Editorial Review Board

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5. To be an important force for the overall improvement of insurance regulation.

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Robert W. Cooper, Ph.D.

Recent discussion of the need for federal intervention in the current state-based insurance regulatory system has highlighted two other areas where a federal presence appears critical— regulation involving international insurance matters, and creation of a federal insurance/reinsurance information entity. This paper proposes a system of insurance regulation that both overcomes the numerous criticisms of the current state-based system, and achieves the purported advantages of an optional federal charter (OFC) system, but without the creation of the type of dual federal-state regulation envisioned in the current OFC legislation.

Martin Eling
Ines Holzmüller

This article provides an overview and comparison of risk-based capital requirements as they currently exist in the United States, the European Union, Switzerland and New Zealand, with a focus on property/casualty insurance. These four systems are representative of different ways capital standards are implemented around the globe.

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James Mumford

Recent years have seen a significant and rapid change in the way annuities, especially fixed annuities, are being sold. The American Council of Life Insurers endorses the NAIC Annuity Suitability in Annuity Transactions Model Regulation and its Annuity Disclosure Model Regulation, but not all states have adopted it. The industry is now asking for guidance from insurance regulators as to what they need to do to ensure compliance with the regulations. This is an opportunity for insurance regulators to establish early in the process the standards that companies and producers need to meet to provide the consumer protection required.

Legal Reviews

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An Overview and Comparison of Risk-Based Capital Standards

Martin Eling
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Abstract

This article provides an overview and comparison of risk-based capital (RBC) requirements as they currently exist in the United States, the European Union, Switzerland and New Zealand, with a focus on property/casualty insurance. These four systems are representative of different ways capital standards are implemented around the globe. The United States uses a static factor model; Switzerland considers dynamic cash-flow-based approaches; New Zealand integrates private rating agencies into its supervisory process. Other differences between these three countries include the use of different risk measures, the use of internal models, and varying consideration of operational risk and catastrophe risk. Regulators in the European Union are being influenced by all three of these approaches as they finalize the design of their new regulatory framework Solvency II. We integrate the current version of this approach in our analysis.

1. Introduction

Since the beginning of the 1990s, most major economies have changed their regulatory framework for the insurance industry from non-risk-based rules to a system of risk-based capital (RBC) standards. RBC standards are thus becoming increasingly the norm for capital regulation in the insurance industry. Canada and the United States were among the first countries to introduce RBC standards in 1992 and 1994, respectively. In 1996, Japan followed with the Solvency Margin Standard; Australia introduced its General Insurance Reform Act in 2001. Europe has been relatively slow to develop RBC requirements. The United Kingdom introduced its concept of an "enhanced capital requirement" and "individual capital assessment" in 2004, and Switzerland enacted the Swiss Solvency Test in 2006. Currently, the European Union (EU) is working toward harmonization across member countries, an effort that includes Solvency II—the implementation of RBC standards in all member countries.

On the topic of RBC standards, the literature to date addresses the economic effects of regulation in general, different methodologies for solvency regulation, and the predictive power of these models. Munch and Smallwood (1980), Rees et al. (1999), and Van Rossum (2005) discuss the economic effects of regulation on insurance markets. Most authors conclude with arguments against extensive solvency regulation. Munch and Smallwood (1980) find that minimum capital requirements reduce the number of insolvencies, but do so only because they reduce the number of small firms in the market, concluding that capital requirements are especially a burden for small insurers. Rees et al. (1999) show that insurers always provide enough capital to ensure solvency if consumers are fully informed of insolvency risk; they thus conclude that regulators should provide information rather than imposing capital requirements. Van Rossum (2005) points out the connection between the degree of regulation and costs, again highlighting the particularly strong effect on small insurers specialized in certain products and niches.

Brockett et al. (1994), Carson and Hoyt (1995), Browne et al. (1999), Baranoff et al. (1999), Segovia-Vargas et al. (2003), and Chen and Wong (2004) analyze alternative factors and methodologies for predicting solvency. One important aspect within this body of literature is the suitability of different risk measures for solvency measurement, such as the value at risk and the expected shortfall (see, e.g., Artzner et al., 1999; Barth, 2000). Focusing on RBC models, Cummins et al. (1995, 1999), Grace et al. (1998), and Pottier and Sommer (2002) empirically analyze the predictive power of existing solvency models, e.g., the U.S. RBC standards and A.M. Best's capital adequacy ratios. These authors conclude that the U.S. RBC ratios are not very effective in identifying financially weak insurers and that other measurers (e.g., those produced by the private sector) might be superior (see Pottier and Sommer, 2002).

This paper contributes to the literature by providing an overview and comparison of four representative solvency systems. As a review of all models

implemented around the globe is hardly feasible, we decided to focus on the U.S., the EU, New Zealand and Switzerland. These four are good examples of different regulatory approaches implemented around the globe. Other systems, such as the Japanese or the Australian, are similar to the U.S. system, but also include some features of the Swiss and the forthcoming EU systems (see Eling et al., 2007, for an overview). Our results are relevant both for regulators and for insurers that are required to implement the RBC measures in their risk management framework. Because we integrate measures of the private sector in our analysis, the results are also relevant for rating agencies. Our goal is to provide a compact overview of the variety of solvency systems implemented around the world and to encourage discussion on the future development of existing solvency systems.

The remainder of the paper is organized as follows. In Section 2, we describe the four selected standards in detail, starting with the U.S. model (Section 2.1), followed by the RBC requirements implemented in the EU (Section 2.2), New Zealand (Section 2.3) and Switzerland (Section 2.4). In Section 3, we compare the four elements of each system: (1) general information, (2) definition of capital required, (3) definition of available capital, and (4) levels of intervention. We conclude in Section 4.

2. Overview

The RBC represents an amount of capital that an insurance company holds to be able to fulfill its obligations against policyholders in the future with a high probability. As we will show in this section, there are different ways of determining this amount. To build a foundation for the comparison in Section 3, we will look at the same four elements of each system: (1) general information (i.e., basic model setting), (2) definition of capital required, (3) definition of available capital, and (4) levels of intervention.

2.1. U.S. RBC Standards

General Information

The U.S. insurance market is the largest in the world. Approximately $1.17 trillion, i.e., 31 percent of the worldwide premium volume, was generated in this market in 2006 (see Swiss Re, 2007; the data are for both for life and non-life insurance and cover direct premiums before cession to reinsurers). Prior to the development of RBC standards, U.S. solvency regulation varied between the states and relied on fixed minimum capital. However, in 1994, the RBC standards, developed by the National Association of Insurance Commissioners (NAIC), were introduced. This new U.S.-wide standard for capital adequacy intended to more accurately reflect the size and risk exposure of a company (see Grace et al., 1998). The RBC standards have two main components: The first is an RBC formula that establishes a minimum capital level, which is compared to the actual level of capital. The second is an RBC model law that grants automatic authority to the state

insurance regulator to take certain actions based on the company's level of impairment (see NAIC, 2005). In addition to the RBC standards, each state still has its own fixed minimum capital requirements, which range from \$500,000 to \$6 million (see Klein, 2005, p. 141). Furthermore, many state insurance regulators use their own measures to screen insurers (e.g., the Financial Analysis Solvency Tools, a scoring system consisting of 25 financial ratios and variables; see Grace et al., 1998). However, these are monitoring instruments only and do not impose capital requirements. Additional restrictions might be applied in individual U.S. states.

Definition of Capital Required

To take into account variations in the economic environments of different lines of business, there are three separate RBC models—one for life, one for property/casualty, and one for health insurance (see NAIC, 2005). All are based on the main principle that the variety of risks an insurer is exposed to must be assigned a corresponding equity capital. We consider the risk-based capital formula for a property/casualty insurer as an example:

$$RBC = 0.5 \cdot \left[R0 + \sqrt{R1^2 + R2^2 + R3^2 + R4^2 + R5^2} \right]$$

The RBC covers two main types of risks: asset risks (factors R1, R2, and R3) and insurance risks (factors R4 and R5). Furthermore, there is a factor for the risk of default of affiliates and off-balance-sheet items, such as derivative instruments and contingent liabilities (R0). R1 models the fixed-income investment risk. Two factors are important when calculating R1. First, to determine the necessary RBC, the portion in each fixed-income investment (e.g., a bond) is weighted by a quality coefficient according to an NAIC classification. Second, large single exposures are modeled by an asset concentration factor, i.e., the weighting factors for the 10 largest exposures are doubled. R2 models risk associated with other investments, such as stocks or real estate, again weighted with a given coefficient. R3 represents credit risk, which is the risk associated with reinsurance contracts. R4 is the underwriting reserve risk. It contains factors for provisions on outstanding claims that differ between branches. R5 reflects the underwriting premium risk. It covers the risk that the premiums collected in a given business year may not be sufficient to meet the corresponding claims (see Feldblum, 1996; Klein and Wang, 2007).

To illustrate how all these different charges are determined, we use the underwriting premium risk R5 as an example. R5 is calculated by multiplying a volume number with a factor. The R5 volume number is the business written in the coming 12 months. However, as the future underwriting volume is unknown, the factor charge is applied to the underwriting volume of the last calendar year. The factor itself is derived using the average loss ratios for the last 10 years for the insurer and for the whole industry. Comparing individual insurer and total industry ratios leads to a reduction in a factor charge if the insurer's average loss ratio is better than that of the industry, and leads to an increase otherwise. The company's

average expense ratio is then added to the loss ratio to form the so-called combined ratio. The combined ratio minus 1 provides the factor for calculating R5. If the combined ratio is less than 1, the capital charge is 0 (see Feldblum, 1996).

The RBC formula accounts for correlations between various types of risks, i.e., it includes a correlation adjustment in the formula. It reflects the fact that the total risk of a portfolio composed of several different risks (if they are not perfectly positively correlated) is lower than the sum of the isolated risks. The factor for affiliate insurers and other off-balance-sheet risks (R0) is not included in the correlation adjustment.

Definition of Available Capital

The required RBC is compared to the amount of available capital. In the U.S. system, available capital is defined as the total adjusted capital, i.e., the insurer's statutory capital and surplus. Furthermore, some other items as provided by the RBC instructions are added, e.g., half the dividend liability or a so-called asset valuation reserve (see NAIC, 2002, for more details).

Intervention

There are four intervention levels depending on the ratio of total adjusted capital to RBC (see Dickinson, 1997; Sandström, 2006, p. 170). A ratio larger than 200 percent represents the target situation. (1) If the ratio is between 150–200 percent, the company must submit a report (called company-action level). (2) If the ratio is between 100–150 percent, the insurer must submit an action plan (regulatory-action level). (3) If the ratio is between 70–100 percent, the regulator has the option of taking over management of the company (authorized-control level). (4) If the ratio is lower than 70 percent, the regulator is obligated to take over management of the company (mandatory-control level).

2.2. The EU Solvency I and Solvency II Framework

General Information

Premiums for all 27 EU countries combined accounted for 37 percent of worldwide premiums in 2006 ($1.39 trillion) and thus even exceeded the U.S. premium volume (see Swiss Re, 2007). In the EU, equity capital regulation is currently undergoing a reform. The European Commission (EC), the body responsible for proposing legislation in the EU, works toward harmonization across member countries as well as toward implementation of appropriate RBC standards. The implementation of the new regulatory framework follows a two-stage process: Solvency I and Solvency II. Solvency I, introduced in 2004, made modest modifications to the fixed ratios and rules-based capital standards that were already introduced in the 1970s (see EC, 2002a, for non-life insurers and EC, 2002b, for life insurers). Against it, Solvency II, intended to go into effect in 2012 for all EU insurance companies, will focus on an enterprise risk management approach. Further characteristics of the upcoming standards will be the use of

internal models to calculate capital requirements and the consideration of two levels of capital requirements: The actual capital of a well-capitalized insurer is supposed to be equal or higher than the SCR (solvency capital requirement, also called target capital) and therewith also higher than the MCR (minimum capital requirement; see Figure 1).

Definition of Capital Required

We first present the current Solvency I rules, introduced in 2004, again taking a non-life insurer as an example. The Solvency I MCR is given by the maximum of the premium basis (PB_t) and the claims basis (CB_t). These two are calculated as (P_t denotes the net premiums in period t; C_t^- is derived on the basis of the average claim payments over the last three years net of reinsurance):

$$PB_t = 0.18 \cdot \left(\min \left(P_t; €50 \text{ million} \right) \right) + 0.16 \cdot \left(\max \left(P_t - €50 \text{ million}; 0 \right) \right)$$

$$CB_t = 0.26 \cdot \left(\min \left(C_t^-; €35 \text{ million} \right) \right) + 0.23 \cdot \left(\max \left(C_t^- - €35 \text{ million}; 0 \right) \right)$$

$$MCR_t = \max \left(PB_t; CB_t \right)$$

The calculation of the MCR for life insurers follows a similar approach. It is based on mathematical reserves (an indicator for market risk) and capital at risk (an indicator for insurance technical risk). Along with these relative capital requirement levels, there is a minimum guarantee fund, which is irrespective of the size of the insurer. For non-life insurers this is €2 or €3 million, depending on the lines of business (see EC, 2002a, p. 21). Life and reinsurers each are required to have a minimum guarantee fund of €3 million (see EC, 2002b, p. 26). Obviously, Solvency I is comparatively crude and its theoretical foundation weak, but its application is very straightforward (see Farny, 1997). Perhaps the most important drawback to this system is that the capital requirements do not depend on the specific risk situation of the insurer, but mainly on its underwriting volume, which can lead to less-than-optimum practices by insurers, e.g., underpricing (the lower the premiums, the lower the MCR).

The Solvency II framework, as currently planned, is described in a directive published by the European Commission (see EC, 2007a). However, the process is ongoing and modifications are still possible. Similar to the solvency regulation for the banking industry (see Basel Committee on Banking Supervision, 2001), the Solvency II framework is based on three pillars: (1) quantitative requirements, (2) qualitative requirements and supervision, and (3) supervisory reporting and public disclosure (see Eling et al., 2007). In the following, we will focus on the first pillar, which is illustrated in Figure 1 (also see CRO and CEA, 2006).

Figure 1: Solvency II, Pillar I
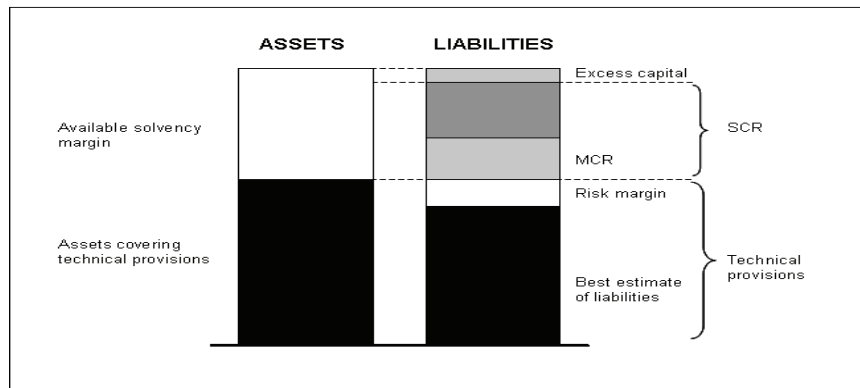
Pillar I takes an integrated balance sheet approach, i.e., it considers assets, liability, and the interdependencies between them. The liabilities are subdivided in technical provisions and the SCR. The MCR is a fraction of the SCR. The assets are subdivided in assets covering the technical provisions and the available solvency margin (to cover the SCR; if the available solvency margin is larger than the SCR, the residual is the excess capital). Both assets and liabilities are calculated at market value (see CEIOPS, 2007).

On the liability side, calculation of the technical provisions is based on their current exit value, i.e., the amount necessary to transfer contractual rights and obligations today to another undertaking (see Esson and Cooke, 2007; Duverne and Le Douit, 2007). The technical provisions are thus the sum of the best estimate of the liabilities and a risk margin, based on the cost-of-capital method. The SCR corresponds to the economic capital an insurer needs to limit the probability of ruin to 0.5 percent; it is determined as the value at risk at a 99.5 percent confidence level. To calculate the SCR, the insurer may choose between the standard approach and an internal model, the latter being subject to certain requirements and approval from the supervisor (see Liebwein, 2006). Larger undertakings will most likely use individual internal models. The internal models might then better reflect the true risk profile, lower the SCR and thus result in lower capital costs. Small insurers, which do not have sufficient personnel and financial resources to develop such models, might prefer the standard model. However, even this model allows for the use of personalized parameters and provides standardized simplifications for small and medium-size enterprises, in order to limit the disadvantages of small insurers (see EC, 2007b, p. 9). Solvency II also allows the use of partial internal models, i.e., internal models that are applicable only to certain individual risk modules or submodules (see EC, 2007a, p. 111).

It is yet to be determined how the MCR will be calculated, that is, whether it will follow the so-called "modular approach" or "compact approach" (see CEIOPS, 2006). The modular approach considers the value at risk at 90 percent

confidence level instead of 99.5 percent (the value used with the SCR). The compact approach sets the MCR at one-third of the SCR (EC, 2007a, p. 14). With either approach, however, the MCR will have an absolute floor of €2 million for life insurers and €1 million for non-life and reinsurers (see EC, 2007a, p. 118).

Definition of Available Capital

As mentioned, Solvency II divides assets into two categories (see Figure 1): (1) assets covering the technical provisions and (2) assets covering the MCR and SCR (available solvency margin). To account for different capability of assets to absorb potential losses, a classification of own funds is made and certain limits are set. This classification is shown in Figure 2 (see EC, 2007a, p.12).

Figure 2: Classification of own funds

	Assets on the balance sheet	Off-balance-sheet assets
High Quality	Tier 1	Tier 2
Medium Quality	Tier 2	Tier 3
Low Quality	Tier 3	/

Note: The three tiers indicate different quality and ability of own funds to absorb losses.

The first distinction is made between own funds that are on the balance sheet and those that are not. On-balance-sheet funds comprise the excess of assets above liabilities plus subordinated liabilities, which can serve as capital in case of liquidation. Off-balance-sheet funds are, for example, letters of credit or members' calls, which the insurer can use to increase its own financial resources. The second distinction applies qualitative criteria, such as loss absorbency and permanence, and assesses the funds as being of high, medium or low quality. The EC has yet to concretize those criteria via an implementing measure (see EC, 2007a, pp. 102-103). As a result, the available capital is classified into three groups called "tiers," with tier 3 items being less eligible to cover the MCR and the SCR than tier 2 and tier 1 items. The following limitations apply:

- The MCR requirement can be met only with tier 1 and tier 2 items on the balance sheet. The proportion of tier 1 items thereby needs to be at least one-half.
- With regard to the SCR requirement, the proportion of tier 1 items must be at least one-third, while the proportion of tier 3 items may not be higher than one-third.

Intervention

Two levels of intervention are possible, depending on the relation of available capital to the SCR and MCR (in the target situation, the available capital is higher than the SCR): (1) If the available capital is lower than the SCR, the regulator will take action aimed at restoring the insurer to a healthy condition. (2) If the available capital is lower than the MCR, the regulator will revoke the insurer's license. This will be followed either by the liquidation of the insurer's in-force business or a transfer of the insurer's liabilities to another insurer (see EC, 2007b, p. 5).

2.3. New Zealand's Self-Regulatory Framework

General Information

The life and non-life insurance premiums in New Zealand were approximately $5 billion for 2006 (0.15 percent of worldwide business; see Swiss Re, 2007). Regulation of the insurance industry in New Zealand is very different from the two approaches discussed above, in that the New Zealand market is one of the least regulated in the world. Insurers in that country are only required to comply with a self-regulatory framework, which intends to assure insurance customers of quality service. The framework, established by the Insurance Council in 1994, consists of three basic parts (see Insurance Council of New Zealand, 2007):

- The Fair Insurance Code is a contract between the insurer and the customer regarding ethical behavior on both sides. Customers should behave honestly by accurately disclosing all relevant information. The insurer should provide services and settle claims fairly and efficiently. Besides the obvious difficulty of identifying breaches of this code, sanctions are not well-defined. An insurer's breach of the code can lead to an investigation by the Insurance Council of New Zealand and, possibly, the taking of appropriate actions, which are not further specified.
- The Insurance and Savings Ombudsman Scheme (ISO) subjects the insurer to independent review by providing the customer with a point of contact in case of disputes. The ISO service is free of charge to the customer and uses the Fair Insurance Code as a basis for its decisions.
- The third part involves the Insurance Council's Solvency Test. The requirement of being financially sound is ensured via the obligation to obtain a rating and renew the same annually. All ratings are published on the regulator's Web page (see http://www.isu.govt.nz). If a rating agency is considering downgrading an insurer, it may issue a credit watch warning that is also published on the regulator's Web page. There are three rating agencies approved to issues these ratings: A.M. Best, Standard & Poor's (S&P), and Fitch Ratings.

As the third part of the framework is crucial in reviewing the New Zealand system, the rating procedure will be explained in more detail using A.M. Best ratings as an example. A.M. Best issues nearly half of all insurance ratings in New Zealand, whereas S&P performs most of the other ratings. Thus the most important differences between the A.M. Best ratings and the S&P ratings will be described below. Fitch plays only a minor role in New Zealand and therefore will not be detailed in this paper (see Fitch Ratings, 2001, for more information on their rating).

Best's Financial Strength Ratings are summary measures of the insurer's ability to pay present and future claims (see Pottier and Sommer, 2002). The sources of information on which the ratings are based include financial statements and, in most cases, an interactive exchange of information with company management. Quantitative as well as qualitative analyses are conducted to assess the insurer's financial strength. Three areas of Best's Financial Strength Rating can be distinguished (see Zboron, 2006):

- A.M. Best measures the exposure of a company's surplus to its operating and financial practices with the *balance sheet strength*. It takes into consideration a company's underwriting, financial, operating and asset leverage. The latter includes a company's exposure to investment, interest rate and credit risk associated with the assets held by the insurance company. The derivation of the balance sheet strength is further detailed below.

- The analysis of *operating performance* is especially important for insurers writing long-tail business. The underlying assumption is that operating performance drives profitability and, therefore, long-term balance sheet strength. To assess the operating performance, A.M. Best performs various profitability tests, e.g., on loss ratio, expense ratio, and combined ratio (see Zboron, 2006; A.M. Best, 2007b).

- An insurer's *business profile* has an influence on current and future operating performance and, subsequently, on balance sheet strength, again especially for insurers writing long-tail business. The corresponding analyses comprise, for example, the spread of risk, i.e., geographic, product, and distribution diversification, competitive market position, and management aspects (see A.M. Best, 2007b).

Definition of Capital Required

To assess balance sheet strength, the underwriting, financial and asset leverage are summarized to Best's capital adequacy ratio (BCAR). The BCAR is the ratio of the available capital (the adjusted surplus) divided by the net required capital (NRC). The insurer's BCAR is then compared to the median of its peer group. It represents the most important measure in the rating process. The NRC formula for property/casualty looks comparable to the U.S. RBC formula (see A.M. Best, 2003):

$$\text{NRC}=\sqrt{\text{B}1^2 + \text{B}2^2 + \text{B}3^2 + (0.5\ \text{B}4)^2 + \left[(0.5\ \text{B}4) + \text{B}5\right]^2 + \text{B}6^2} + \text{B}7 \quad (5)$$

Three main types of risk are covered. The first is investment risk, including fixed income securities (B1), equities (B2), and interest rates (B3). B3 reflects the potential drop in the fixed income portfolio of an insurer as a consequence of rising interest rates. The second type of risk covered is credit risk (B4), which reflects third-party default risk originating from, for example, reinsurers or affiliates. The third type, underwriting risk, includes the risks inherent in an insurer's loss reserves (B5) and the pricing risk inherent in a company's mix of business (B6). Outside the covariance adjustment, the formula accounts for off-balance-sheet items (B7), which A.M. Best also calls the "business risk component" (see A.M. Best, 2003). As under the U.S. RBC standards, the capital charges (B1 to B7) are calculated by multiplying a volume number with a factor. Different from the U.S. regulation is that the factors are calibrated to correspond to a 1 percent expected policyholder deficit, defined as expected deficit divided by the expected loss amount (see A.M. Best, 2007a; Butsic, 1994). Three adjustment factors are applied to the investment risk category. First, an asset concentration factor doubles the risk charge for all investments greater than 10 percent of the surplus. (Compared to that, the U.S. system doubles the charge for the 10 largest investments irrespective of their size.) Second, the spread of risk factor is a portfolio-size adjustment. If the portfolio has less than $5 million in invested assets, this factor can go up to 50 percent. Third, the investment leverage factor concerns stock investments that represent more than 50 percent or 100 percent of the reported surplus. In this case, the normal risk charge of 15 percent for stocks is increased to 20 percent or 30 percent (see Towers Perrin, 2006).

The analysis of the *balance sheet strength* (the BCAR), *operating performance* and *business profile* is then summarized to derive the insurer's financial strength rating. These ratings range from A++ (superior) to D (poor). Additional ratings are assigned to companies under review by the supervisory authority (E), companies in liquidation (F), and companies whose rating is suspended (S). The cut-off point between a *vulnerable* rating and a *secure* rating is located between B and B+. "Vulnerable" means that the company's ability to meet obligations to policyholders is fair, instead of good as in the case of "secure" rated insurers (see A.M. Best, 2007b). As of October 2007, approximately 80 percent of all New Zealand insurers rated by A.M. Best had a rating of A+, A or A–; approximately 10 percent had a B+ or B++. Less than 10 percent had a vulnerable rating of B or B– (see Ministry of Economic Development, 2007).

Definition of Available Capital

To derive the BCAR, the required capital is compared to an insurer's *adjusted surplus*. The adjustments are intended to even out differences between insurers and to account for economic values not reflected in the statutory financials. They mainly correspond to an insurer's equity and adjustments for unearned premiums, loss reserves and reinsurance. Furthermore, potential catastrophe losses and future

operating losses are considered. In contrast with the U.S. RBC model, qualitative factors, such as reinsurance quality, are also covered by those adjustments (see Pottier and Sommer, 2002; A.M. Best, 2003).

Intervention

There are no consequences for insurers who fall below a certain threshold rating or have been the subject of a credit watch warning. However, the implicit sanctions imposed by the market, e.g., higher cost of capital or reduced willingness to pay for policies, are assumed to be effective (see Pottier and Sommer, 1999). All ratings and credit watch warnings are published on the regulator's Web page. Additionally, the ratings must be disclosed each time an insurer enters into or renews a contract. If the insurer fails to comply with the disclosure requirements, the insured has the right to cancel the contract. Thus, New Zealand regulators completely rely on market discipline, presuming that market participants themselves enforce appropriate insurer behavior. There is no empirical evidence on the strengths and effectiveness of market discipline in the New Zealand insurance market. However, there is some evidence for market discipline in the U.S. insurance industry, e.g., premium purchases decline after a rating downgrade (see Epermanis and Harrington, 2006).

Similarly to A.M. Best, the S&P capital adequacy model takes into consideration all major quantitative and qualitative factors that influence the probability of insurer failure. Although the A.M. Best and S&P models are not identical, their basic rating methodologies are quite similar. The equivalent to A.M. Best's BCAR in the S&P model is the area capitalization, which employs a factor-based capital adequacy model (see S&P, 2007a). Historically, the main difference between A.M. Best's BCAR and S&P's capital model was that the latter did not explicitly account for diversification effects. However, with the new model introduced by S&P in May 2007, this is no longer true, albeit S&P still claims to handle diversification benefits more conservatively than do its competitors (see S&P, 2007b). Other differences between the two rating agencies include:

- Determination of A.M. Best's BCAR is oriented at the expected policyholder deficit concept, whereas S&P uses a value at risk concept. It applies stress tests to each risk variable, using the potential movement expected over a one-year period. A rating is then assigned for the occurrence of a policyholder loss at a certain confidence level (see S&P, 2007a).
- A.M. Best and S&P use different cut-offs when rating companies as either vulnerable or secure. A.M. Best sets this border between B+ and B ratings, whereas for S&P it is located between BBB and BB (see A.M. Best, 2007a; S&P, 2002). Above this cut-off point, A.M. Best distinguishes six rating categories, S&P four. There is no information available on the equivalence of the rating scales across rating agencies. Even if there was, such would be of questionable value, due to the

differing methodologies (see Pottier and Sommer, 1999). Furthermore, no clear indications could be found that one rating agency's method is systematically more rigid than the other's, or that one of them is consistently better at predicting insurer insolvency. However, Pottier and Sommer (1999) note that S&P ratings tend to be lower on average than the ratings given by A.M. Best.

- The importance assigned to the S&P capital model and the BCAR model by the respective rating agencies is different. A.M. Best claims the BCAR to very often be a "minimum requirement to support a certain rating" (A.M. Best, 2007a). On the contrary, S&P emphasizes that strength or weakness in capital adequacy can be more than offset by strength or weakness in other key areas, such as a company's market position, management and strategy (see S&P, 2007a).
- Both agencies make adjustments to their ratings based on size and concentration of invested assets. In contrast to A.M. Best, S&P makes no adjustment for high volumes of stock investment (see Towers Perrin, 2006).

2.4. Swiss Solvency Test

General Information
Accounting for 1.1 percent of the worldwide life and non-life insurance business, the 2006 premium volume of Swiss insurance companies was approximately $42 billion (see Swiss Re, 2007). This volume is eight times higher than that of New Zealand, although the Swiss population is only double that of New Zealand. The relatively high volume is explained by the extremely high share of overseas activities conducted by Swiss insurers, which amounted to 42 percent of their life and non-life insurance business in 2006 (see Swiss Federal Office of Private Insurance, 2006).

The Swiss Solvency Test (SST) went into force for large insurers in 2006, and will be mandatory for all Swiss insurance companies beginning in 2008. However, there is a grace period for compliance that will last until 2011, a time period insurers can use to ensure that they meet the requirements set forth by the new system. The SST is comparable to Solvency II in that determination of the capital requirements follows a two-level approach. The first level is a rules-based minimum capital analogue to the Solvency I rules. The second level is a required "target capital" based on market value, which we discuss in more detail below. The SST also includes a quality assessment that focuses on internal processes and risk control (similar to pillar II of Solvency II; see Swiss Federal Office of Private Insurance, 2007).

Definition of Capital Required
Under the SST, standardized factor models are used to calculate market, credit and insurance risks. Other risk categories such as catastrophes are covered by

scenario analyses. Figure 3 illustrates the modular structure of the SST (see Swiss Federal Office of Private Insurance, 2004). To determine target capital, the results of the standard models are aggregated with the results of the scenario analyses. Accompanying this aggregation is an extensive SST report, in which the insurer's exposure in the different risk categories is summarized. As with Solvency II, the SST allows the use of internal risk models instead of standard models (including the use of partial internal models for different risk categories).

Figure 3: Structure of the SST
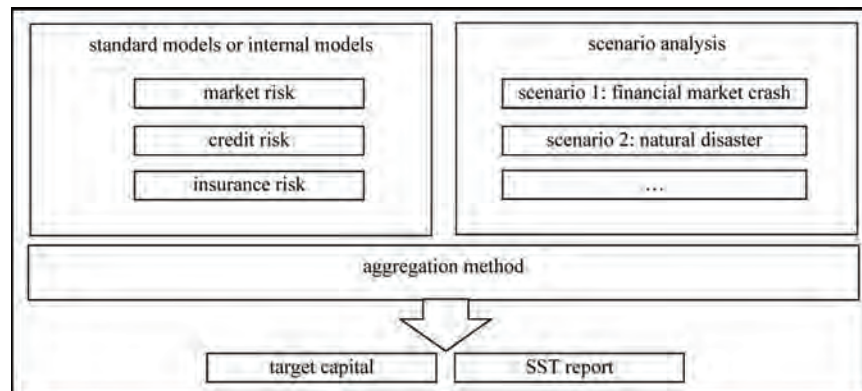
Interest rates, stock prices, currencies and real estate prices are considered in the *market risk* model. It is based on risk metrics developed by J.P. Morgan, the most widespread approach for calculating value at risk in the field of banking. The risk factors are multivariate, normally distributed and aggregated using a variance-covariance approach. The factors are estimated using 10 years of monthly returns of selected indices. Note that not all parameters are determined by the regulator. Several are estimated by the insurer itself based on its own portfolio, which illustrates a main difference of the SST compared to other approaches (principles instead of fixed rules).

The Basel II credit risk approach is used under the *credit risk* standard model. In contrast to Basel II, operational risks are not considered in the model. Instead these risks are considered on a qualitative basis within the SST report. Applying the Basel II approach within the SST framework has the advantage of being easy to implement and to reduce incentives for regulatory arbitrage between banking and insurance.

Three separate *insurance risk* models were developed for life, non-life and health insurance. There is no standard model for reinsurers, as these should employ adequate internal risk models for calculating insurance risk.

- The standard model for life insurance consists of seven risk factors, such as mortality, lapse rate, exercising of product options, and costs. All risks are modeled using a normal distribution and aggregated under given assumptions on correlations between these risks.
- In the non-life insurance model, risk is subdivided into three groups: small claims, large claims, and change in provisions (resulting from previous years' claims). Catastrophe risks are included as part of the scenario analyses. The sum of the small claims is modeled using a normal distribution, whereas for large claims, number and size are modeled separately. The number of claims is Poisson distributed. Each line of business has a specific distribution, e.g., a Pareto distribution, and given parameters for the claim size (see Luder, 2005).
- The health insurance standard model considers three lines: nursing expenses, individual per diem allowance, and collective per diem allowance. For each line, a mean and a standard deviation is estimated on the basis of historical data. The lines are aggregated using assumptions on the correlations between them (see Swiss Federal Office of Private Insurance, 2004).

Risks not covered by these standard models are covered by quantitative and qualitative scenarios. The qualitative scenarios are included in the SST report, while the quantitative scenarios are considered in calculating the target capital. Among the quantitative scenarios are natural disasters or a financial market crash. For these scenarios, probability of occurrence and resulting effect on the solvency level are estimated.

To calculate the target capital, the results of the standard models and of the scenarios are aggregated using a weighted average of the loss distribution of the standard models and the loss distribution of the scenarios (using the scenario probabilities as weights; see Swiss Federal Office of Private Insurance, 2004). The target capital should correspond to the economic capital an insurance company needs for running its business within a given safety level. It is calculated as the tail value at risk (also known as expected shortfall or conditional value at risk) of the aggregated loss distribution within a year at a confidence level of 99 percent.

Definition of Available Capital

Under the SST, the available capital is called risk-bearing capital and is defined as the difference between the market value of the assets and the best estimate of the liabilities. The regulator does not provide a method for estimating the market value of the liabilities. However, the embedded options and guarantees must be taken into account when determining the best estimate of the liabilities. Several different methods for present value calculation are deemed acceptable, such as risk-neutral valuation.

Intervention

The SST's provisions for intervention are still under construction, but will probably be in place by 2011, the end of the transition period. Current planning is going in the direction of Solvency II. There will be different intervention levels depending on the relation of available capital to target capital and minimum capital.

3. Comparison

In this section we compare the four systems described in Section 2 and analyze the main differences between them. Table 1 provides a summary of this comparison. The structure of the table reflects that of Section 2, i.e., it covers (1) general information, (2) definition of capital required, (3) definition of available capital, and (4) levels of intervention. The subsections below follow the structure of Table 1.

Table 1: Comparison of Solvency Systems

System	RBC standards	Solvency II	Self-Regulatory Framework	Swiss Solvency Test
1. General information				
Country of application	USA	European Union	New Zealand	Switzerland
Year of introduction	1994	2012 (expected)	1994	2006
Main pillars	1. Rules-based RBC formula 2. RBC model law on intervention authority	1. Quantitative regulations for capital requirements 2. Qualitative supervisory review 3. Public disclosure	1. Fair Insurance Code 2. Insurance and Savings Ombudsman Scheme 3. Insurance Council's Solvency Test	1. Principles-based target capital model 2. Risk management report 3. Quality assessment
Regulated companies	Insurers (domestic & foreign); no reinsurers	Insurers and reinsurers (domestic & foreign)	P&C insurers (domestic & foreign); no life insurers or reinsurers	Insurers and reinsurers (domestic & foreign)
Consideration of management risk	No	Rudimentarily addressed by pillar II	Yes	No
Public disclosure requirements	Yes	Yes	Yes	No
2. Definition of capital required				
Model typology	Static factor model	Static factor + dynamic cash-flow model	Static factor model	Static factor + dynamic cash-flow model
Rules- versus Principles-based	Rules-based	Principles-based	Principles-based	Principles-based
Total balance sheet approach	No	Yes	Yes	Yes
Time horizon	1 year	1 year	1 year	1 year
Risk measure/calibration	No risk measure	Value at risk/99.5% confidence level	A.M. Best: Expected policyholder deficit S&P: Value at risk	Expected shortfall/ 99% confidence level
Consideration of operational risk	Not explicitly (implicit via off-balance-sheet items—R0)	Quantitatively	A.M. Best: No explicit consideration S&P: Quantitatively	Qualitatively
Consideration of catastrophe risk	No	Yes (as part of underwriting risk)	Yes	Yes
Use of internal models	No	Appreciated	No	Appreciated for insurers; required for reinsurers
3. Definition of available capital				
Definition based on market or book values	Book values	Market values	Market values	Market values
Classification of available capital	No	Yes (three tiers)	No	No
Consideration of off-balance-sheet items	No	Yes	Yes	No
4. Intervention				
Levels of intervention	4	2	No intervention by regulator, but market discipline	2
Clarity of sanctions	Strict, clear rules	Not clear yet	No direct sanctions	Not clear yet

3.1. General Information

Country of Application/Year of Introduction

The U.S. RBC standards have been in effect since 1994 without major revisions. In the same year, New Zealand's Fair Insurance Code was introduced. However, due to its reliance on different rating agencies, the underlying models were adapted continuously. The two youngest models are the SST (introduced in 2006) and Solvency II (currently developed, expected to be effective in 2012). The Solvency I rules currently in use in the EU were implemented in the 1970s, with a minor revision in 2004.

Transferring the task of model revision to rating agencies as done in New Zealand seems to be a flexible way of ensuring that a system reflects recent developments in the insurance and financial markets and recent findings in academic research. The fact that only a few rating agencies (selected by the Ministry of Economic Development) are authorized to issue ratings reduces incentives for moral hazard by the rating agencies, e.g., to systematically provide better ratings than other rating agencies. Additionally, inaccurate or wrong ratings by a rating agency might be punished not only by the regulator, but also by the market, which would lose faith in the agency's ratings. Thus the demand for ratings from that rating agency would decrease. This also reduces incentives for moral hazard by the insurance companies, e.g., to exert pressure on the rating agency. Another idea in the context of flexibility, which we will address below, is to use principles-based approaches instead of strict rules, as done in the SST.

Basic Setting

The 1994 U.S. standards consist of a formula for determining an amount of necessary capital. Younger systems, such as the SST and Solvency II, take a more holistic approach and take both quantitative and qualitative aspects into consideration. Based on an analysis of failures and near-failures of insurance companies, it appears that the root of most insurance company failure is inexperienced management (see Conference of Insurance Supervisory Services of the Member States of the European Union, 2002; Ashby et al., 2003). Regulators thus also should include qualitative criteria, such as assessment of management capabilities, in the review process. This might then result in several segments of regulation with different criteria as can be seen under Solvency II: Pillar I addresses quantitative requirements and pillar II qualitative aspects. The U.S. system, in contrast, does not focus on qualitative aspects; however, these can be addressed by additional rules in individual states. Another interesting difference between the systems is that some regulatory authorities do not rely completely on their own assessment, but also take the opinion of the market into consideration. This is the third pillar of Solvency II and the main foundation of New Zealand's self-regulatory approach.

Regulated Companies

Solvency II and the SST are effective for all insurance undertakings, i.e., property/casualty, life, health and reinsurers. In contrast, the U.S. RBC standards do not apply to reinsurers (these are subject to regulation in their state of domicile). New Zealand's framework applies neither to reinsurers nor to life insurers. Regulation of life insurance in New Zealand is conducted by way of several legislative frameworks, of which the Life Insurance Act of 1908 is the most important. However, an extensive review of life insurance regulation in New Zealand is currently in process (see Law Commission of New Zealand, 2004).

Another question in this context is how to regulate third-country insurers and insurance groups. All four systems studied here apply the country-of-destination principle. This makes all insurers conducting business in the country, domestic or foreign, subject to national legislation. An alternative is the country-of-origin principle. Solvency II aims to facilitate compliance with regulation for foreign insurers with affiliates active in the EU when the home country's solvency regime is at least equivalent to that of the EU (see EC, 2007a, p. 238). However, cross-country operations would be best facilitated by global harmonization of solvency frameworks.

Consideration of Management Risk

As mentioned, regulators have recently begun to include qualitative aspects in their review processes, an important part of which is assessment of management capability. Rating agencies (e.g., A.M. Best and S&P), as compared to regulators, have a great deal of experience with this type of assessment, and an important part of it is the interactive exchange of information with management. This type of evaluation is not even a part of the U.S. RBC system. However, Solvency II addresses management capabilities, in that it specifies that board members, senior management, and people in key management positions must be "fit and proper" (EC, 2007b, p. 8). More precisely, an insurer is required to demonstrate that its board collectively has sufficient knowledge and expertise to exercise effective supervision (see EC, 2007b, p. 8). Insurers are also obligated to provide the regulator with certain information concerning board members (see EC, 2007a, p. 73).

Public Disclosure Requirements

A new aspect of insurance regulation is market transparency, especially via public disclosure requirements. A transparent process should result in less regulation as market participants themselves ensure appropriate behavior. Academic evidence highlights the advantages of public disclosure (see, e.g., Rees et al., 1999; Epermanis and Harrington, 2006). Market discipline thus might be a building block in creating a strong and solvent insurance industry. Extensive disclosure requirements are the main foundation of New Zealand's regulatory system. Under Solvency II, market discipline is addressed within pillar III, which obliges insurers to issue an annual public report on their solvency and financial condition (see EC, 2007a, p. 77). U.S. insurers are required to report the RBC and

their available capital in their annual statements; however, the detailed calculations remain confidential (see Klein, 2005, p. 143). Currently, there are no disclosure requirements under the SST. Rating agencies have recently been criticized for the lack of transparency of their rating assignment methodologies (see Doherty et al., 2007). The publicly available rating information serves as advertising material and thus cannot be relied on for insight into the objectivity of the rating procedures. An insurer's rating might be of some use in comparing companies, but it is difficult to understand why an insurer received the rating it did. Furthermore, mainly due to recent failures of rating agencies to provide adequate information (e.g., U.S. mortgage crisis, Enron, Worldcom), the concentration of market power in a small number of rating agencies has been questioned (see Doherty et al., 2007).

3.2. Definition of Capital Required

Model Typology

The regulatory models used in practice can be classified as either static factor-based models or dynamic cash-flow-based models (see Eling et al., 2007). Static factor-based models apply a certain factor to a static accounting position. Dynamic cash-flow-based models, on the contrary, use projected future cash flows as a basis for calculation (see CEA and Mercer Oliver Wyman, 2005). The U.S. and the rating agencies use static factor models. Solvency II and the SST are risk-based factor models combined with scenarios, e.g., for financial market crisis and natural disasters. Both allow the use of dynamic cash flow models.

Rules- Versus Principles-based Approach

The U.S. RBC standards is a rules-based approach, with a precisely defined solvency formula and no built-in flexibility to handle individual situations (see Klein and Wang, 2007). On the one hand, this simplifies supervision. However, on the other hand, it is not a very effective way of assessing the wide range of insurance risk profiles. Against it, principles-based approaches provide the insurer the opportunity of integrating regulatory requirements into its own risk management processes. The resulting alignment of business and regulatory objectives leads to more efficient insurance regulation (see FSA, 2007). The EU Solvency II framework, the SST, and the New Zealand model are all principles-based approaches.

Total Balance Sheet Approach

Under a total balance sheet approach, capital requirements are calculated based on a comprehensive analysis of risks, taking into account the interaction between assets and liabilities, risk mitigation, and diversification (see CEA, 2007). The U.S. RBC standards do not follow this approach. These standards do not adequately account for correlation between different risks because they employ a simple covariance formula (see Farny, 1997). Even though A.M. Best applies a similar covariance formula, its rating model achieves more of total balance sheet

assessment because it considers risk mitigation techniques and diversification effects, among others. Solvency II, the SST, and the model used by S&P include all relevant activities of the insurance companies and their risk-driving factors and thus can be considered total balance sheet approaches (see Liebwein, 2006).

Time Horizon

The models use different lengths of data history as input for the calculations—the U.S. model, for example, includes the loss ratios of the past 10 years; in the Solvency II model, the data encompass the past 15 years (see Klein and Wang, 2007; CEIOPS, 2007). For long-tail business, future cash flows are generally calculated using historical payout patterns. For example, in the SST, payout patterns derived for the next 25 years are used in long-tail lines such as liability and transport (see Bundesamt für Privatversicherungen, 2006, p. 20). The future cash flows are discounted in order to obtain a best estimate of the liabilities. The resulting capital requirements should then cover the risks that the insurer faces within a one-year time horizon, i.e., the capital required is calculated as the capital the insurer needs for running its business at a given safety level for the next year. This seems generally appropriate, especially for non-life insurers, as these mainly write annual contracts. However, some lines of business have long-term character. For example, in liability the claim settlement may take decades. Life insurance business also has long-term nature. When modeling liabilities, the (stochastic) trend of mortality must therefore be taken into consideration. Asset modeling for life insurance is also different from that of non-life insurers because of the different investments horizon. Therefore, especially in the life insurance business, a longer time horizon might be more appropriate. However, to date, this would be possible only under internal models in the SST and Solvency II.

Risk Measure/Calibration

There has been a long and intense discussion in academia and practice regarding the use of different risk measures in regulation (see, e.g., Artzner et al., 1999; Barth, 2000). Solvency II relies on the value at risk at a 99.5 percent confidence level. Statistically, regulators thus deem acceptable a 1-in-200 chance of the insurer becoming insolvent (see EC, 2007b, p. 5). In contrast, the SST uses the expected shortfall, which corresponds to the tail value at risk, at a 99 percent confidence level. The main difference between value at risk and tail value at risk is that the latter takes the expected tail loss into consideration while the first approach relies on ruin probability. The tail value at risk is thus more relevant to policyholders since it is they who have to bear the loss in case of insolvency. Shareholders, who have a limited downside risk (in case of limited liability), might be more interested in the ruin probability. Another advantage of the tail value at risk is that it has a number of desirable mathematical features, such as additivity and convexity (see Artzner et al., 1999; McNeil et al., 2005, p. 243). One drawback, however, is its reliance on a precise estimation of the costs in case of insolvency, which are difficult to obtain in practice. The value at risk approach has the further advantage that it is widely used in practice and is possibly one of the best understood risk measures.

The Swiss, the New Zealand, and the EU systems all have in common that they determine a stochastic distribution of the future outcomes (or cash flows) and then apply a risk measure to derive the capital requirements. For example, one might consider the 0.5 percent quantile of this stochastic distribution, which leads to the value at risk at a 99.5 percent confidence level (as considered under Solvency II). In contrast, the U.S. system does not operate on the stochastic nature and distribution of capital requirements and therefore does not apply any risk measure when deriving the RBC.

Consideration of Operational Risk

Operational risk is the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events (see Basel Committee on Banking Supervision, 2001). Although this definition originates in the banking sector, operational risk is also highly relevant in the insurance industry. Solvency II follows Basel II by using various quantitative approaches to measure operational risk (i.e., basic indicator approach, standardized approach, advanced measurement approach). Against it, the designers of the SST argued that it is impossible to properly quantify operational risk. They thus decided to include it on a qualitative basis. Under the SST, management must complete a qualitative statement, which becomes part of the SST report. The U.S. system does not explicitly address operational risk, but it could be interpreted as part of the off-balance-sheet items (R0). Rating agencies vary in the way they take operational risk into consideration. A.M. Best does not explicitly assess them. S&P includes them on a quantitative basis using a factor-based approach with premiums written and total liabilities as variables.

Consideration of Catastrophe Risk

Catastrophe risk has become important in recent years due to adverse developments such as climate change (see Klein and Wang, 2007). Accordingly, of the systems under evaluation here, only the older U.S. standards do not incorporate catastrophe risk. The Solvency II directive explicitly states that extreme events should be considered within the underwriting risk category (see EC, 2007a, pp. 107–108). Within A.M. Best's rating process, catastrophe stress tests are conducted. These tests not only evaluate the insurer's financial resilience, but also their overall catastrophe risk management process (see A.M. Best, 2007b). S&P only partially includes catastrophe risk, in that it applies a catastrophe capital charge to property/casualty insurers, but not to life insurers (see S&P, 2007a). The SST includes catastrophe risk via predefined scenarios (see Swiss Federal Office of Private Insurance, 2004).

There are various ways to include catastrophe risk in regulation, and these also should reflect the multiple alternatives for catastrophic risk financing, including reinsurance, options, swaps, catastrophe bonds, and weather derivatives. With regard to regulation, it is important to ensure that insurers will be motivated to use these devices and techniques in an appropriate manner. An extensive study on alternative means of catastrophic risk financing, its current status in the U.S.

and EU solvency systems, and various proposals for improvement can be found in Klein and Wang (2007).

Use of Internal Models

Another recent innovation in regulation is the use of internal, instead of standard, risk models in determining the solvency capital required. On the one hand, those internal models result in more accurate analysis, control and management of the insurer's financial situation than do the more generic standard models. On the other hand, the regulatory authorities need resources to review all the different sophisticated models. The use of internal models is allowed under Solvency II and the SST, but not under the U.S. RBC standards. Under the SST and Solvency II, regulators can even *require* the use of an internal model if the insurer's particular conditions are substantially different from standard model assumptions (see EC, 2003, p. 39; Bundesamt für Privatversicherungen, 2006). Furthermore, reinsurers are required to use internal models under the SST (see Swiss Federal Office of Private Insurance, 2004). In New Zealand, an insurer's internal model is considered an add-on to the rating agencies' models (see S&P, 2007a).

3.3. Definition of Available Capital

Market/Book Values

One of the main criticisms of the U.S. system relates to its use of book values (see Grace et al., 1998). Market values are considered a more appropriate and accurate indicator of an insurer's risk profile. However, it is difficult to derive these market values. The SST states that observable market prices are to be used wherever possible (so-called marking-to-market). If not available, comparable market values, taking into account liquidity and other product-specific features, or values derived on a model basis (marking-to-model) should be used (see Swiss Federal Office of Private Insurance, 2004). Solvency II stipulates a mixture of marking-to-market and marking-to-model valuation (see Sandström, 2006, p. 152). A.M. Best and S&P both rely on market values and make adjustments when these are not available (see A.M. Best, 2007a; S&P, 2007a).

Classification of Available Capital

There are different ways to ensure that an insurer has sufficient assets to fulfill policyholder obligations. One involves restrictive investment rules for insurers. However, these rules also reduce investment return, which in turn increases policy prices (see Klein, 1995). Another approach is to limit the eligibility of certain asset classes to offset capital requirements. Solvency II follows this approach and identifies three tiers of capital, along with clear guidelines for the accountability of each tier against capital requirements (see EC, 2007a, p. 12). The SST, the U.S. RBC standards, and the rating agencies only identify one overall amount of available capital. However, they also differentiate between the quality of different

asset classes (e.g., subordinated debt or hybrid instruments) by either limiting or adjusting the value of these assets when calculating the available solvency margin.

Consideration of Off-Balance-Sheet Items

In addition to capital recorded on the balance sheet, Solvency II, S&P, and A.M. Best also consider off-balance-sheet items when determining an insurer's available capital. Those can be letters of credit, which the insurer can call upon and therewith gain additional financial resources to meet policyholder obligations. Off-balance-sheet items that decrease the amount of available capital include, for example, guarantees for affiliates issued by the insurer itself. Only A.M. Best makes deductions based on off-balance-sheet items from available capital. Solvency II and S&P, in contrast, consider only those off-balance-sheet items that increase the available capital. The SST and the U.S. standards do not consider off-balance-sheet items at all when determining an insurer's *available* capital. However, the U.S. standards and the A.M. Best model consider off-balance-sheet items, such as derivative instruments or contingent liabilities, when calculating the insurer's *required* capital. One goal of Solvency II is to coordinate the recognition of off-balance-sheet items with the development of the International Financial Reporting Standards (see Duverne and Le Douit, 2007).

3.4. Intervention

Levels of Intervention

There is a fair amount of variation in the intervention approaches of the four systems. The U.S. system has four different levels of intervention, whereas the Solvency II system planned for the EU and the SST have only two. The New Zealand system has no levels of intervention.

Clarity of Sanctions

The U.S. system has relatively strict rules with clear sanctions for each of the five levels of solvency it encompasses. Interventions are relatively soft in the Swiss and EU systems, where it is vaguely specified what intervention should take place at each of the solvency levels. The less detailed system of intervention can again be characterized as a principles-based approach—that is, the essential purpose of intervention is the minimization of policyholder loss (see Klein, 1995). There is no evidence as to whether the relatively strict U.S. rules, the soft rules of the SST, or the New Zealand system of sole reliance on market forces has the best outcome as to protecting policyholders.

4. Conclusion

The aim of this paper was to provide an overview and comparison of the risk-based capital (RBC) requirements implemented in the U.S., the EU, New Zealand, and Switzerland. Differences in the time of introduction, industrial environment, and regulatory philosophy have resulted in very different kinds of regulation. Some systems impose very clear and strict rules (the U.S.); others simply provide a few principles, leaving the insurers with a great deal of discretion in conducting their businesses (Switzerland). Another extreme is to provide nothing else than the requirement to obtain a rating (New Zealand). It is as yet unclear exactly what form and direction regulation will take in the EU, where regulators are currently in the process of developing the new Solvency II framework. However, the three-pillar structure (I–Quantitative requirements; II–Qualitative requirements; III–Public disclosure) on which the new regulations will be based shows that the regulators have considered and been influenced by all the different types of solvency regulation examined in this paper.

In summary, the three most important differences between the solvency systems analyzed in this paper are as follows:

1. Two different risk measures—value at risk and expected shortfall—are used. Whereas value at risk is the simpler and more widespread approach, expected shortfall takes into consideration the severity of a possible insolvency, which is important from a policyholder and thus also from a regulatory point of view. In addition, expected shortfall has some valuable mathematical features that the value at risk has not. Each measure has its advantages and disadvantages, and it is difficult to say which one is better. However, academic evidence suggests that expected shortfall might be more appropriate (see Artzner et al., 1999).

2. Solvency II and the Swiss Solvency Test (SST) encourage the development and use of internal risk models to calculate RBC. Internal models provide a more accurate and individualized assessment of an insurer's solvency position compared to the standardized models that are the foundation of the U.S. system and of the private ratings agencies. Developing internal models can foster innovation in insurance companies and provide the insurer with the opportunity to integrate regulatory requirements into its risk management process. However, it remains to be seen whether regulatory authorities will have the resources to deal with a large number of different and highly sophisticated models.

3. The importance of accounting for operational and catastrophic risk is unquestioned, but how to best measure it is contested. There are great differences in the way the four systems cover operational risk: There is no explicit consideration in the U.S. standards or in the A.M. Best model.

The SST makes a qualitative assessment, whereas under Solvency II, operational risk is a quantitative factor. Similarly, catastrophe risk is variously integrated into the different models, including by way of catastrophe stress tests (in the SST), submodules to underwriting risk covering extreme events (planned under Solvency II), simple capital charges (S&P), and quantitative stress tests in combination with qualitative assessment of catastrophe risk management processes (A.M. Best).

This comparison of the various systems reveals that there is not one single capital standard in the insurance industry; indeed, there is a fair amount of variation in how the insurance industry is regulated around the world. Thus, comparing the systems provides an opportunity to learn from other countries. There is only limited empirical evidence on the outcome of the different models in terms of costs and benefits, and it is thus not obvious which system is the best and/or most efficient. Therefore, comparing the different approaches and recognizing differences is important, especially as a basis for identifying the best way to determine RBC standards.

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