to calculate the economic value of technical provisions. It is meant to reduce the volatility of the economic balance sheet by reducing the effect of changes in credit spreads (see, e.g., EC, 2015). For details, see EIOPA (2014c).

Assets	Maturity	% of Total Assets	Asset Value	Face Value	Coupon Rate	Modified Duration
Stocks	–	9.0%	900.0	–	–	–
Government Bonds	–	35.0%	3500.0	–	–	–
German Government Bonds	1 Year	1.4%	140.0	137.6	1.67%	1.0
German Government Bonds	5 Years	7.3%	728.0	670.7	1.88%	4.8
German Government Bonds	10 Years	9.1%	910.0	712.2	3.63%	8.7
German Government Bonds	15 Years	3.4%	336.0	197.2	6.25%	11.2
German Government Bonds	20 Years	3.4%	336.0	212.4	4.75%	14.6
German Government Bonds	30 Years	3.5%	350.0	288.4	2.50%	22.0
U.S. Government Bonds	1 Year	0.4%	35.0	34.3	2.25%	1.0
U.S. Government Bonds	5 Years	1.8%	182.0	172.5	2.61%	4.7
U.S. Government Bonds	10 Years	2.3%	227.5	179.0	5.10%	8.2
U.S. Government Bonds	15 Years	0.8%	84.0	55.7	6.35%	10.8
U.S. Government Bonds	20 Years	0.8%	84.0	60.4	4.97%	13.9
U.S. Government Bonds	30 Years	0.9%	87.5	82.3	3.04%	19.9
Corporate Bonds	–	38.0%	3800.0	–	–	–
EU IG Corporate Bonds	1 Year	5.2%	524.4	506.0	4.05%	1.0
EU IG Corporate Bonds	5 Years	10.6%	1060.2	936.5	3.59%	4.6
EU IG Corporate Bonds	10 Years	13.3%	1333.8	1153.7	3.35%	8.6
EU IG Corporate Bonds	15 Years	8.8%	881.6	756.3	3.44%	12.0
Mortgage Loans	–	6.0%	600.0	–	–	4.87
Real Estate	–	4.0%	400.0	–	–	–
Alternative Investments	–	2.0%	200.0	–	–	–
Hedge Funds	–	1.0%	100.0	–	–	–
Private Equity	–	1.0%	100.0	–	–	–
Cash at Bank	–	6.0%	600.0	–	–	–
Total	–	100.0%	10000.0	–	–	–

Equity and Liabilities	% of Total Assets	Absolute Value	Modified Duration
Life Insurance Liabilities	87%	8700.0	9.0
Basic Own Funds	13%	1300.0	–
Total	100%	10000.0	–

Table 1: Stylized Economic Balance Sheet

This table shows the life insurer's stylized economic balance sheet. The market and face values of assets and the values of liabilities and BOF are given in CU million. The asset portfolio is also used to calculate the Basel III/III* charges.

The value of total assets and total liabilities is set at 10 CU billion, the approximate average balance sheet total (EUR 9,730,449,000) of German life insurers in 2013 (see BAFIN, 2015, Table 100). In order to determine the general structure of the asset portfolio, we rely on the average composition of a large European insurance company's investment portfolio calculated by EIOPA (2014a) for the end of 2013. As we do not have further information about the category of other investments, we assume that a small proportion are alternative investments. The remainder is omitted and the portfolio weights of the other asset classes are rescaled such that all weights sum up to 100%. We also slightly simplify some asset classes. Thus, we obtain the following portfolio structure: 35% government bonds, 38% corporate bonds, 9% stocks, 4% property, 6% cash at bank, 6% residential mortgage loans, and 2% alternative investments.

The report by EIOPA (2014a) does not provide information on the exact composition of the subportfolios. For government bonds, we assume that 80% and 20% are issued by Germany and the U.S., respectively. These percentages equal the proportions of EU and non-EU sovereign debt in the portfolio derived by Höring (2013). Moreover, we assume that the portfolio only comprises bonds with annual coupon payments and maturities m of 1, 5, 10, 15, 20, or 30 year(s). In order to obtain appropriate maturity distributions, we adapt the empirically derived maturity distributions in Höring (2013) to our discrete maturities. The coupon rate for German government bonds with a maturity of m years is determined by averaging the coupons of German Federal bonds expiring in the second half of the year $2014 + m$, as reported by the German Federal Agency. The coupons for the classes of U.S. government bonds are calculated similarly, using the year-end interest rates for U.S. Treasury Bonds provided by the Federal Reserve System. Based on the asset value (i.e., the present value), the coupon rate, and the corresponding yield curve, we further calculate the associated nominal value for each bond class. The yield curves are given by the spot rates for AAA-rated euro area government bonds and U.S. Treasury bonds (as of 28/11/2014), as estimated by the European Central Bank and the U.S. Treasury Department, respectively. Finally, we also determine the bonds' yield-to-maturities and the respective modified durations.

As insurers rarely invest in high yield corporate bonds (see, e.g., Höring, 2013, and Assekurata, 2014), our reference portfolio only comprises (EUR dominated) investment grade rated corporate bonds. Furthermore, we assume a sector composition in accordance with the Bloomberg EUR Corporate Bonds Index (BERC) as of 28/11/2014 and maturities of 1, 5, 10, and 15 years, only. The annual coupon payments are approximated using the par-weighted average coupons calculated for the BERC indices for the different maturity ranges. Accordingly, we use the spreads for the BERC term indices as proxies for the spreads of the four classes of corporate bonds and derive the corresponding yield curves by adding the spreads to the risk free curve for the eurozone. The nominal values, yield-to-maturities, and modified durations are computed as in the case of government bonds.

In line with Braun et al. (2011) and Braun et al. (2014), among others, we use a stock market index as a proxy for the equity portfolio. In our work we choose the DAX30. Furthermore, all cash is assumed to be held at banks with investment grade ratings, and only real estate investments are taken into account in the "property" category. For residential mortgage loans, the modified duration is set at 4.87 (see Assekurata, 2014). Moreover, as most European countries have legal upper limits for the loan-to-value (LTV) ratio of 80% or less, we assume the following LTV ratio distribution: 30% of loans with an LTV of 40%, 40% with an LTV of 60%, and 30% with an LTV of 80%. In accordance with Höring (2013), the subportfolio of alternative investments consists of equal proportions of hedge funds and private equity.

The general structure of the liability side is chosen in accordance with the composition in the QIS 5 economic balance sheet (see EIOPA, 2011, p. 37). Thus, the proportions of liabilities (technical provisions and other liabilities) and BOF are set at 87% and 13%, respectively. Moreover, we assume a liability duration of 9. This value approximately corresponds to the median of the liability durations of European life insurers according to the QIS 4 study (see CEIOPS, 2008) and is also used by EIOPA (2013).

The asset portfolio in Table 1 represents a stylized version of a European life insurer's investment portfolio. Although the portfolio weights might be different, banks also invest into the selected asset classes. Thus, the same asset portfolio can be used for the calculation of the Basel III/III* capital charges. However, the Basel capital requirements are based on the assets' fair values or amortized costs and not on their economic values (see Al-Darwish et al., 2011). In our first calculations, we abstract from this difference and calculate the Basel III/III* capital using the asset values in Table 1. As the Basel Pillar I capital requirements are independent of the liability side, no assumption about the bank's liabilities is necessary.

In order to calculate the Basel III/III* capital charge, we have to determine the trading book composition of the asset portfolio. According to the European Central Bank (2014), the proportion of assets held for trading varies considerably between small (2%), medium-sized (4%), and large banks (19%) in the euro area. As regulatory arbitrage is more likely to occur in large financial institutions, we assume a share of traded assets of 15%. We use a proportion below 19%, as this value includes the proportion of traded derivative instruments. An analysis of the GSIBs' annual reports further shows that the equity-to-debt ratio substantially differs among large banks. Due to the small proportion of stocks in our portfolio, we assume that the trading book consists of 1/3 stocks and 2/3 bonds. Thus, $55.6\%(=\frac{15\%\cdot 33.3\%}{9\%})$ and $13.7\%(=\frac{15\%\cdot 66.7\%}{73\%})$ of the bank's stocks and bonds (of each category) are assigned to the trading book, respectively.

3.2.2 Parameter Calibration

The implementation of the capital standards requires the derivation of the parameters for our reference portfolio. Table 2 gives an overview of the Basel III/III* and Solvency II risk weights and stress factors derived for our portfolio. For the correlation matrices, we refer to BCBS (2014c) and EC (2014a).

Current Basel III In their current version and for the asset classes considered in our portfolio, the Basel III standard approaches for market and credit risks maintain the Basel II calibration (for this subsection, refer to BCBS, 2006). The market risk weights w_i for the calculation of $CR_{int,sp}$ depend on the bond type, its rating, and for some categories also the maturity. According to Standard&Poor's, Germany and the U.S. qualify for the rating classes AAA and AA+, respectively (at the end of the year 2014). Thus, we obtain $w_i = 0\%$ for German and U.S. government bonds. For investment grade rated corporate bonds with a maturity of 1 year (more than one year), the weight is $w_i = 1.00\%$ ($w_i = 1.60\%$).

To calculate the general interest rate risk charge $CR_{int,gen}$, the Basel Committee has specified yield changes Δr_i for 15 duration bands. The required shocks Δr_i for the sixteen bond categories in the stylized balance sheet are therefore determined based on the calculated modified durations.

The supervisory risk weights v_i for the calculation of CR_{cr} are given within the credit risk module. For cash, residential mortgage loans, stocks, hedge funds, and private equity, the BCBS requires weights of 0%, 35%, 100%, 100%, and 150%, respectively. The 100% weighting for real estate has not changed compared to the Basel I framework (see BCBS, 1988). For bonds from AAA and AA+ rated countries, no charge is required, i.e., $v_i = 0\%$. The risk weights for corporate bonds vary between bonds issued by banks and non-banks. Based on the sector composition of Bloomberg's BERC index as of 28/11/2014, we set the proportion of corporate bonds issued by banks to 43.62%. The risk weights for claims on banks have to be chosen based on the rating of either the countries in which they are incorporated or of the banks themselves. Assuming that the second option is used, we calculate $v_i = 40\%$ by averaging the weights for the three highest rating categories. Similarly, $v_i = 56.67\%$ is derived for bonds issued by non-banking companies.

In order to calculate the Basel III capital requirements, we also have to choose the parameters for the capital buffers. As the capital conservation buffer should always amount to 2.5% of total risk-weighted assets and reductions are only possible in times of distress (see BCBS, 2011a), we set $\alpha^{CCB} = 2.5$. The parameter $\alpha^{CC} \in [0, 2.5]$ for the countercyclical buffer depends on the credit growth and other indicators (see BCBS, 2010b). In our calculations, we use $\alpha^{CC} = 1.25$. Moreover, we calculate the buffer for GSIBs for both $\alpha^{GSIB} = 0$ (i.e., a non-GSIB) and $\alpha^{GSIB} = 2.5$ (i.e., a GSIB with the highest degree of systemic importance according to the classification of the Financial Stability Board, 2014).

Forthcoming Basel III* The calibration of the SBA approach comprises the assignment of assets to risk buckets, the determination of the risk weights, and the derivation of the correlations ρ and γ. Our calibration is based on the Basel Committee's Consultative Document of December 2014 (see BCBS, 2014c).

Under the interest rate risk module, separate buckets are required for each of the main currencies. For our portfolio, this implies one bucket for the classes of German government and EU corporate bonds and another for U.S. government bonds. The risk weights u_k decrease from 160bp for vertex $V_t = 0.25$ years to 100bp for $V_t = 30$ years. In order to derive the bucket-specific charges, the sums of the weighted sensitivities at each of the 10 vertices are aggregated by means of a 10×10 correlation matrix. The total charge for interest rate risks is derived based on a uniform correlation $\gamma_{bc} = 0.5$ for each currency pair (b, c).

The spread risk module defines 12 buckets that classify spread sensitive instruments according to the issuers' ratings and sector affiliations. In order to account for the diversification effects that are assumed between single bonds, we assume that the value of each of our four subportfolios of corporate bonds is equally distributed among 1,762 issuers, the number of members of the BERC index as of 28/11/2014. Furthermore, we assign the bonds to the relevant buckets based on the sector composition of the BERC index. The German and U.S. government bond holdings are not subject to the spread risk module, as these securities are considered to involve no spread risk.[16] The risk weights only vary between buckets, not between vertices. For our portfolio, the weights range between 200bp and 500bp. Within each bucket, the sensitivities are merged using the correlation $\rho_{k,l} = 0.9$ if the sensitivities refer to exposures of the same name, and $\rho_{k,l} = 0.4$ otherwise. The correlations $\gamma_{b,c}$ are specified in a 12×12 correlation matrix.

For equity risks, 10 buckets categorize equity instruments based on the issuer's sector, market capitalization, and region (emerging or advanced market). Using the Global Industry Classification Standard (GICS), we assign the stocks issued by the DAX30 companies to the corresponding buckets.[17] Both the risk weights u_k and the correlations $\rho_{k,l}$ vary between the buckets. Moreover, for each bucket combination (b, c), an individual correlation coefficient $\gamma_{b,c}$ is defined in a 10×10 correlation matrix.

As the basis for the calculation of the capital charge for default risks of bonds in the trading book, we choose a loss given default of 75%, the regulatory value for senior debt. The risk weights depend on the issuer's credit quality and total 0.5% for AAA rated (and thus German government) bonds and 2.0% for

[16] This information was provided by an expert in the SBA approach.

[17] There is no bucket for companies in the health sector. In accordance with ISDA (2014), we think that the bucket specification is incomplete and that stocks issued by the health industry should not be allocated to the residual bucket with the highest risk weight. As the standard deviation of the returns of the MSCI Europe Health Care Index and the MSCI Europe Utilities Index are quite similar, we assign stocks from the health industry to the bucket specified for the utility sector.

Basel III Market Risk

Interest Rate Risk	w_i	Δr_i
GER Gov. Bonds 1Y	0.0	0.9
GER Gov. Bonds 5Y	0.0	0.7
GER Gov. Bonds 10Y	0.0	0.6
GER Gov. Bonds 15Y	0.0	0.6
GER Gov. Bonds 20Y	0.0	0.6
GER Gov. Bonds 30Y	0.0	0.6
U.S. Gov. Bonds 1Y	0.0	1.0
U.S. Gov. Bonds 5Y	0.0	0.7
U.S. Gov. Bonds 10Y	0.0	0.6
U.S. Gov. Bonds 15Y	0.0	0.6
U.S. Gov. Bonds 20Y	0.0	0.6
U.S. Gov. Bonds 30Y	0.0	0.6
Corp. Bonds 1Y	1.0	1.0
Corp. Bonds 5Y	1.6	0.7
Corp. Bonds 10Y	1.6	0.6
Corp. Bonds 15Y	1.6	0.6
Equity Risk	w^{sp}	w^{gen}
	8.0	8.0

Basel III* Market Risk

Interest Rate Risk	u_k
$t=1$	150
$t=2$	125
$t=3$	115
$t=5$	100
$t=10$	100
$t=15$	100
$t=20$	100
$t=30$	100
Spread Risk	u_k
Bucket 2	500
Bucket 3	350
Bucket 4	300
Bucket 5	250
Bucket 6	200
Equity Risk	u_k
Bucket 5	30
Bucket 6	35
Bucket 7	40
Bucket 8	50
Default Risk	u_i
GER Gov. Bonds	0.5
U.S. Gov. Bonds	2.0
Corp. Bonds	2.88
AA Issuer	2.0
A Issuer	3.0
BBB Issuer	6.0
BB Issuer	15.0
Unrated Issuer	15.0

Solvency II Market Risk

Interest Rate Risk	$s_t^{int,up}$	$s_t^{int,down}$
$t=1$	70	-75
$t=2$	70	-65
$t=3$	64	-56
$t=4$	59	-50
$t=5$	55	-46
$t=6$	52	-42
$t=7$	49	-39
$t=8$	47	-36
$t=9$	44	-33
$t=10$	42	-31
$t=11$	39	-30
$t=12$	37	-29
$t=13$	35	-28
$t=14$	34	-28
$t=15$	33	-27
$t=16$	31	-28
$t=17$	30	-28
$t=18$	29	-28
$t=19$	27	-29
$t=20$	26	-29
$t=90$	20	-20
$\frac{1}{30}\sum_{t=1}^{30} s_t^{int,k}$	38	-35
Spread Risk	$s_i^{spr,0}$	$s_i^{spr,1}$
Corp. Bonds 1Y	0.00	1.48
Corp. Bonds 5Y	0.00	1.48
Corp. Bonds 10Y	7.38	0.83
Corp. Bonds 15Y	11.48	0.63
Equity Risk	$s^{equ,k}$	
Type 1 Equity	-46.5	
Type 2 Equity	-56.5	
Property Risk	s^{prop}	
	-25.0	

Basel III Credit Risk

	v_i
Stocks	100.0
GER Gov. Bonds	0.0
U.S. Gov. Bonds	0.0
Corp. Bonds Banks	40.0
Corp. Bonds Others	56.7
Real Estate	100.0
Hedge Funds	100.0
Private Equity	150.0
Cash	0.0
Mort. Loan LTV=0.4	35.0
Mort. Loan LTV=0.6	35.0
Mort. Loan LTV=0.8	35.0

Basel III* Credit Risk

	v_i
Stocks	300
GER Gov. Bonds	0.0
U.S. Gov. Bonds	0.0
Corp. Bonds Banks	43.8
Corp. Bonds Others	75.0
Real Estate	100.0
Hedge Funds	400.0
Private Equity	400.0
Cash	0.0
Mort. Loan LTV=0.4	35.0
Mort. Loan LTV=0.6	45.0
Mort. Loan LTV=0.8	60.0

Solvency II Counterparty Default Risk

	PD	LGD
Cash	0.002	600.0
Mort. Loan LTV=0.4		0
Mort. Loan LTV=0.6		0
Mort. Loan LTV=0.8		34.7

Table 2: Input Parameters for the Calculation of the Capital Charges

This table summarizes the input parameters for the calculation of the capital requirements. The Basel III weights w_i, w^{sp}, w^{gen}, and v_i are given in percent and derived from BCBS (2006) and BCBS (1988). Δr_i is the assumed yield change in percentage points according to BCBS (2006). The risk weights v_i for the calculation of the Basel III* charge (given in percent) are based on BCBS (2006) and BCBS (2014d). Moreover, the parameters u_k ,u_i are specified in BCBS (2014c). They are given in basis points under the interest rate and credit spread risk modules and in percent under the equity and default risk modules. The Solvency II shocks (given in percent), PD (given in percent), as well as the LGD (given in CU million) are based on EC (2014a).

securities from issuers with AA rating (and thus the U.S. government). For the portfolio of corporate bonds, we use the average of the weights for the rating categories AAA to BBB (2.88%). The default weights for stocks in the trading book are based on the credit rating of the issuing company (see BCBS, 2014b). Thus we select the corresponding weights using the S&P and / or Moody's long-term ratings of the DAX30 members (as reported on their websites as of 16/12/2014).

The Basel III* credit risk framework maintains the weights for government bonds, cash, and real estate investments (for this paragraph, refer to the reform proposal BCBS, 2014d). For stocks and alternative investments, the risk weights are increased to 300% and 400%, respectively. The proposed risk weights for claims on banks depend on a financial institution's CET1 ratio and its so-called net non-performing assets (NPA) ratio. We approximate the weight for corporate bonds from banks using the average (43.75%) of the weights defined for the two highest CET1 ratio classes combined with the two lowest NPA ratio classes (a low NPA ratio means high asset quality). For (senior debt) corporate bonds issued by non-banking companies, the new risk weights are based on a firm's leverage and revenue. The arithmetic mean of the four lowest risk weights comes to 75%. The reform of the credit risk approach further introduces new risk weights for mortgage loans in dependence on the loans' LTV and debt service coverage (DSC) ratios. Averaging the weights for the two DSC ratio categories, we obtain risk weights of 35%, 45%, and 60% for the three LTV ratio classes.

Solvency II Our derivation of the parameters for the calculation of the Solvency II SCR is based on the Delegated Act (see EC, 2014a). Within the interest rate risk submodule, the Solvency II framework defines upward and downward shocks for each maturity of the term structure of interest rates (see CEIOPS, 2010). These have to be multiplied by the spot rates for euro area and U.S. government bonds in order to determine the absolute changes in the risk free rates. If the resulting absolute interest increases in the upward scenario are lower than 1 percentage point (which is currently the case due to the low risk free rates), the calculated values have to be replaced by 1 percentage point. In addition, according to the specifications in the Delegated Act, a downward shock of zero has to be used for maturities t where the risk-free rates are negative.

For the interest rate risk of the mortgage loan portfolio and liabilities, we make the following approximation, similar to Braun et al. (2014) and Braun et al. (2015): In order to avoid the modeling of individual cash flows, we assume a flat yield curve for the euro area (with $\overline{r} = 1.09\%$ as of 28/11/2014), calculate the average stress $\overline{s}^{int,k} = (\sum_{t=1}^{T} s_t^{int,k})/T$, and approximate the change in the value of liabilities / mortgage loans by the product of the modified duration, value of liabilities /mortgage loans, and yield change $\overline{s}^{int,k} \cdot \overline{r}$ (taking the requirement of a minimum increase by 1 percentage point into account).

The property shock for real estate investments is -25%. For stocks and alternative investments, the equity risk module specifies -39% and -49% as base levels for the stress factors for "type 1 equity" and "type 2 equity", respectively. Moreover, a symmetric adjustment of -7.5% is proposed in the EIOPA (2014b) document. Thus, the adjusted equity stresses are -46.5% and -56.5%, respectively. For the aggregation of the charges of the two equity categories, a correlation coefficient of 0.75 is required.

According to the spread risk submodule, no capital is required for spread risks of government bonds issued by EU countries (and thus Germany) or AAA to AA rated countries (and thus the U.S.). The parameters

$s_i^{spr,0}$ and $s_i^{spr,1}$ that specify the shocks for corporate bonds depend on the bonds' modified durations and issuers' credit qualities. We determine the parameters for the four classes of corporate bonds by averaging the values $s_i^{spr,0}$ and $s_i^{spr,1}$ specified for credit quality classes 0 to 3 in the respective duration ranges.[18]

In order to calculate the SCR for counterparty default risks, we set the LGD of "cash at bank" equal to the asset's value (600 CU million), in accordance with the Solvency II Delegated Act. Moreover, we choose a probability of default of 0.08%, the average of the PDs for credit quality steps 0 to 3. The LGDs for the three classes of mortgage loans are calculated by means of formula (11). Thus we obtain 34.8 CU million for mortgage loans with an LTV ratio of 80% and zero otherwise. To aggregate the charges for type 1 and type 2 exposures, a correlation coefficient of 0.75 is required.

After calculating the individual charges for market and counterparty default risks, we have to factor in the diversification effects between these risk categories and the underwriting risk modules. In line with EIOPA (2013), we derive a proxy for the diversified charge as follows: An approximate capital charge for life risks SCR_{life} is calculated by assuming that SCR_{life} amounts to 35% of SCR_{mkt}. This proportion is determined by EIOPA (2013) based on the QIS 5 results for the sample of European life insurers (see EIOPA, 2011). We then compute the life insurer's BSCR using the correlation matrix defined by the regulatory authorities. Subsequently, we determine the ratio $r < 1$ of the BSCR and the sum of the charges for the three risk modules. Finally, the diversified charge for market and counterparty default risks is obtained by multiplying the factor r with the sum of SCR_{mkt} and SCR_{def}.

The Solvency II capital charge is further reduced by the adjustments for the loss absorbing capacity of technical provisions and deferred taxes. The QIS 5 report shows average adjustments Adj_{TP} and Adj_{DT} of 28% and 19% of BSCR, respectively (see EIOPA, 2011). In line with EIOPA (2013), we use a conservative estimate and assume a total reduction of 40%. In addition, we set the individual adjustments at $24\%(= 0.4 \cdot 0.28/0.47)$ and 16% of BSCR.

3.2.3 Capital Requirements for the Stylized Balance Sheet

Table 3 and Figure 1 show the capital requirements for the stylized portfolio in Table 1 under the current Basel III version, the forthcoming Capital Accord Basel III*, as well as Solvency II. A comparison of the current Basel III and Solvency II charges reveals that the Solvency II BSCR exceeds the capital requirements for the banking sector. However, the adjustments for the loss absorbing capacity of technical provisions and deferred taxes permit insurance companies substantial reductions in the amount of required capital and the final SCR is lower than CR_{III}: Depending on the degree of global systemic importance, banks have to hold between 16% and 40% more capital than insurers for our stylized balance sheet.

The reform of the market and credit risk frameworks is likely to produce considerable increases in capital charges under the Third Basel Accord. For our portfolio, we calculate a rise in the capital requirements for market and credit risks of 83% and 63%, respectively. In consequence, the Basel III* charge is not only higher than the Solvency II SCR, but also than the BSCR. With respect to the SCR, non-GSIBs are required to have almost twice as much capital as insurance firms. In the case of a high degree of global systemic importance, the capital charge for banks exceeds that for insurers by 139%.

[18] For the relation between the credit quality steps and the rating classes defined by the large rating agencies, see EIOPA (2014c).

Basel III		Basel III*		Solvency II	
Market Risk	140.5	Market Risk	256.9	Market Risk	907.2
Credit Risk	230.4	Credit Risk	375.3	Credit Risk	42.3
Market + Credit Risk	370.9	*Market + Credit Risk*	632.2	*BSCR*	784.4
Capital Conservation Buffer	115.9	Capital Conservation Buffer	197.6	Adj_{TP}	-188.2
Countercyclical Buffer	58.0	Countercyclical Buffer	98.8	Adj_{DT}	-125.5
CR_{III}, *non-GSIB*	544.8	CR^*_{III}, *non-GSIB*	928.6	*SCR*	470.6
GSIB Buffer, $\alpha^{GSIB} = 2.5$	115.9	GSIB Buffer, $\alpha^{GSIB} = 2.5$	197.6		
CR_{III}, *GSIB*	660.7	CR^*_{III}, *GSIB*	1126.2		

Table 3: Capital Requirements for the Stylized Portfolio

This table presents the capital requirements (in CU million) for market and credit risks under the Basel III, Basel III*, and Solvency II standard approaches. The calculation is based on the stylized balance sheet in Table 1.

Figure 1 illustrates the qualitative composition of the capital requirements. The higher amounts of total capital charges combined with more stringent requirements with respect to the capital quality under Basel III/III* imply that banks have to hold far more Tier 1 capital than insurance companies. In our example, the amount of required Tier 1 capital for GSIBs under Basel III (Basel III*) exceeds that under Solvency II by 141% (311%). For non-GSIBs, the Tier 1 requirements are higher by 92% and 227% for Basel III and Basel III*, respectively.

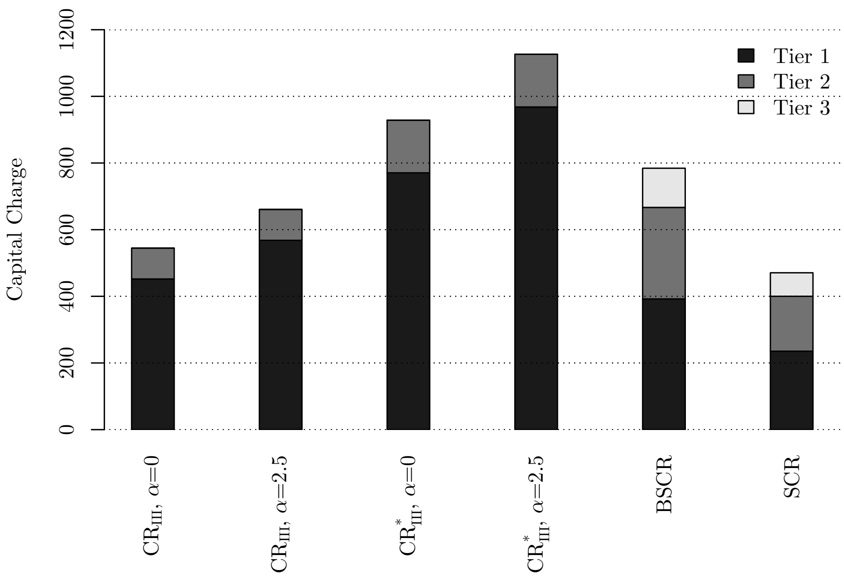

Figure 1: Quantity and Quality of Regulatory Capital for the Stylized Portfolio

This figure shows the quantity and quality of capital required under the Basel III/III* and Solvency II standard approaches for market and credit risks (in CU million). The first four bars illustrate the capital requirements for non-GSIBs ($\alpha = \alpha^{GSIB} = 0$) and GSIBs ($\alpha = \alpha^{GSIB} = 2.5$) under the current Basel III version and Basel III*. The heights of the last two bars correspond to the Solvency II BSCR and SCR, respectively. Furthermore, in each bar, the black, gray, and white parts represent the amount of required Tier 1, Tier 2, and Tier 3 capital, respectively.

A financial institution only has incentives to engage in regulatory arbitrage if its eligible capital is close to or lower than the amount of capital required by the relevant regulatory framework (see Boyson et al., 2014). In our example, the life insurer's BOF (1300 CU million) substantially exceed the SCR of 471 CU million. In contrast, if the company only had BOF of 5% of total assets (i.e., the ratio of BOF to total assets of German life insurers in the QIS 5 study, see BAFIN, 2010), its BOF would be just sufficient to meet the SCR for market and credit risks. Consequently, an inclusion of the charges for operational and underwriting risks would lead to a breach of SCR (if the company does not have large amounts of ancillary own funds).[19]

So far, we have not made any assumption with regard to the bank's liability side. In order to comply with the current Basel III rules, the eligible capital of a non-GSIB (GSIB with $\alpha^{GSIB} = 2.5$) with our stylized asset portfolio must be 5.4% (6.6%) of total assets plus the amount of capital required for operational risks. An analysis of the annual reports for 2013 of several large banks shows that various banks have a ratio of eligible capital to total assets lower than 7%. If this is also the case for the bank in our analysis, it either just meets or breaches the regulatory requirements. Moreover, it falls far short of the charges under the forthcoming Basel III* Accord (9.3% and 11.3% of total assets for $\alpha^{GSIB} = 0$ and $\alpha^{GSIB} = 2.5$, respectively).

3.2.4 Capital Requirements for Varying Portfolio Compositions

In order to check the sensitivity of the result of higher capital requirements for banks than insurers and to gain further insights, we contrast the capital charges for a series of portfolios derived from our reference balance sheet. In detail, for each asset class, we construct the following set of asset portfolios (similar to Braun et al., 2011, and Braun et al., 2014): For the considered asset type, we successively increase the corresponding portfolio weight from 0% to L% in steps of one percentage point. We choose $L = 100$ for bonds, $L = 40$ for stocks, real estate investments, and mortgage loans, and $L = 20$ for alternatives.[20] As the weights of all securities must total 100%, the proportions of the remaining asset classes are reduced accordingly, such that the relative weights between pairs of asset classes remain the same as in the stylized asset portfolio. In the following, we assume a medium-sized GSIB buffer of 1.5% of TRWA.

Figure 2 illustrates the capital charges for the six series of portfolios. In addition, the first six columns in Table 4 show the average relative changes in the capital requirements due to an increase in the portfolio weight of the considered asset class by one percentage point, as well as the absolute changes in required capital if the portfolio weight of one asset category is increased by one percentage point compared to the weight in the reference portfolio (e.g., if the weight of stocks is increased from 9% to 10%).

The results are mainly in line with the findings from the previous section. As can be seen in Figure 2, the Basel III* charge exceeds the Solvency II SCR for all considered portfolios. Depending on the portfolio composition, the capital requirement for banks under Basel III* is between 52% and 307% higher than the charge for insurers. The capital requirements under the current Basel III Accord are higher than the SCR for the majority of portfolios. Insurance companies only have to hold more capital than banks in the case of quite high proportions of stocks or alternative investments, which are inadmissible (see EC, 2002) or very unlikely (see, e.g., Assekurata, 2014, and EIOPA, 2014a) for European life insurers.

Furthermore, the analysis confirms the result of the theoretical comparison that the frameworks are largely consistent with regard to the evaluation of the riskiness of one asset type compared to the remaining

[19] In case of a proportion of liabilities of 95%, the SCR (479 CU million) only marginally differs from the originally calculated SCR, see also Section 3.2.5.

[20] As we are also considering the capital requirements for banks, we do not take the investment limits for insurance companies into account, as given, e.g., by the Directive for European Life Insurers (see EC, 2002).

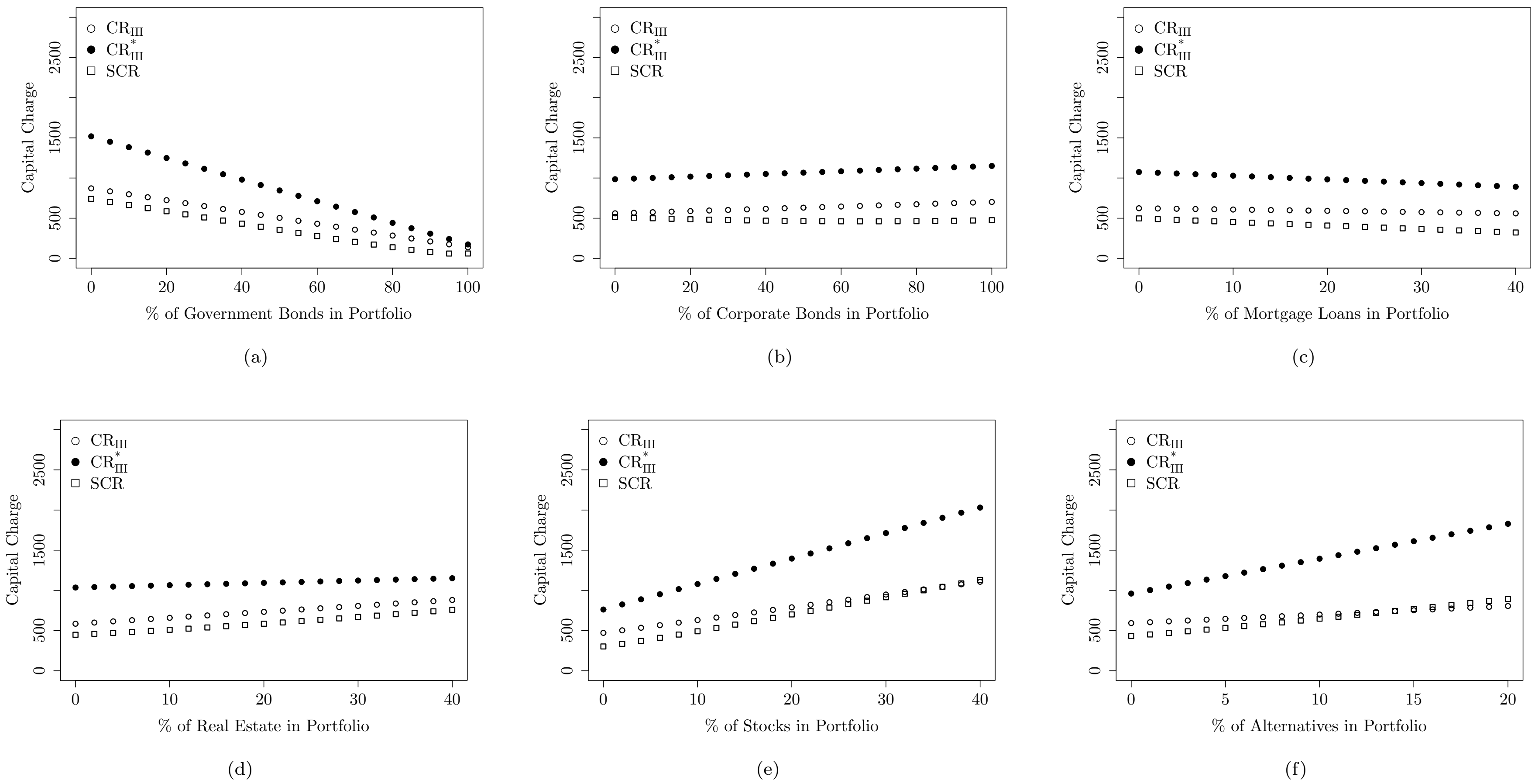

Figure 2: Capital Requirements for Different Portfolio Compositions

This figure shows the capital charges (in CU million) for varying compositions of the asset portfolio. The current Basel III requirements are indicated by a circle ∘, the forthcoming Basel III* charges by a bullet •, and the Solvency II SCR by a square □. In Subfigures (a) and (b), the proportions of government and corporate bonds are increased from 0% to 100% in steps of 5 percentage points. The weights of the remaining asset classes are reduced accordingly, keeping the relative weights constant (equal to those in the stylized asset portfolio). Subfigures (c), (d), and (e) show the capital charges with respect to the portfolio weights of mortgage loans, real estate investments, and stocks, respectively. The weights range from 0% to 40% and are increased in steps of 2 percentage points. The last subfigure illustrates the capital requirements if the proportion of alternative investments is increased from 0% to 20% in 1 percentage point steps. The Basel III/III* charges are calculated for a GSIB with $\alpha^{GSIB} = 1.5$.

portfolio. Under all three regimes, zero or very low risk weights for spread and / or credit risks of highly rated government bonds and mortgage loans imply a decrease in the capital charges as a result of a rise in the portfolio weights of these asset classes (see Subfigures a and c).[21] Similarly, as all three approaches specify high risk weights and stress factors for stocks and alternative investments, the capital charges for both banks and insurers rise with increasing proportions of stocks or alternatives in the portfolio (see Subfigures e and f). Due to the medium risk weight of 100% and shock $s^{prop} = -25\%$ assigned to real estate investments, the three frameworks further agree in requiring slightly more capital for portfolios with higher proportions of real estate holdings. For IG corporate bonds (Subfigure b), CR_{III}, CR^*_{III}, and SCR only slightly change.

However, a close look at the figures shows a few differences: While CR_{III} and CR^*_{III} marginally rise for corporate bonds, the curve describing the Solvency II SCR is slightly U-shaped (with the minimum for the portfolio with 66% corporate bonds). The SCR also grows if the portfolio weight of government bond rises above 97%. These increases at the upper end of the scale reflect the decrease in the diversification effect between the market risk submodules under Solvency II.

Although the ranking of the six asset classes with respect to their riskiness is quite consistent under the three approaches, the extent to which one asset type is considered as more / less risky than the remaining classes varies. On the one hand, for our portfolio, the average relative change in the Solvency II capital requirements due to a raise of the portfolio weight of real estate, stocks, or alternatives exceeds the relative increase in CR_{III} and CR^*_{III} (see Table 4, Columns 1 to 3). On the other hand, if the proportion of government bonds or residential mortgage loans is increased, insurance companies can achieve a higher relative reduction in their capital charges than banks.

	Mean Relative Change (Reallocation)			**Absolute Change** (Reallocation)			**Absolute Change** (Capital Increase)		
	ΔCR_{III}	ΔCR^*_{III}	ΔSCR	ΔCR_{III}	ΔCR^*_{III}	ΔSCR	ΔCR_{III}	ΔCR^*_{III}	ΔSCR
Government Bonds	-1.8%	-2.1%	-2.5%	-7.3	-13.5	-7.7	1.4	1.7	-1.2
Corporate Bonds	0.2%	0.2%	-0.1%	1.4	1.7	-0.7	7.0	11.5	3.4
Mortgages	-0.3%	-0.5%	-1.1%	-1.6	-4.6	-4.4	4.6	6.2	-0.4
Real Estate	1.0%	0.3%	1.3%	7.4	2.9	6.1	13.3	13.3	9.7
Stocks	2.2%	2.5%	3.4%	15.9	37.7	20.5	20.6	39.3	22.4
Alternatives	1.5%	3.3%	3.7%	10.6	43.4	20.1	16.6	53.0	23.5

Table 4: Changes in the Capital Requirements

This table presents the changes in the Basel III/III* and Solvency II capital charges resulting from changes in the portfolio composition. ΔCR_{III}, ΔCR^*_{III}, and ΔSCR denote the changes under Basel III, Basel III*, and Solvency II, respectively. The first three columns contain the average relative changes resulting from stepwise increases of the portfolio weight of one asset class from 0% to L% in steps of one percentage point. Columns 4, 5, and 6 show the absolute changes (in CU million) if the portfolio weight of the considered asset category is increased by one percentage point compared to the weight in the reference portfolio. The last three columns report the absolute changes in the capital charges (in CU million) if the financial institution raises its capital stock by 0.1 CU billion and invests the additional capital in the asset class considered in the respective row.

If the BCBS maintains the current calibration of the Basel III* standard approaches for market and credit risks, the attractiveness of investments in certain asset classes is likely to change fundamentally (see Table 4, columns 4 to 6). Due to the specification of substantially higher risk weights for stocks and alternative investments, an increase in the portfolio proportions of these asset classes causes much

[21] Until a proportion of government bonds of 60%, a small part of the decrease in SCR also results from a decline of the SCR for interest rate risks due to a reduction in the duration gap.

higher absolute changes in the capital charges of banks than under the current Basel III framework. As a result, the increase in the amount of required capital under Basel III* also considerably exceeds that under the Solvency II framework. Compared to insurance companies, banks also have a disadvantage if they increase the proportion of corporate bonds. A shift in investments towards more government bonds or real estate holdings, in contrast, leads to a higher reduction / lower increase in the capital charges under Basel III* than Solvency II.

The comparison of the absolute changes above shows whether a portfolio reallocation towards one asset class is more profitable (in terms of the changes in the capital requirements) under Basel III/III* or Solvency II. These changes depend on the regulatory treatment of all asset classes in the portfolio, as the increase in the portfolio weight of one asset category implies a reduction in the weights of the remaining classes. The situation differs if a financial institution raises its capital base and invests the additional amount of capital in one asset class. In this case, the decline or increase in the capital requirements is mainly driven by the treatment of the considered asset class.

The last three columns in Table 4 report the changes Δ in the capital charges resulting from the investment of additional capital of 0.1 CU billion (1% of the original amount of total assets) in one of our asset classes.[22] If the new capital is invested in stocks or alternatives, the results are similar to those above, i.e., ΔSCR exceeds ΔCR_{III}, but is substantially lower than ΔCR^*_{III}. For the remaining asset classes, the capital burden rises less for insurers than for banks. If the funds are invested in government bonds or residential mortage loans, the Solvency II requirements actually decline due to a reduction in the duration gap (and thus decline of the charge for interest rate risks) and the absence of charges for spread risks of German and U.S. government securities / very low charges for credit risks of residential mortgage loans.

3.2.5 Discussion of the Assumptions

Total Capital Requirements

Our calculations are based on various assumptions. A variation of these assumptions shows that the extent of discrepancy between the Basel III/III* and Solvency II charges may differ from our calculated values. The key result of higher total capital charges for banks than insurance companies seems robust with respect to our assumptions:[23]

Value and Duration of Liabilities The Solvency II charge for interest rate risks depends on the value and duration of an insurer's liabilities. Under our assumption of 87% liabilities and a duration of 9, the downward shock leads to a loss in BOF. If the company has a higher proportion of liabilities or liabilities with a higher duration, a decline in the interest rates leads to a higher loss and the insurer is therefore obliged to hold a higher amount of capital. For a very high liability duration of 15, the Solvency II SCR is 537 CU million, still slightly below the Basel III requirement for a non-GSIB (545 CU million). An increase in the proportion of liabilities towards 100% induces an increase in SCR towards 485 CU million, which is far below the Basel III/III* charges. We also calculate the SCR for liability durations between 3 and 9 and proportions of liabilities between 60% and 87%. Independent of the dominance of the downward or upward shock, the final SCR is always substantially lower than CR_{III} and CR^*_{III}.

[22]This analysis was motivated by an analysis by EIOPA (2013), which examines the changes in SCR as a result of reallocating some of an insurer's cash holdings (not newly raised capital as in the case of our analysis) into another asset classes.
[23]The detailed results are available upon request from the authors.

SCR for Life Underwriting Risks In order to derive a proxy for the relative reduction of the Solvency II charges for market and credit risks due to the diversification effect between market, credit, and underwriting risks, we assume an SCR_{life} of 35% of SCR_{mkt}. While a higher value of SCR_{life} implies a higher diversification effect and thus lower BSCR for market and credit risks, lower charges for life underwriting risks lead to a higher value of BSCR. Nevertheless, the finding of higher charges for banks than insurance companies seems robust with respect to the amount of SCR_{life}, as the Basel III/III* charges exceed the Solvency II SCR even for a very low value of SCR_{life} of 5% of SCR_{mkt} (in this case it is $SCR = 533$ CU million).

Loss Absorbing Capacities As shown in Table 3, the capital charge under the forthcoming Basel Accord exceeds the Solvency II BSCR (even for non-GSIBs). Thus, banks are required to hold more capital for our reference portfolio than insurers, independent of the adjustments for the loss absorbing capacity of technical provisions and deferred taxes. Furthermore, the current Basel III charge exceeds the Solvency II SCR for all adjustments Adj_{TP} and Adj_{DT} of at least 16% (31%) in case of $\alpha^{GSIB} = 2.5$ ($\alpha^{GSIB} = 0$).

Trading Book - Banking Book Allocation An analysis of the Basel III risk weights and capital requirements reveals that for stocks, U.S. and German government bonds, and our classes of corporate bonds with a maturity of at least 5 years, the current Basel III market risk framework requires higher charges than the credit risk module. Similarly, under Basel III*, more capital will be necessary for government and corporate bonds in the trading book than in the banking book. For our stock portfolio, the charges are comparable, with marginally lower charges for traded stocks. In consequence, if a bank has a higher proportion τ of traded assets than our assumed value ($\tau = 0.15$), it has to hold more capital under both Basel III and Basel III*. For example, the regulatory capital charge for a GSIB with $\alpha = 2.5$ and $\tau = 0.25$ is $CR_{III} = 756$ / $CR^*_{III} = 1258$ CU million, compared to $CR_{III} = 661$ / $CR^*_{III} = 1126$ CU million in our calculations. Thus the discrepancy between the capital charges for banks and insurers are even higher than in our reference case. If a bank engages less in trading (i.e., $\tau < 0.15$), CR_{III} and $CR_{III}*$ are lower than our calculated values and therefore fall somewhat closer to the Solvency II SCR. However, the Basel III/III* requirements for a GSIB are also higher than the Solvency II charge in the most extreme case of no trading activity. For a non-GSIB, we obtain $CR^*_{III} > SCR$ for all $\tau \geq 0$ and $CR_{III} > SCR$ for all $\tau \geq 0.06$.

Basel III* Interest Rate and Credit Spread Risk Charges Our computation of the Basel III* charges for interest rate and credit spread risks is based on the assumption that the shock at vertex V_t only increases the risk-free rate r_t and credit spread cs_t, not the yields in the neighborhood of V_t. According to an expert in the SBA approach, the new framework in principle demands the estimation of a new shocked yield curve in order to derive the (smaller) rate increases in the neighborhood of V_t. Thus, we slightly underestimate the Basel III* requirements and the discrepancy between the forthcoming Basel III* framework and Solvency II.

Valuation Differences In our numerical analysis we abstract from the differences in the valuation of assets and calculate both the capital charges for banks and for insurers based on the economic balance sheet in Table 1. However, the amortized costs used for some assets under the Basel III/III* credit risk framework may substantially deviate from the economic values. For example, the amortized cost of the Allianz Group's held-to-maturity debt portfolio in 2013 is 11% lower than the portfolio's fair value (see

Allianz Group, 2014). If we reduce the value of all government and corporate bonds assigned to the bank's banking book by this percentage (compared to the values we use in our original calculations), the current and forthcoming Basel III requirements for a GSIB with $\alpha^{GSIB} = 2.5$ drop to 646.6 and 1109.6 CU million, respectively. For a non-GSIB, we obtain $CR_{III} = 533.2$ and $CR^{*}_{III} = 914.9$ (CU million), respectively. Thus, the capital charges for banks move towards the requirements for insurers, but still lie above them. Even if the values of all non-traded securities only amount to 80% of the values assumed in our calculations, the Basel III (and thus also Basel III*) charge for a non-GSIB exceeds the Solvency II SCR.

Changes in the Capital Charges

With regard to the absolute changes in required capital due to portfolio reallocations or investments of new capital, a change in the duration or total value of liabilities merely affects the absolute increases or declines in SCR. Higher (lower) adjustment factors for the loss absorbing capacity of technical provisions and deferred taxes imply lower (higher) absolute changes in SCR. However, for adjustments between 30% and 50% of BSCR, our findings with regard to the attractiveness of additional investments in one asset class under Solvency II compared to Basel III/III* (in terms of a higher or lower absolute change in capital) hardly change. Deviations from our reference proportion of 15% of traded assets also lead to slightly modified absolute changes, but in most cases the result that a portfolio reallocation towards one asset category or the investment of newly raised capital into one asset category is more / less profitable for insurers than for banks is quite robust. For example, for a trading book proportion τ of 25%, the purchase of government bonds / corporate bonds / stocks by means of newly raised capital of 0.1 CU billion causes an increase in CR^{*}_{III} of 2.9 / 13.7 / 39 CU million, compared to 1.7 / 11.5 / 39.3 CU million in the original case of $\tau = 0.15$. For both values of τ, the increase in the Basel III* charge substantially exceeds the rise in SCR.

Nevertheless, the absolute changes in capital depend on the portfolio composition. If, for example, the asset duration exceeds the duration of liabilities, investments of new capital in government bonds or mortgage loans lead to an increase in SCR, in contrast to the decrease observed for our portfolio. For some asset classes it is therefore not possible to conclude in general whether it is more profitable to transfer assets from the banking to the insurance sector or vice versa.

4 Conclusion

Motivated by the regulatory authorities' goal to establish consistent regulatory frameworks for the supervision of the financial sector, this paper provides a comprehensive analysis of the consistency of the standard approaches for market and credit risks under the Third Basel Accord and Solvency II. In a first step, the consistency is assessed from a theoretical standpoint via a thorough comparison of the mechanics of the standard approaches. The comparative analysis of the current Basel III and Solvency II standards reveals considerable discrepancies between the two frameworks, especially with regard to the scope of the risk modules, applied risk metrics, consideration of diversification effects, and calculation formulas. According to the reform proposals, the reform of the Basel Accord's market and credit risk regimes might lead to some alignment of the capital standards for banks and insurance companies. For example, similar to Solvency II, the SBA approach derives the capital charges from predefined shocks to the market prices. However, substantial inconsistencies will persist and new discrepancies will be introduced. These include, among others, the use of different risk measures, the level at which diversification is taken into account, as well as the calculation of the individual charges for interest rate and spread risks. The frameworks also differ in their valuation methods and definitions of eligible capital. Moreover, the Third Basel Accord requires a substantially higher quality of capital than Solvency II.

As a second step, the consistency is evaluated in the form of a numerical analysis contrasting the Basel III/III* and Solvency II capital charges for market and credit risks for an empirically calibrated stylized balance sheet. The results show that, for the same asset portfolio, banks are subject to higher capital requirements than insurers, especially under the proposals for the forthcoming Basel III* rules. The regulators' goal of a comparable ranking of asset classes with respect to the amount of required capital (see EC, 2014b) has largely been achieved. However, the requirements for individual risks differ considerably, and portfolio reallocations or investments of newly raised capital entail unequal changes in the capital charges.

The inconsistencies have several causes. These include the independent developments of the frameworks by different supervisory authorities with unequal regional focus, differences in the core business activities of banks and insurance companies, disparate goals of the reforms, and varying levels of systemic risks in the banking and insurance sectors (see Harrington, 2009, Al-Darwish et al., 2011, Gatzert and Wesker, 2012). Several discrepancies can further be attributed to shortcomings of one framework (e.g., the neglect of diversification effects under the current Basel III rules) which should not be adopted by the other regime purely for consistency reasons. Nevertheless, even if the inconsistencies may in parts be justified, the regulatory authorities have to be aware that they may lead to regulatory arbitrage. In particular, financial conglomerates can reduce their capital burden by shifting risks to the entity that is subject to lower requirements. Of course, a financial institution's decision about its asset allocation and risk transfers does not depend solely on regulatory capital requirements (see also IAIS, 2009). Other influence factors are, for example, the new liquidity rules for banks (see BCBS, 2010a), tax issues, the need of portfolio diversification, and the liability structure (see also Al-Darwish et al., 2011). In addition, not only the capital charges, but also the rules for the calculation of a financial institution's capital base and the requirements with respect to the capital quality are relevant. A company also only has to consider risk transfers to the less strictly regulated sector if it otherwise will have problems in meeting the regulatory capital requirements (see Boyson et al., 2014).

The forthcoming years will show the extent to which financial firms will exploit these cross-sectoral discrepancies. Based on experience with former inconsistencies within and between regulatory frameworks (see, e.g., Jones, 2000, Houston et al., 2012, Acharya and Steffen, 2015), we may expect that some firms with a narrow capital base will indeed engage in regulatory arbitrage. In addition, there is already some evidence that several companies are transferring parts of their business to the less strictly regulated industry (see Thibeault and Wambeke, 2014). Among others, Thibeault and Wambeke (2014) provide a series of examples of banks which have passed on some of their corporate or infrastructure lending to their partner companies in the insurance sector.

Our work does not question the regulators' goal of cross-sectoral consistency in order to avoid regulatory arbitrage. This goal stems from the assumption that regulatory arbitrage may threaten the stability of the financial markets, as some institutions may be undercapitalized and therefore subject to higher risk of insolvency (see, e.g., Jones, 2000, and Siegel, 2013). However, some papers suggest that, under certain circumstances, regulatory consistency may be suboptimal. According to Mälkönen (2004) and Freixas et al. (2007), regulatory arbitrage might increase market efficiency and social welfare if risky positions are shifted to entities with higher market discipline. As our analyses indicate higher charges for stocks and alternative investments under the forthcoming Basel III* framework than Solvency II, this might prove true after the introduction of the new Basel III* standard approaches. Under the current Basel III version, in contrast, stocks and alternatives seem to be subject to lower charges than under Solvency II and there are incentives to shift these risky asset classes from insurance companies to banks (which in general have lower market discipline, see, e.g., Mälkönen, 2004).

Our analyses focus on certain asset classes and risk categories. Future work could extend the examination to other asset types (such as derivative products) and risk categories (e.g., foreign exchange risks). Moreover, we use quite rough approximations for the Solvency II requirements for underwriting risks and the adjustments for the loss absorbing capacity of technical provisions and deferred taxes. Although our results seem robust with respect to these approximations, this issue could also be addressed in future research. Using data from specific financial institutions, future work can investigate more exactly the effect of the use of market values under Solvency II in contrast to amortized costs under the Basel III/III* credit risk framework.

References

Acharya, V. V., 2003. Is the International Convergence of Capital Adequacy Regulation Desirable? *Journal of Finance*, 58(6):2745–2781.

Acharya, V. V. and S. Steffen, 2015. The "Greatest" Carry Trade Ever? Understanding Eurozone Bank Risks. *Journal of Financial Economics*, 115(2):215–236.

Al-Darwish, A., M. Hafeman, G. Impavido, M. Kemp, and P. O'Malley, 2011. Possible Unintended Consequences of Basel III and Solvency II, International Monetary Fund, Working Paper No. 187.

Allianz Group, 2014. *Allianz Group Annual Report 2013*. Munich, Germany.

Assekurata, 2014. *Marktausblick zur Lebensversicherung 2014*. Cologne, Germany.

Basel Committee on Banking Supervision (BCBS), 1988. International Convergence of Capital Measurement and Capital Standards.

Basel Committee on Banking Supervision (BCBS), 2006. International Convergence of Capital Measurement and Capital Standards, A Revised Framework, Comprehensive Version.

Basel Committee on Banking Supervision (BCBS), 2009. Enhancements to the Basel II framework.

Basel Committee on Banking Supervision (BCBS), 2010a. Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring.

Basel Committee on Banking Supervision (BCBS), 2010b. Guidance for National Authorities Operating the Countercyclical Capital Buffer.

Basel Committee on Banking Supervision (BCBS), 2010c. Review of the Differentiated Nature and Scope of Financial Regulation, Key Issues and Recommendations.

Basel Committee on Banking Supervision (BCBS), 2011a. Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems.

Basel Committee on Banking Supervision (BCBS), 2011b. Global Systemically Important Banks: Assessment Methodology and the Additional Loss Absorbency Requirement, Rules Text.

Basel Committee on Banking Supervision (BCBS), 2011c. Revisions to the Basel II Market Risk Framework, Updated as of 31 December 2010.

Basel Committee on Banking Supervision (BCBS), 2013. Fundamental Review of the Trading Book: A Revised Market Risk Framework, Consultative Document.

Basel Committee on Banking Supervision (BCBS), 2014a. Basel III Monitoring Report.

Basel Committee on Banking Supervision (BCBS), 2014b. Frequently Asked Questions on Basel III Monitoring.

Basel Committee on Banking Supervision (BCBS), 2014c. Fundamental Review of the Trading Book: Outstanding Issues, Consultative Document.

Basel Committee on Banking Supervision (BCBS), 2014d. Revisions to the Standardised Approach for Credit Risk, Consultative Document.

Boyson, N. M., R. Fahlenbrach, and R. M. Stulz, 2014. Why Do Banks Practice Regulatory Arbitrage? Evidence from Usage of Trust Preferred Securities, NBER Working Paper No. 19984.

Braun, A., P. Rymaszewski, and H. Schmeiser, 2011. A Traffic Light Approach to Solvency Measurement of Swiss Occupational Pension Funds. *Geneva Papers on Risk and Insurance – Issues and Practice*, 36(2):254–282.

Braun, A., H. Schmeiser, and F. Schreiber, 2015. Portfolio Optimization Under Solvency II: Implicit Constraints Imposed by the Market Risk Standard Formula. *Forthcoming in: the Journal of Risk and Insurance.*

Braun, A., H. Schmeiser, and C. Siegel, 2014. The Impact of Private Equity on a Life Insurer's Capital Charges under Solvency II and the Swiss Solvency Test. *Journal of Risk and Insurance*, 81(1):113–158.

Committee of European Insurance and Occupational Pension Supervisors (CEIOPS), 2008. CEIOPS' Report on its Fourth Quantitative Impact Study (QIS 4) for Solvency II, CEIOPS-SEC-82/08.

Committee of European Insurance and Occupational Pension Supervisors (CEIOPS), 2010. Solvency II – Calibration Paper.

Cummins, J. D. and R. D. Phillips, 2009. Capital Adequacy and Insurance Risk-Based Capital Systems. *Journal of Insurance Regulation*, 28(1):25–72.

Darlap, P. and B. Mayr, 2006. Group Aspects of Regulatory Reform in the Insurance Sector. *Geneva Papers on Risk and Insurance – Issues and Practice*, 31(1):96–123.

Eling, M. and I. Holzmüller, 2008. An Overview and Comparison of Risk – Based Capital Standards. *Journal of Insurance Regulation*, 26(4):31–60.

European Central Bank, 2014. Banking Structures Report, October 2014.

European Commission (EC), 2002. Directive 2002/83/EC of the European Parliament and of the Council of 5 November 2002 Concerning Life Assurance.

European Commission (EC), 2003. Design of a Future Prudential Supervisory System in the EU - Recommendations by the Commission Services, MARKT 2509/03.

European Commission (EC), 2006. Directive 2006/48/EC of the European Parliament and of the Council of 14 June 2006 Relating to the Taking up and Pursuit of the Business of Credit Institutions (Recast).

European Commission (EC), 2009. Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the Taking-Up and Pursuit of the Business of Insurance and Reinsurance (Solvency II).

European Commission (EC), 2013a. Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on Access to Activity of Credit Institutions and Investment Firms, Amending Directive 2002/87/EC and Repealing Directives 2006/48/EC and 2006/49/EC.

European Commission (EC), 2013b. Regulation (EU) NO 575/2013 of the European Parliament and of the Council of 26 June 2013 on Prudential Requirements for Credit Institutions and Investment Firms and Amending Regulation (EU) No 648/2012.

European Commission (EC), 2014a. Commission Delegated Regulation (EU) of 10.10.2014 Supplementing Directive 2009/138/EC of the European Parliament and of the Council on the Taking-up and Pursuit of the Business of Insurance and Reinsurance (Solvency II).

European Commission (EC), 2014b. Solvency II Delegated Act – Frequently Asked Questions, Memo 14/578.

European Commission (EC), 2015. Solvency II Overview Frequently Asked Questions, Memo 15/3120.

European Insurance and Occupational Pension Authority (EIOPA), 2011. EIOPA Report on the Fifth Quantitative Impact Study (QIS5) for Solvency II, EIOPA-TFQIS5-11/001.

European Insurance and Occupational Pension Authority (EIOPA), 2013. Technical Report on Standard Formula Design and Calibration for Certain Long Term Investments.

European Insurance and Occupational Pension Authority (EIOPA), 2014a. Financial Stability Report, May 2014, EIOPA-FS-14-044.

European Insurance and Occupational Pension Authority (EIOPA), 2014b. Technical Specification for the Preparatory Phase (Part I), EIOPA-14/209.

European Insurance and Occupational Pension Authority (EIOPA), 2014c. Technical Specification for the Preparatory Phase (Part II), EIOPA-14/210.

Federal Financial Supervisory Authority (BAFIN), 2010. Ergebnisse der fünften quantitativen Auswirkungsstudie zu Solvency II (QIS 5).

Federal Financial Supervisory Authority (BAFIN), 2015. Statistik der Bundesanstalt für Finanzdienstleistungsaufsicht – Erstversicherungsunternehmen und Pensionsfonds.

Financial Stability Board, 2013. Global Systemically Important Insurers (G-SIIs) and the Policy Measures that will Apply to Them.

Financial Stability Board, 2014. 2014 Update of List of Global Systemically Important Banks.

Flamée, M. and P. Windels, 2009. Restructuring Financial Sector Supervision: Creating a Level Playing Field. *Geneva Papers on Risk and Insurance - Issues and Practice*, 34(1):9–23.

Freixas, X., G. Lóránth, and A. D. Morrison, 2007. Regulating Financial Conglomerates. *Journal of Financial Intermediation*, 16(4):479–514.

Gatzert, N. and M. Martin, 2012. Quantifying Credit and Market Risk under Solvency II: Standard Approach versus Internal Model. *Insurance: Mathematics and Economics*, 51(3):649–666.

Gatzert, N. and H. Wesker, 2012. A Comparative Assessment of Basel II/III and Solvency II. *Geneva Papers on Risk and Insurance – Issues and Practice*, 37(3):539–570.

Harrington, S. E., 2009. The Financial Crisis, Systemic Risk, and the Future of Insurance Regulation. *Journal of Risk and Insurance*, 76(4):785–819.

Herring, R. J. and J. Carmassi, 2008. The Structure of Cross-Sector Financial Supervision. *Financial Markets, Institutions & Instruments*, 17(1):51–76.

Herring, R. J. and T. Schuermann, 2005. Capital Regulation for Position Risk in Banks, Securities Firms and Insurance Companies. In H. S. Scott, editor, *Capital Adequacy beyond Basel: Banking, Securities and Insurance*, pages 15–86. Oxford University Press, New York.

Holzmüller, I., 2009. The United States RBC Standards, Solvency II and the Swiss Solvency Test: A Comparative Assessment. *Geneva Papers on Risk and Insurance – Issues and Practice*, 34(1):56–77.

Höring, D., 2013. Will Solvency II Market Risk Requirements Bite? The Impact of Solvency II on Insurers' Asset Allocation. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 38(2):250–273.

Houston, J. F., C. Lin, and Y. Ma, 2012. Regulatory Arbitrage and International Bank Flows. *Journal of Finance*, 67(5):1845–1895.

International Association of Insurance Supervisors (IAIS), 2009. Issues Paper on Group-wide Solvency Assessment and Supervision.

International Association of Insurance Supervisors (IAIS), 2012. Insurance Core Principles, Standards, Guidance and Assessment Methodology.

International Association of Insurance Supervisors (IAIS), 2013. Global Systemically Important Insurers: Policy Measures.

International Swaps and Derivatives Association (ISDA), 2014. ISDA/GFMA/IIF Response Letters to the BCBS's TBG on the Firm-wide FRTB QIS Instructions, July 17, 2014. (Available at: http://www2.isda.org/, accessed February 4$^{\text{th}}$ 2015).

Jones, D., 2000. Emerging Problems with the Basel Capital Accord: Regulatory Capital Arbitrage and Related Issues. *Journal of Banking & Finance*, 24(1-2):35–58.

Kupiec, P. and D. Nickerson, 2005. Insurers are not Banks: Assessing Liquidity, Efficiency and Solvency Risk under Alternative Approaches to Capital Adequacy. *Geneva Papers on Risk and Insurance - Issues and Practice*, 30(3):498–521.

Lord, K., 2014. Reinsurance in Capital Management, Effect of Reinsurance and Tiering of Own Funds at Insurers with Little Surplus Capital, Munich RE Solvency Consulting Knowledge Series.

Mälkönen, V., 2004. Capital Adequacy Regulation and Financial Conglomerates, Bank of Finland, Discussion Paper 10.

Menezes, F. M., 2009. Consistent Regulation of Infrastructure Businesses: Some Economic Issues. *Economic Papers: A Journal of Applied Economics and Policy*, 28(1):2–10.

Monkiewicz, J., 2007. Integrated, Consolidated or Specialized Financial Markets Supervisors: Is There an Optimal Solution? *Geneva Papers on Risk and Insurance – Issues and Practice*, 32(1):151–162.

Morrison, A. D. and L. White, 2009. Level Playing Fields in International Financial Regulation. *Journal of Finance*, 64(3):1099–1142.

Nabilou, H., 2013. Global Governance of Financial Institutions and Regulatory Arbitrage: the Case of Hedge Funds, Ludwig-Maximilians-University Munich, Faculty of Law, Working Paper.

Schwarze, J., 2011. Risikomanagement bei Banken und Versicherungsunternehmen - Ein Vergleich. In F. Wagner, editor, *Standpunkte - Beiträge renommierter Persönlichkeiten der Versicherungswirtschaft in Leipziger Seminaren*, pages 65–90. Verlag Versicherungswirtschaft, Karlsruhe, Germany.

Siegel, C., 2013. Solvency Assessment for Insurance Groups in the United States and Europe a Comparison of Regulatory Frameworks. *Geneva Papers on Risk and Insurance - Issues and Practice*, 38:308–331.

Thibeault, A. and M. Wambeke, 2014. Regulatory Impact on Banks' and Insurers' Investments, Vlerick Business School.

Van Roy, P., 2005. Credit Ratings and the Standardised Approach to Credit Risk in Basel II, European Central Bank, Working Paper No. 517.