The United States RBC Standards, Solvency II and the Swiss Solvency Test: A Comparative Assessment

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Cummins *et al.* (1994) provide a conceptual framework for policymakers to use in analysing risk-based capital systems. Based on their framework, this article provides an overview and critical analysis of risk-based capital requirements, with a focus on property/casualty insurance, as implemented in three regions of the world (the United States, the European Union and Switzerland). To integrate the dynamics of the insurance and capital markets and recent developments in regulation we add four new criteria to the original framework of Cummins *et al.* The analysis reveals various shortcomings of the standards used in the United States and indicates a need for reform in that country. In contrast, the Swiss standards and the framework planned for the European Union perform generally well. It is, however, not yet possible to identify which of these two systems is superior, as empirical evidence on their effectiveness in protecting policyholders is still lacking.
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Introduction

Insurance company insolvency may have disproportionately high costs for the customer, and even for society as a whole, compared to insolvency in other industries. This is partly because policyholders buy insurance to protect themselves against a particular loss, so when the loss occurs and the insurance company becomes insolvent and unable to pay the claim, it is possible that the policyholder's very economic existence is jeopardised. The insolvency of an insurance company can also affect the economic existence of a third party, for example, in the case of liability insurance. Imperfect information on the solvency status of insurance companies, combined with the severe consequences of insurance company failures, make regulation of the insurance industry, with the aim of decreasing the risk of insolvency, of public interest.[1] However, regulation comes at a cost. Although a well-designed regulatory framework can reduce the risk of insurer insolvency, it can also distort the decisions of financially sound insurers. These distortions create market inefficiencies, leading to an eventually even lower safety level and higher premium prices.[2] Also, ineffective

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[1] For example Klein (1995).
[2] Cummins *et al.* (1995).

regulatory frameworks can give insurance companies, the regulator and policyholders a false sense of security.

Cummins *et al.*,[3] among others, analyse this regulatory trade-off. They review major criteria affecting an insurer's insolvency risk and discuss the rationale and objectives of solvency regulation in the form of risk-based capital (RBC) standards. The main contribution of their work is a conceptual framework that stakeholders of insurance companies can use to evaluate RBC standards. To our knowledge, two applications of these criteria have been published to date. KPMG[4] use a related set of criteria in their study of different methodologies for assessing an insurer's financial position. However, they do not explicitly consider existing solvency regulation systems. Doff[5] utilises the Cummins *et al.*[6] framework and explicitly considers the Solvency II standards. Doff encouraged us to engage in research that would extend the contributions of his paper and also that of Cummins *et al.*[7]

Since the publication of Cummins *et al.*,[8] capital regulation has changed dramatically; the former volume-driven capital requirements have, for the most part, been replaced by risk-sensitive capital requirements. This change was a response to underlying changes in the insurance and capital markets, including, for example, the convergence of the banking and the insurance business, and the increasing complexity and interdependence of insurer assets and liabilities.[9] We account for these changes and trends by adding four new criteria to the original framework of Cummins *et al.*[10]. These new criteria put special emphasis on the dynamics of insurance and capital markets, as well as on recent developments in regulation. This extension of Cummins *et al.*'s list of criteria is the paper's first contribution.

Our second contribution is an application of this extended framework. Using all (now) 11 criteria, we analyse the RBC requirements of the United States, of the Solvency II framework of the European Union (EU), and of the Swiss Solvency Test (SST) of Switzerland. We consider the U.S. RBC requirements and the Solvency II framework as most important, as these regulations cover the two largest insurance markets in the world, accounting for almost 70 per cent of the global life and non-life premiums in 2006.[11] We further integrate the SST in our analysis to allow for a comparison of the SST with Solvency II against the background of a set of predefined criteria. This provides the opportunity to assess the compatibility of the SST with Solvency II, which is an explicit goal of the Swiss regulator. This paper's contributions are of value for both regulators and insurers, perhaps most especially for those insurers engaged in activities in more than one of the three geographic regions.

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[3] Cummins *et al.* (1994).
[4] KPMG (2002).
[5] Doff (2008).
[6] Cummins *et al.* (1994).
[7] *Ibid.*
[8] *Ibid.*
[9] See van Rossum (2005).
[10] Cummins *et al.* (1994).
[11] Swiss Re (2007).

The remainder of this paper is organised as follows. The next section provides a short overview of the three systems. A critical analysis, structured along the individual criteria, is conducted in "Critical analysis of RBC standards" section. In the last section, we provide a summary of the results as well as an integrated assessment of each of the three systems.

RBC standards: an overview

This section provides a short overview of the three systems under consideration. The requirements of each system are quite different, ranging from a pure RBC formula (implemented in the United States) to a comprehensive analysis of quantitative and qualitative criteria, including disclosure requirements, as planned in the EU.[12]

U.S. RBC standards

The National Association of Insurance Commissioners (NAIC) introduced the U.S. RBC standards in 1994. This framework aims to incorporate the size and risk profiles of insurers when determining capital requirements. To account for the differences between lines of business, the framework contains three separate formulas to calculate the required capital for property/casualty, life, and health insurance.[13]

Each of the three RBC formulas is an aggregation of individual risk charges for prescribed risk categories. The property/casualty formula, for example, includes charges for underwriting, credit, asset and growth risk. The aggregation of the risk charges includes a covariance adjustment in order to account for the diversification between the risk categories. The individual risk charges are factor-based. More precisely, the risk charges are calculated by multiplying a certain factor with a volume number. For example, the volume number employed to calculate the underwriting risk charge is comprised of the insurer's reserves and the insurer's premiums written within 1 year.[14] In addition to the capital requirements based on these RBC formulas, each insurer must comply with state-specific rules.

Comparing an insurer's available capital with the amount of capital required provides information on the insurer's financial strength. Under the U.S. standards, the available capital corresponds to the total adjusted capital, which equals total surplus for most insurers.[15] Depending on how total surplus compares to RBC, the regulator applies one of five action levels to the company: (1) no action is required; (2) the insurer must submit a corrective plan to the regulator; (3) the regulator may issue a corrective order against the insurer; (4) the regulator may require the liquidation or rehabilitation of the insurer; or (5), and most severe, the regulator must require the liquidation or rehabilitation of the insurer.[16]

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[12] For a more detailed overview of the three systems, see Eling and Holzmüller (2008).
[13] Grace *et al.* (1998).
[14] Cummins *et al.* (1995).
[15] Grace *et al.* (1998).
[16] Dickinson (1997).

Solvency II in the EU

EU insurance regulation is in a transition phase. Solvency I has been in effect since 2004. This framework is a rules-based approach, under which capital requirements are calculated by applying fixed ratios to measures for risk exposures. Those measures can be technical provisions, premiums or claims.[17] Solvency I is a transitional regulatory scheme that will be abandoned when Solvency II comes into effect, which is expected to occur in 2012.

The goal of the Solvency II framework is to harmonise insurance regulation across the EU member countries, improve policyholder protection and increase the stability of the financial system as a whole. To achieve these goals, Solvency II follows a three-pillar structure: capital requirements (Pillar I), qualitative requirements (Pillar II), and public disclosure rules (Pillar III). Within Pillar I, the determination of capital requirements follows a two-level approach. The solvency capital requirement (SCR) is the target capital level the insurer should aim for; the lower level, the minimum capital requirement (MCR), is the minimum capital necessary to protect policyholder interests.[18]

Under Solvency II, there are two main ways to determine an insurer's SCR. First, and new to insurance regulation, insurers can calculate the SCR using their own internal models, provided those models have been approved by the regulator.[19] The internal models are, of course, entity-specific and hence reflect an insurer's actual risk situation more accurately than is possible using a generic model. The second way of determining the SCR is by use of a standard model, a one-size-fits-all approach. The Solvency II standard model is still to be finalised, which is expected to occur in the second half of 2009. Further discussion in this paper thus will be reference to the current proposal, detailed in Committee of Insurance and Occupational Pension Supervisors (CEIOPS).[20] In addition to these two possibilities for determining SCR, insurers can use a combination method comprised of the standard model supplemented with internally developed components.

Under Solvency II, an insurer's available capital is measured according to its ability to absorb losses. This measurement results in three classes of capital, each of which have differing eligibility to offset the MCR and the SCR. The European Commission still has to finalise this classification system via implementing measures.

Depending on the ratio of available capital to SCR and MCR, three levels of intervention are possible: (1) no intervention when the insurer's available capital is equal to or greater than the SCR; (2) if the insurer's available capital falls between the SCR and the MCR levels, the regulator will take action with the goal of restoring the insurer to situation (1); (3) if the insurer's available capital is less than the MCR, the regulator will withdraw the insurer's license. The insurer's ongoing business is then liquidated, or its liabilities are transferred to another insurance entity.[21]

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[17] Linder and Ronkainen (2004).
[18] EC (2007a).
[19] CEIOPS (2007b); van Rossum (2005).
[20] CEIOPS (2007a).
[21] See EC (2007a, b).

Swiss solvency test

The Swiss Federal Office of Private Insurance developed the SST in close cooperation with the Swiss insurance industry and academic representatives from the field of insurance. The project began in 2003 and was field-tested in 2004 and 2005. In 2006, the new framework became applicable for large insurers and, since the beginning of 2008, is now in effect for all insurers.[22]

The main goal of the SST is similar to that of Solvency II: protection of policyholder interests. Furthermore, the SST has increased the transparency of the insurance industry by, for example, the introduction of consistent, industry-wide valuation techniques. Apart from these two main objectives, the SST aims to be compatible with its European counterpart Solvency II.

The SST consists of two parts: the SST target capital (based on quantitative elements) and the SST report, which addresses qualitative items. Within the first part, the SST follows a two-level approach similar to that of Solvency II. The higher target capital is risk-based and relies on a market-consistent valuation. The lower level, which is the minimum solvency allowed, is a volume indicator based on statutory values. Overall, the SST includes a number of models that take into consideration market risk, insurance risk and credit risk. Additionally, predefined scenario analyses are used.[23]

Also in line with Solvency II, the SST target capital can be calculated using a standard model, an insurer-specific internal model or a combination of the two.[24] Internal models and partially internal models are also subject to supervisory approval in Switzerland, details on the requirements for internal models are provided in Swiss Federal Office of Private Insurance.[25] Under the SST, reinsurers and other insurers conducting business too specialised to allow for a standardised procedure are actually required to develop and apply internal models.[26]

The SST will likely encompass three levels of regulator intervention, based on the relation of available capital to SCR and MCR, but these are as yet under construction and their precise design is somewhat contingent on the development of Solvency II.

Critical analysis of RBC standards

Overview of criteria catalogue

In this section we assess the three systems presented in the section called "RBC standards: an overview". Our aim is to evaluate the advantages and disadvantages of

[22] See Keller (2007).
[23] Swiss Federal Office of Private Insurance (2004); Schweizerischer Bundesrat (2005).
[24] Luder (2005).
[25] Swiss Federal Office of Private Insurance (2006a).
[26] von Bomhard and Frey (2006).

the different approaches based on a broad criteria framework. Our framework builds on the seven criteria provided by Cummins *et al.*,[27] which are as follows:

1. *Getting the appropriate incentives*: The RBC formula should provide incentives for weak companies to hold more capital and/or reduce their exposure to risk without significantly distorting the decisions of financially sound insurers.
2. *Formula should be risk-sensitive*: The RBC formula should reflect the major types of risk that affect insurers and be sensitive to how these risks differ across insurers.
3. *Formula should be appropriately calibrated*: The RBC charges (or weights) for each major type of risk should be proportional to their impact on the overall risk of insolvency.
4. *Focus on the highest insolvency costs for the economy as a whole*: The RBC system should focus on identifying those insurers likely to impose the highest costs of insolvency.
5. *Focus on economic values*: The formula and/or the measurement of actual capital should reflect the economic value of assets and liabilities whenever practicable.
6. *System should discourage misreporting*: To the extent possible, the RBC system should discourage underreporting of loss reserves and other forms of manipulation by insurers.
7. *Formula as simple as possible*: The formula should avoid complexity that is of questionable value in increasing accuracy of risk measurement.

We extend this framework with four additional criteria. The aim of this extension is to integrate the dynamics of insurance and capital markets observed in the last several years. The intention behind each criterion will be detailed separately under *Comparison of the three systems under the extended criteria*, later in this paper.

8. *Adequacy in economic crises and anticipation of systemic risk*: Solvency regulation should anticipate systemic risk and prevent the insurance industry from being trapped in a vicious cycle when economic crises occur.
9. *Assessment of management*: A solvency system should take into consideration "soft" factors including, particularly, management capabilities.
10. *Flexibility of framework over time*: A model should be flexible with regard to its general concept and to its parameters. Empirical insights and theoretical development, such as new models and concepts, should lead to continuous improvement.
11. *Strengthening of risk management and market transparency*: Solvency regulation should require insurers to handle the predominantly quantitative risks with sound risk management. Increased market transparency will, in the long run, reduce the need for regulation.

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[27] Cummins *et al.* (1994).

Comparison of the three systems under the existing criteria

Criterion 1: Getting the appropriate incentives
If a situation of asymmetric information exists, insurance markets can be exposed to a moral hazard with regard to insolvency risk. On the one hand, it is in the interest of the policyholder that the insurance company holds a high capital cushion. The insurance company, on the other hand, has an incentive to reduce the safety level, as it will be rather the policyholders, not itself, who will be hurt most by a possible insolvency (different for mutual insurers).[28] The existence of state guarantee funds further reinforces the incentive to reduce the safety level, as solvent insurers – by means of non-risk-based premiums – pay the losses of insolvent insurers.[29] Based on these market imperfections, the goal of RBC systems should be to provide incentives for weak companies to hold more capital and/or reduce their exposure to risk. At the same time, the system should minimise distorting the decisions of financially sound insurers.

The U.S. RBC framework fails to satisfy this criterion. On the contrary, it provides incentives to insurers to charge lower premiums, as this reduces their capital requirements. This dependency originates in the factor-based calculation of the underwriting risk charge, which uses premiums and reserves as volume indicators. Cautious rate making thus results in higher capital requirements, although the company is, *ceteris paribus*, safer if it collects higher premiums. The same relationship holds with regard to the reserving practices of insurers. The RBC formula ''rewards'' insurers holding lower reserves – having a higher risk of insolvency – with relatively lower capital requirements.[30] The calculation of the asset risk charge is, in contrast, at least partly in line with Criterion 1. The respective capital requirement is calculated as the product of the asset's balance sheet amount and a predefined risk factor. These risk factors reflect the risk associated with different asset classes – the risk factor for government bonds for example is 0, the one for shares is 0.2.[31] In addition to the RBC requirements, U.S. state statutes define absolute minimum capital levels between $0.5 million and $6 million. The level depends on the state and the insurer's lines of business, but not on its actual risk profile.[32] However, even though these capital requirements fail to provide the right incentives according to Criterion 1, they are not significant due to their low absolute level.

In principle, Solvency II does satisfy Criterion 1. The standard approach to determine the SCR is in its main parts risk-sensitive – higher risk exposures lead to higher capital requirements. However, some risks are too complex to be addressed by a one-size-fits-all standard approach. Accordingly, the non-life and health underwriting risks are only included in the form of factor-based calculations using gross premiums (and claims expenditure) of the accounting year as variables. This simplification allows the inclusion of those risks in the standard approach, but it reduces the risk-sensitivity of the resulting capital requirement. The incentives based on these two risk categories

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[28] Klein (1995).
[29] Cummins *et al.* (1995).
[30] Feldblum (1996).
[31] Sandström (2006).
[32] Klein (2005).

thus do not satisfy Criterion 1, as higher premiums, and not necessarily higher risk exposures, lead to higher capital requirements.[33] The alternative method of calculating the SCR – by use of internal models – is discussed below for Solvency II and the SST together. As for calculation of the MCR under Solvency II, two approaches are currently under discussion. First, the modular approach calculates the MCR with a simplified version of the standard approach calibrated to a 90 per cent confidence level. This simplified version will include the non-life underwriting risk module of the standard approach, which is factor-based using gross premiums as variables. The modular approach therefore inherits the previously mentioned problem that the capital requirement increases with increasing premiums, not with increasing risk, and therefore fails to satisfy Criterion 1. Second, the compact approach simply requires the MCR to be one-third of the SCR. The SCR, which needs regulator approval, ought to reflect the actual risk situation of the insurer. Hence, the MCR calculated by means of the compact approach is risk-based as well and thus satisfies Criterion 1.[34] Irrespective of the MCR approach selected, an absolute minimum capital floor, €2 million for life insurers and €1 million for non-life and reinsurers, is required under Solvency II.[35] Again, even though not compliant with Criterion 1, this minimum capital floor is too low to have a significant effect.

As for the SST, Criterion 1 is generally satisfied. The target capital calculated under the standard approach increases with increasing risk and thus sets the right incentives for insurers. The use of internal models to calculate target capital is discussed below, for Solvency II and the SST together. Not in line with Criterion 1 is the factor-based calculation of minimum solvency under the SST, which is determined through the multiplication of a specific factor with premiums or claims for non-life insurers and with mathematical provisions for life insurers. This approach is model-independent and objective but it does not reflect the insurer's specific risk exposures and therefore does not provide the right incentives.[36]

Internal models for calculating the SCR, under Solvency II, and target capital, under the SST, must be approved by the regulator and therefore are assumed to satisfy Criterion 1. Their development and use is encouraged by the European Commission and the Swiss Federal Office of Private Insurance as the effort will force insurance companies to focus on risk management, which also supports Criterion 1.[37] Empirical evidence on the effectiveness of the internal model approach is still lacking, but it seems likely that this approach will satisfy Criterion 1.[38]

Criterion 2: Formula should be risk-sensitive
Criterion 2 stipulates that solvency frameworks should cover all major types of risk, as this reduces the possibility for system arbitrage. Additionally, to the degree possible,

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[33] Doff (2008); CEIOPS (2007b).
[34] Doff (2008); EC (2007a).
[35] EC (2007a).
[36] Swiss Federal Office of Private Insurance (2004); Schweizerischer Bundesrat (2005).
[37] EC (2004); Swiss Federal Office of Private Insurance (2004).
[38] Eling *et al.* (2007).

RBC requirements ought to be sensitive to how these risks differ across insurers. Risk-sensitivity reduces the extent of undesirable distortions and the likelihood of discrimination against certain segments of the industry, particularly against small insurers. Compliance costs that are too high can eat into the profitability of small insurers, who are often specialised in certain products or niches. If those insurers are pushed out of the market, the result will be less competition and less choice for customers.[39] Hence, as a third aspect within Criterion 2, we test the models for potential discrimination against small insurers.

Most RBC systems incorporate the main types of risks – market, credit and underwriting – which is in line with the first part of Criterion 2. The systems differ, however, in how they recognise operational and catastrophe risk. Operational risk is not explicitly considered within the U.S. RBC standards; instead, it is subsumed under business risk. Solvency II chooses a quantitative approach to account for operational risk. It applies a factor-based charge, using premiums and technical provisions as variables.[40] The SST covers this risk category qualitatively within the SST report.[41] Hence, none of the three approaches is truly sensitive towards operational risk. However, operational risk is, indeed, difficult to measure and it is thus questionable whether more sophisticated models would lead to a better recognition of this type of risk. A good solution might be a factor-based charge, similar to Solvency II, complemented with qualitative organisational requirements.[42]

The three systems also differ in their treatment of catastrophe risk. The U.S. RBC formula does not cover catastrophe risk at all. Under Solvency II, catastrophe risk – extreme or exceptional events – is considered within underwriting risk.[43] The SST includes catastrophe risk via predefined scenarios.[44] There are several ways to incorporate catastrophe risk into solvency regulation and in today's globalised world, which appears to be experiencing ever more frequent extreme events, doing so is essential. Accordingly, Klein and Wang[45] provide recommendations on how the U.S. system could integrate catastrophe risk and hence be improved.

There are two other risk categories that we will discuss only briefly at this point. The first of these is liquidity risk, which is different from solvency risk and thus absent of most solvency systems unless mentioned in connection with the liquidity of an asset position. Even though not part of this paper, liquidity risk in general is important also for insurers and not only for banks. This importance is underlined by the developments within the recent financial market crisis. The corresponding collapse of interbank funding threatened the liquidity position of many insurers, with the American International Group (AIG) currently being a prominent example. The second type of risk is business/strategic risk, which can be important in explaining

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[39] van Rossum (2005).
[40] EC (2007a).
[41] Sandström (2006); Swiss Federal Office of Private Insurance (2004).
[42] Doff (2008).
[43] EC (2007a).
[44] Swiss Federal Office of Private Insurance (2004).
[45] Klein and Wang (2007).

insurance company failures.[46] In this paper, this type of risk is included within operational risk and addressed in more detail in our discussion of Criterion 9, that is, management risk.

The second aspect of Criterion 2 specifies that capital requirements be sensitive to how these risks differ across insurers. The U.S. RBC standards are for many risk categories not risk-sensitive, since the volume-based capital charges are independent of the riskiness of the business written by the insurer. An example is the asset concentration factor within the category of investment risk, which arbitrarily stipulates doubling the capital charges of the 10 largest investments, independent of their absolute size or riskiness. Another example is a fixed 10 per cent charge on all reinsurance recoverables within the category of credit risk.[47] Solvency II is generally more risk-sensitive. Limitations are the factor-based charges for operational risk, non-life and health underwriting risk. Similarly, the capital requirements under the SST reflect different levels of risk, except for operational risk, which is considered only qualitatively.

The third aspect of Criterion 2 is that RBC frameworks should not unfairly and inefficiently disadvantage small insurers.[48] Solvency II and the SST impose high introductory costs on insurers and thereby the potential for discrimination. To counteract this possibility, Solvency II applies the principle of proportionality that aims to facilitate compliance for small and young insurers. More precisely, simplifications are provided, including, for example, the calculation of technical provisions or the length of data input requirements.[49] Furthermore, the SST and Solvency II offer a standard model that can be used to determine capital requirements in cases where the insurer's operations are relatively straightforward.[50] However, even though using the standard model avoids the high development cost of an internal model, it can result in higher capital requirements.

Criterion 3: Formula should be appropriately calibrated
According to Criterion 3, solvency systems should reflect the impact of the individual risks on the overall risk of insolvency. This implies appropriate calibration of the respective solvency models. We thus examine the three systems as to whether they account for (1) the dependencies between the different risk categories, (2) the time horizon, and (3) the confidence level applied. Owing to the fact that the U.S. framework does not operate on the stochastic nature and distribution of capital requirements, the third aspect is valid only for Solvency II and the SST.

Under the U.S. system, the individual risk charges are aggregated by means of a covariance formula. This aggregation method follows Butsic,[51] who argued that not all

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[46] Conference of Insurance Supervisory Services of the Member States of the European Union (2002); Doff (2008).
[47] Feldblum (1996).
[48] Munch and Smallwood (1980) provide a more detailed discussion.
[49] CEIOPS (2007a); EC (2007b).
[50] EC (2007b); Bundesamt für Privatversicherungen (2006).
[51] Butsic (1993).

risks will occur simultaneously. Whereas deductions for diversification are justified, the U.S. RBC formula goes further and omits any correlation or covariance terms, that is, it assumes the individual risks to be independent. However, because in practice there is at least partial dependence, this leads to an underestimation of capital requirements.[52] Hence, the dependencies between the different risk categories are not well accounted for under the U.S. system.

The Solvency II aggregation method for the individual risks, as proposed by the European Commission, makes use of a square root formula. The formula contains predefined correlation coefficients that account for the dependencies between the risks.[53] The SCR calculated by means of this formula thus considers diversification effects, which is in line with Criterion 3. However, calibration of the formula is not yet final and thus Solvency II's satisfaction of the first aspect of Criterion 3 will need to be reassessed when the formula is published. The internal models under Solvency II need to be tested on an individual case level.

In contrast to the U.S. framework, the dependencies between the risk categories are well accounted for under the SST standard approach. The standard risk models – asset, liability and credit – are therein aggregated by means of assumed correlations between the individual risks, yielding to one probability distribution of the insurer's capital. In addition, evaluation of each scenario within the SST results in one probability distribution, which are then aggregated with the distribution of the standard models. This aggregation corresponds to a weighted average, with the weights given by the respective probability of each scenario.[54] As with Solvency II, whether dependencies are given adequate consideration within the SST's internal models needs to be assessed on an individual case level.

The second aspect of model calibration has to do with the time horizon applied. All three systems identify capital requirements based on the risks the insurer faces within one year. This seems justified in the case of non-life insurers, who usually write annual contracts. However, considering, for example, the uncertain extent of incurred but unreported losses, or the potentially lengthy processes of claims settlement, a time horizon of one year might not be sufficient. Also, for life insurers a longer time horizon would possibly produce more reliable results.[55]

Third, with regard to confidence level, Solvency II applies a value at risk on a confidence level of 99.5 per cent.[56] In light of the fact that higher confidence reduces the risk of insolvency but also imposes a higher capital burden on insurers and thus eventually increases policy prices, the choice of 99.5 per cent is in line with Criterion 3. The SST uses the expected shortfall at a confidence level of 99 per cent. In an extensive field test, the Swiss Federal Office of Private Insurance (2005) identified the value at risk for Swiss life and non-life insurers that would be equivalent to a 99 per cent expected shortfall. At the minimum it corresponded to 99.5 per cent, at maximum to 99.7 per cent, and for the median to a 99.63 per cent value at risk. Thus, the confidence

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[52] Feldblum (1996).
[53] EC (2007a).
[54] Swiss Federal Office of Private Insurance (2004).
[55] Eling and Holzmüller (2008).
[56] EC (2007a).

level applied by the SST is approximately equivalent to that of Solvency II and therefore in line with Criterion 3.

Criterion 4: Focus on the highest insolvency costs for the economy as a whole
Based on an analysis of approximately 200 insurance company failures, Cummins *et al.*[57] find that the major part of insolvency costs is induced by a small number of large insurer insolvencies. Hence, the objective of reducing total insolvency costs for the economy as a whole can best be achieved through an increased regulatory focus on large insurers' solvency situations.

With the capital requirements more dependent on company size than on an insurer's risk profile, the U.S. RBC system results in relatively higher capital requirements for large insurers. In light of the fact that most insolvency costs are induced by large insurance company failures, this would in principle appear to satisfy Criterion 4. However, the U.S. RBC requirements lack information about the insurer's actual risk profile, and thus do not allow the regulator to focus on the highest potential insolvency costs. In its main parts, the U.S. RBC standards are thus not in line with Criterion 4. This statement is backed up by the results of an empirical analysis on the relationship between property liability insurers' insolvency risk and their capital adequacy conducted by Cummins *et al.*,[58] who find that the solvency ratio used under the U.S. RBC framework is significantly less successful in predicting large insurers' insolvency than in predicting small insolvencies.

In contrast to the U.S. RBC formula, Solvency II and the SST are not factor-based, but rely on probabilistic risk measures to identify the necessary capital requirements. Solvency II is based on the value at risk; the SST applies the expected shortfall (tail value at risk). The expected shortfall corresponds to the average loss in case of insolvency, as compared to the value at risk, which represents the threshold loss beyond which an insurer is insolvent. If the distribution of the losses (insolvency costs) is not symmetric, then, of the two risk measures, only the expected shortfall will appropriately incorporate the severity of the insolvency. The expected shortfall and therewith the SST is thus more in line with Criterion 4. Despite the conceptual advantage of using the expected shortfall, the European Commission decided in favour of the value at risk, mainly because it is less complex and more widespread in practice.[59, 60]

The internal model approach, under both Solvency II and the SST, does not completely satisfy Criterion 4. In particular, regulators motivate the use of internal models with reduced capital requirements as compared to when insurers would apply the standard approach (note that this is not definite in the case of Solvency II, but seems likely).[61] As mainly large insurers have the resources to develop internal models,

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[57] Cummins *et al.* (1994).
[58] Cummins *et al.* (1995).
[59] CEA (2006).
[60] For detailed discussions on the choice of the risk measure, the reader is referred to Artzner *et al.* (1999), McNeil *et al.* (2005), as well as Filipovic and Vogelpoth (2008).
[61] EC (2007b); Steffen (2008); Swiss Federal Office of Private Insurance (2004).

they face relatively lower capital requirements. Nevertheless, the internal model approach is generally in line with Criterion 4, as those reduced capital requirements are based on a more accurate reflection of the insurer's risk profile.

Criterion 5: Focus on economic values
According to Cummins *et al.*,[62] any solvency system that ignores the potentially large difference between balance sheet data and market values has only limited ability to assist regulators. Even though balance sheet data in the United States are considered to be relatively close to market values, the U.S. RBC standards have been criticised for their use of a factor-based approach applied to historic statutory values.[63] The framework is thus not designed to identify the true net worth and therefore does not satisfy Criterion 5. Cummins *et al.*[64] define the true net worth as the difference between the economic values of the assets and the liabilities.

Solvency II satisfies Criterion 5. Calculation of capital requirements under Pillar I is based on an economic total balance sheet approach. This implicates the use of market-consistent values of assets and liabilities, whenever possible.[65] To reduce the administrative burden for insurance companies, an alignment of Solvency II with the International Financial Reporting Standards (IFRS) is intended.[66] However, these standards are still works in progress and thus the use of market-consistent values is still not definite. Further areas of discussion relevant for Solvency II include accounting for discretionary bonuses within participating contracts and the role of the insurer's own credit standing within the valuation of insurance liabilities. Solvency II's ultimate compliance with Criterion 5 therefore still depends on the development of IFRS and the level of convergence between the two standards.[67]

The SST is based on a market-consistent valuation of assets and liabilities. The assets should represent market values, whenever possible; otherwise, an appropriate model to estimate the asset's current value must be applied. Liabilities have to be valued under the principle of best estimate. These procedures are in line with Criterion 5 but they only apply to the determination of target capital. Calculation of the minimum solvency requirement is based on the statutory balance sheet.[68] However, because not all balance sheet data change with market movements (e.g., premiums) and because insurers will more likely focus on the target capital level rather than on the minimum solvency, the SST still satisfies Criterion 5.

Criterion 6: System should discourage misreporting
The problem of potential misreporting is not explicitly mentioned in any of the solvency systems. Moreover, the stated goals of the regulatory frameworks do not

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[62] Cummins *et al.* (1994).
[63] Sandström (2006); Klein (2005).
[64] Cummins *et al.* (1994).
[65] EC (2007a); CEA (2007).
[66] Duverne and Le Douit (2007); Flamée (2008); EC (2007a).
[67] Flamée (2008); Doff (2008).
[68] Swiss Federal Office of Private Insurance (2004, 2007).

touch upon this pitfall and instead focus their attention on policyholder security and market efficiency. Even though insurers might be tempted to manipulate data in order to lower capital requirements, it is questionable whether prohibiting this behaviour should be part of the solvency regulation or better covered by other laws and regulations.

Within a factor-based solvency framework, misstatements of financials can cause an equivalent reduction of capital requirements. An exemplary U.S. insurer who states a lower-than-actual combined ratio will receive a reduced written premium risk charge.[69] The factor-based approach of the U.S. RBC standards thus does not encourage correct reporting and therefore does not satisfy Criterion 6.

Under Solvency II, the SCR is not factor-based, which makes it less straightforward to use misreporting to lower capital requirements. However, as data inputs and estimation techniques within the standard and the internal models under Solvency II are subject to management discretion, potential misreporting is of relevance also under Solvency II. Accordingly, Solvency II does address, if only rudimentarily, the issue of potential manipulations by insurers within Pillar II, which contains, among other things, specifications on corporate governance, the supervisory review process and the empowerment of the supervisory authority.[70] However, to ensure that these ''soft'' requirements are effective, the sanctions following a breach would need to be more clearly defined and transparent for all market participants.

As with Solvency II, the SST is not factor-based. Thus using misreporting to lower capital requirements is not as straightforward. However, beyond that fact, potential misreporting is not addressed within the SST. Solvency II and the SST are principle- rather than rules-based regulatory systems, a characteristic that becomes evident with regard to Criterion 6, where both systems rely more on the individual responsibility of the insurer than on strict rules. Consequently, the SST and Solvency II only satisfy Criterion 6 to a low degree.

Criterion 7: Formula as simple as possible
The solvency system should avoid complexity. If, however, complexity is increased, the additional costs for the insurers and for the regulator should at the very least be offset by improvement of the system to predict and avoid potential failures of insurance undertakings. An inappropriate level of complexity will otherwise result in increased premiums for the insurance customers and in decreasing innovation for the insurance market as a whole.[71] One limitation to Criterion 7 is the difficulty of accurately measuring, or even defining, ''complexity'' and ''system improvement''. The following discussion is thus, in some parts, mostly theoretical.

The U.S. RBC formula looks very simple at first glance, but some of the calculations of individual risk charges are complex and require long data histories – 10 years for most risk charges.[72] Because the foundation of the formula is theoretically

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[69] Feldblum (1996).
[70] EC (2007a).
[71] van Rossum (2005).
[72] Feldblum (1996); Klein and Wang (2007).

weak, this complexity does not serve to enhance policyholder security.[73] Overall, however, especially compared to Solvency II and the SST, the U.S. RBC formula is relatively simple and thus at least partly satisfies Criterion 7.

In principle, Solvency II satisfies Criterion 7. The market-consistent valuation of assets and liabilities and the overarching value at risk concept do increase complexity compared to the Solvency I framework, but this increase is justified by the capital requirements becoming more risk-sensitive.[74] As for Pillars II and III of the Solvency II framework – the qualitative requirements and the rules on public disclosure – it is not yet known if or how well they will satisfy Criterion 7. Only time will tell how the practical application of these pillars will affect the administrative burden of insurers; however, there is potential misalignment with Criterion 7 due to, for example requirements necessitating the documentation of internal control mechanisms, internal audit procedures and outsourcing activities.[75]

The SST is considered even more complex than Solvency II.[76] Complexity arises, for example, from the application of the tail value at risk and the performance of scenario analyses. The tail value at risk, though, has the advantage that it considers not only the probability but also the distribution of the costs in case of a potential insurer insolvency. The scenario analyses make it possible to adequately consider the fat tails inherent in the distribution of insurance risks. Consequently, the complex characteristics of the SST improve the accuracy of the model and are therefore in line with Criterion 7.

As for the underlying calculation of capital requirements under Solvency II and the SST, the internal and the standard models are the extremes at each end of the spectrum. At one end are the internal models, which are very complex, but have great predictive power and high risk-sensitivity.[77] Their complexity may thus be justified and the internal model approach is widely regarded as a major step forward in insurance regulation and risk management.[78] At the other end of the spectrum is the one-size-fits-all standard model. The standard model's role as a simple alternative to resource-intensive internal models may justify the corresponding but unfortunate side effect of reduced risk-sensitivity. In principle, both the standard and the internal model approach are thus in line with Criterion 7.

Comparison of the three systems under the extended criteria

Criterion 8: Adequacy in economic crises and systemic risk
Historically, systemic risk was primarily associated with the occurrence of a bank run.[79] However, increasing securitisation and globalisation have led to an increased relevance of systemic risk to the insurance industry also, which is sharply illustrated by

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[73] Farny (1997).
[74] Doff (2008).
[75] EC (2007a).
[76] von Bomhard and Frey (2006).
[77] Eling *et al.* (2007).
[78] Linder and Ronkainen (2004); Klein and Wang (2007).
[79] Swiss Re (2003).

the recent U.S. mortgage crisis. We thus see a need to introduce a new RBC criterion addressing adequacy in economic crisis situations and systemic risk aspects.

Deficient regulation is one potential source of systemic risk. If all insurers use the same risk models, they will react similarly to external shocks in the capital or insurance markets. This can, in a worst case, again enforce the primary cause and thus induce systemic risk. In recognition of these dynamic aspects, insurers should employ different models, for example, internal models. Hence the SST and Solvency II, which motivate insurers to develop and apply internal models, satisfy Criterion 8. In addition, the principle-based approach of the SST and Solvency II give insurers more discretion than does a strict rules-based system. Thus, insurers apply a variety of models and the potential for systemic risk decreases.[80] The U.S. RBC formula, in contrast, may expose U.S. insurers to a high level of systemic risk and is therefore not in line with Criterion 8.

Criterion 9: Assessment of management
In an analysis of insurance company failures and near-misses, the Sharma Report found that inexperienced management was at the root of most insurance company failures. Based on this insight, we introduce Criterion 9 – the assessment of management. Solvency systems should thus not solely rely on a quantitative assessment of the insurer's solvency level, but should encompass the full casual chain of insurance failures, including requirements for management team experience, early warning indicators and an emphasis on forward-looking information such as, for example, business plans.[81]

The call to include management risk in solvency systems is not new. As early as 1997, Dickinson reported that management risk is omitted in the U.S. RBC formula, a situation that has not changed and thus the U.S. RBC system does not satisfy Criterion 9.

Solvency II rudimentarily addresses management risk in Pillar II, which details qualitative requirements and rules on supervision. As part of the qualitative requirements, the European Commission sets out governance principles in general and the "fit and proper" standard in particular. The latter stipulates that people effectively running the undertaking or people in other key functions must be fit with regard to their professional qualification, experience and knowledge, and proper with regard to their personal integrity.[82]

The SST does not address management risk and therefore does not satisfy Criterion 9. However, this need is partly fulfilled by the "Versicherungsaufsichtsgesetz" and the corresponding initiative, which is called Swiss Quality Assessment. According to the legislative act, insurance licenses will be granted only if certain management positions are filled by persons having a good reputation and who can warrant sound business practices. The corresponding initiative addresses corporate governance, risk control

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[80] Nebel (2004).
[81] Conference of Insurance Supervisory Services of the Member States of the European Union (2002); Ashby *et al.* (2003).
[82] EC (2007a); Eling and Holzmüller (2008).

and internal processes, but fails to concretise the requirements for good reputation and sound business practices.[83]

Criterion 10: Flexibility of framework over time

History shows that solvency systems can live a long life before they are replaced or adjusted to changed market conditions. An example is the European solvency margin system, the predecessor of Solvency I. Despite general agreement on the need for change, the system was in force for approximately 30 years.[84] Similarly, Solvency I, originally designed as a stop-gap approach, will be in force within the EU for at least 10 years – from 2002 to presumably 2012.[85] However, in light of how fast financial markets can change, this system longevity can result in major gaps within regulatory frameworks and to adverse effects on policyholder protection. We thus propose Criterion 10, which requires that new or improved-upon solvency systems are designed flexible towards changes and do not ask for bureaucratic processes in case of reform.

Wide geographic scope, multiple stakeholders and slow political processes are among the most common reasons for inflexible solvency systems. All three systems under evaluation here have legislative characteristics that can hinder modification. The U.S. and the EU frameworks face the additional complexity of being applicable to a federation of states/countries with a concomitant increase in the number of stakeholders. Switzerland, in contrast, benefits from its reduced geographical scope. For example, the SST framework was developed in a relatively short time period, going from project start in 2002 to introduction in 2006.[86] In contrast, Solvency II, which covers the entire EU, also began in 2002 and is not expected to finalise until 2012.

Although the geographic scope of the EU or the United States is more or less a given, it is within the power of the regulator to design the solvency framework itself as flexible as possible. A rather radical approach is implemented in New Zealand, which relies almost entirely on private rating agencies to regulate the insurance industry. Those private companies, such as A.M. Best and Standard & Poor's, have proven to be extremely adaptable to changing circumstances due to their lack of external commitments and information supply duties.[87] Less radical is a principles-based framework, like Solvency II and the SST. As long as the underlying principles are not affected, small changes and updates are easy to implement in a system like this as compared to a rules-based system, where even small modifications can involve a lengthy process.

Criterion 11: Strengthening of risk management and market transparency

The last criterion focuses on the qualitative elements of supervision and evaluates whether the regulator promotes internal risk management and market discipline. The

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[83] Schweizerische Bundesversammlung (2004); Swiss Federal Office of Private Insurance (2007).
[84] Dickinson (1997).
[85] EC (2007a, b).
[86] Schweizerischer Bundesrat (2005).
[87] Eling and Holzmüller (2008).

idea behind the latter is that transparent processes will require less regulation in the long run as market participants themselves force appropriate insurer behaviour.[88] Hence, internal risk management and market discipline should be addressed by regulation.

Both Solvency II and the SST view strengthening risk management as one of their main goals. Both systems thus provide a strong incentive for insurers to develop and apply internal models to determine capital requirements, which forces the insurers to focus on risk. Even when it is the standard model that is used, though, both systems incorporate risk management. For example, Solvency II requires all insurers to perform the "Own Risk and Solvency Assessment", during which insurers have to assess their overall solvency need under their specific risk profile on a regular basis and report the results to the supervisory authority.[89] As for the SST, the design of the standard approach as a rather complex model instead of as a simple formula has the explicit goal of ensuring adequate risk management capabilities of all insurers. In contrast, the U.S. RBC system contains no provisions for assessing the adequacy, or even existence, of insurer risk management.

Of the three systems being compared here, Solvency II best satisfies Criterion 11. It not only strengthens risk management but also fosters market transparency by requiring a public disclosure of the insurer's solvency and financial condition (Pillar III).[90] The SST and the U.S. RBC standard do not require public disclosure and thus do not make use of market forces.

Summary

With the introduction of new solvency frameworks such as Solvency II and the SST, insurance regulation has entered a new era. Compared to the significantly older U.S. RBC system, the newer Solvency II and SST go in the direction of an integrated asset and liability perspective, principles – instead of rules-based regulation, and an additional consideration of qualitative aspects. In this paper, we compare all three systems on the basis of the broad criteria framework provided by Cummins *et al*.[91] In recognition of the dynamics in the insurance industry, we then extend the framework with four new criteria.

Table 1 summarises our analysis. A "full" moon indicates "fully satisfied" criterion; an "empty" moon indicates "not satisfied" criterion.

Our main findings are as follows:

(1) The EU Solvency II framework and the SST score significantly better than the U.S. RBC formula, disclosing that the U.S. framework is the system most in need of reform. To be fair, however, it should be remembered that the U.S. framework was introduced more than 10 years before the other two, and at that time was

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[88] Eling *et al.* (2007).
[89] EC (2007a, b); Swiss Federal Office of Private Insurance (2004, 2006b).
[90] EC (2007a).
[91] Cummins *et al.* (1994).

Table 1   Summary table

Criterion	U.S.	EU	Switzerland
1. Getting the appropriate incentives	○	◕	◕
2. Formula should be risk-sensitive	○	◕	◕
3. Formula should be appropriately calibrated	◔	●	●
4. Focus on the highest insolvency costs for economy as a whole	○	◑	◕
5. Focus on economic values	○	●	●
6. System should discourage misreporting	○	◑	◔
7. Formula as simple as possible	◑	◕	◕
8. Adequacy in economic crises and systemic risk	◔	◕	◕
9. Assessment of management	○	◑	◔
10. Flexibility of framework over time	○	◑	◕
11. Strengthening of risk management and market transparency	○	●	◕

Legend: ● Fully satisfied   ○ Not satisfied

viewed as a major advance in solvency regulation.[92] Nevertheless, the reform movement afoot in the United States towards a principles-based solvency framework similar to that of the EU is a good sign and is currently gaining some momentum.[93]

(2) We agree with Doff[94] that Solvency II satisfies the seven criteria of Cummins *et al.*[95] Based on our extended analysis, we can further attest that Solvency II satisfies our additional criteria (8–11), and that also the SST is in line with the requirements. Remaining concerns with regard to Solvency II are the factor-based calculations within parts of the standard approach, the use of the value at risk concept, which does not incorporate the distribution of the costs in case of insolvency, and the inadequate consideration of management risk. As for the SST, areas of concern relate to the derivation of the minimum solvency level, which is not risk-based and relies on statutory financials and its disregard of management risk.

(3) A comparison between Solvency II and the SST does not lead to an obvious answer to the question of which system is superior. Each has a few deficiencies, but both incorporate some of the most recent and most promising findings from the fields of risk management and insurance regulation (e.g., internal model approach, total balance sheet approach). Only future empirical evidence on the systems' ability to protect policyholders from insurance company failures will allow a judgment on which system works best.

[92] Feldblum (1996); Farny (1997).
[93] IAIS (2007); Iuppa (2006).
[94] Doff (2008).
[95] Cummins *et al.* (1994).

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