EXTENDED SOLVENCY MARGIN AS A MEASURE OF THE INSOLVENCY RISK OF NON-LIFE INSURANCE COMPANIES[1]

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ABSTRACT

This paper gives a presentation of the solvency margin, and proposes the concept of the extended solvency margin. The concept of a scale of safety is introduced; this allows the operating risk of an insurance company to be expressed in terms of capital requirement. A method is presented for assessing the extended solvency margin (ESM). The risk of insolvency is analyzed in an annual time perspective.

The theoretical discussion is illustrated with an empirical example derived from non-life insurance companies operating as joint stock companies in Poland in the period 1995-2002.

Keywords: *solvency, scale of safety, solvency margin, extended solvency margin.*

1. INTRODUCTION

The countries of the European Union are getting ready to introduce a reform of the system used to monitor the solvency of insurance companies. The *"Solvency II Project"* is being realized, and its aim will be to achieve, among other things, the following goals[2]:

1. Provide the instruments for assessing the overall insolvency of insurance companies with regard to quantitative and qualitative aspects.
2. Introduce an approach aimed at measuring and managing the risk of the insurance company that would permit, among other things, the use of internal risk assessment models.

[1] The author is grateful to Marcin Polkowski for English translation of this paper.

[2] The aims of "*Solvency II Project*" are laid down in various documents of the European Commission, e.g. in the memorandum from March 3, 2003 MARKT/2509/03 "Design of a future prudential supervisory system in the EU".

3. Introduce rules for determining the solvency capital requirement (SCR) level, and its minimum value.

The aim of this paper is to introduce a model for assessing the risk of insurance companies, and solvency indicator such as the extended solvency margin constructed on the basis of these models. The approach presented here offers a basis for formulating the conclusion that the aims of the "S*olvency II Project*" can be realized using relatively simple instruments.

The empirical examples refer to non-life insurance companies operating as joint stock companies in Poland. The analysis has been made on the basis of financial reports for the years 1995 - 2002 published in the Official Journal "Monitor Polski B". During that period the rules in force concerning the scope and form of presenting the financial reports of insurance companies were of a comparable type.

The topics treated in the chapters below include: basic concepts and definitions connected with the problem of the solvency of insurance companies, the extended solvency margin model for non-life insurers and conclusions.

A new concept is introduced in this paper, namely that of the scale of safety, a function correlating the company's risk with the magnitude of its capital requirement. The security scale allows for individualizing the capital requirements in relation to a particular insurance company.

2. BASIC CONCEPTS AND DEFINITIONS

2.1. SOLVENCY

The solvency of an insurance company relates to every aspect of its activity.[3] The general definition of solvency is hard to use in practice, and this means that an operative definition has to be adopted, which would allow the relevant entities (e.g. the boards of insurance companies, supervisory organs, rating agencies, clients) to make specific decisions and act in a particular way. What is most important from the operative point of view is the incidence of a state in which the risk of insolvency occurs. This state may be defined as follows:

Risk of insolvency – a given state of an insurance company, in which a solvency indicator or a set of indicators (e.g. the solvency margin, risk-based capital, the probability of ruin) arbitrarily adopted by the insurance company, laid down in legal regulations, or adopted by the authority charged with assessing the solvency of an insurance company, exceeds an acceptable limit.

In order to examine solvency, an insolvency risk indicator (*IRI*) is typically constructed in the form of a quotient:[4]

[3] This view can be found e.g. in "Prudential Supervision of Insurance Undertakings" (P. Sharma 2002), a report by the Conference of Insurance Supervision Authorities of the Member States of the European Union, in which risk maps and causal links become part of the procedures for examining solvency.

[4] Below, the variable t denotes the time measured in years. The convention has been adopted, that for variable X – denoting the state – X represents the value of the variable in the moment t, whilst in the case of variable X denoting the stream – $X(t)$ represents the value of this variable for the period t.

$$IRI(t+1) = \frac{AVAILABLE\ CAPITAL_t}{REQUIRED\ CAPITAL(t+1)},$$

or else the following condition is examined:

$$AVAILABLE\ CAPITAL_t > REQUIRED\ CAPITAL\ (t+1).$$

The available capital at the given point in time t is a safety buffer, while the required capital for the period $t+1$ determines the foreseen level of risk for the activities of the insurance company measured using the capital required to protect solvency.

2.2. SAFETY BUFFER

A common basis for all systems used to monitor the solvency of insurance companies is the available capital.[5] It forms a safety buffer that absorbs the financial consequences of any unfavorable phenomena, which might occur in the activities of the company.

The available capital is defined as the assets of the insurance company, excluding the assets intended to cover all foreseeable obligations, and excluding goodwill and other intangible assets.

In the alternative definitions, the available capital is determined by providing a list of the acceptable capital instruments (including hybrid capital instruments that have the characteristics of both equity and debt), and specifying the extent to which the individual instruments can be booked as available capital. If the available capital is defined in this way, several layers (classes) of instruments are typically listed, depending on their quality. In relation to the instruments placed in the lowest qualitative class, the permission of the supervisory organ is often required to book a given instrument as available capital.

Legal regulations are usually constructed in such a way as to ensure that both definitions of available capital are mutually equivalent.[6]

The quality of capital instruments is determined through a range of criteria that allow the assumption that the given instrument protects the interests, broadly understood, of the insured. An assessment of the quality depends on the degree to which the individual criteria are satisfied. The most important criteria include[7]:

1. Constant and unlimited access to funds.
2. Ease of use as regards absorbing the losses that might result from the company's activities.
3. Absence of criteria for the unconditional payment of earnings from the instrument.
4. Ability to use the instrument to settle claims in case of bankruptcy after satisfying the claims of policyholders regarding compensation.

In this paper, it has been assumed that the available capital (according to Polish law terminology – the company's own fonds) is equal to the capital and reserves of the insurance

[5] Available capital is called differently in different countries: e.g. in Poland – own (company) resources, in the U.S. – adjusted capital, in Australia and South Africa – the capital base.

[6] Two definitions of available capital can be found e.g. in the FSA document "Enhanced capital requirements and individual capital assessments for non-life insurers", Consultation Paper 190, June 2003. This document clearly states (on p. 33) that both definitions specify the same level of available capital.

[7] The criteria presented here, and the division of capital in levels has been adopted from Australian standards for capital adequacy. Specific information on standards of adequacy in relation to property and personal non-life insurance can be found among APRA standards: Prudential Standard GPS 110 and Guidance Note GGN 110.1, GGN 110.2, GGN 110.3, GGN 110.4, GGN 110.5.

company, less intangible assets, and the company's sellable shares. In the points below, the amount of available capital at the moment in time *t* will be denoted using the symbol u_t.

2.3. REQUIRED CAPITAL

Apart from available capital, another essential category of all systems used to monitor the solvency of insurance companies is the amount of capital required to protect the activities of the insurance company. This is a function of the foreseen level of risk attached to the activities of an insurance company in a given period (generally assumed to be an annual one). An annual period gives enough time for financial and statistical data to be collected and compiled, and means that the proper actions can be recommended in order to restore the proper financial relations, if the activities of the company are considered to be at risk.

In this paper, the function linking the capital requirement with risk and with the range of insurance activities will be called the scale of safety.

The short-term character of non-life insurance allows one to assume that the foreseen premium constitutes a good estimate of the potential risk and scale of insurance activities. The scale of safety constructed by referring to the premium can be based, therefore, on the relation of the premium to the required solvency capital. Let us assume that in the given moment *t* we posit the requirement that the ratio of the foreseen gross earned premium in the period *t*+1 equal $b(t+1)$ and the solvency protection capital (required capital) in that period $v(t+1)$ at the given insurance company should be at the fixed level:

$$\frac{b(t+1)}{v(t+1)} = \beta . \tag{1}$$

The value of parameter β can be fixed or dependent on the adopted risk factors, in particular on the foreseen gross earned premium, the reinsurance program, the structure of the insurance portfolio, the legal status of the insurance company, etc.

The solutions adopted in Council Directive 73/239/EEC, later applied in the regulation of the Minister of Finance of the Republic of Poland, October 17, 1995, introduced the following scale of safety for joint stock companies:

$$\beta(d) = \begin{cases} \dfrac{d}{KG} & \text{for } d \le \dfrac{KG}{0{,}18} \\ \dfrac{1}{0{,}18} & \text{for } \dfrac{KG}{0{,}18} < d \le H \cdot P_1 \\ \dfrac{d}{0{,}18 \min\{d; H \cdot P_1\} + 0{,}16 \max\{0; d - H \cdot P_1\}} & \text{for } d > H \cdot P_1 \end{cases}, \tag{2}$$

where:

H denotes the coefficient dependent on the reinsurers' share in claims incurred ($0{,}5 \le H \le 1$), *d* – the forecast amount of gross earned premiums *b* multiplied by *H* ($d = b \cdot H$), *KG* – the guarantee fund, which, depending on the insurance group, may equal 200 000, 300 000, 400 000 or 1 400 000 EUR, P_1 – the fixed (threshold value) equal 10 000 000 EUR.

Reinsurance affects the security scale by way of coefficient *H*. The premium *b* and the reinsurance customize the security scale for a particular insurance company.

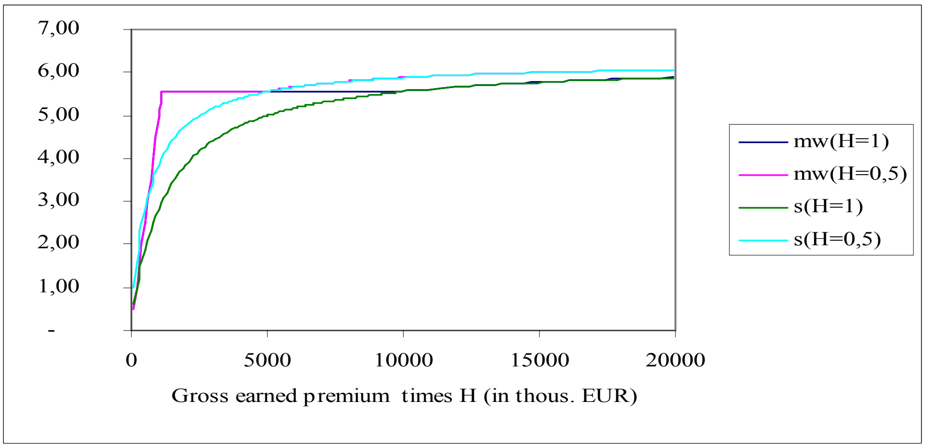
The function $\beta(d)$ is the non-decreasing spline function with knots $\frac{KG}{0{,}18}$ and $H \cdot P_1$ and with asymptotic value $\beta_{as} = \lim_{d\to\infty}(\beta(d)) = \frac{1}{0{,}16} = 6{,}25$.

In empirical research, one can use other scales of safety, e.g. the one determined by the function:

$$\beta(d) = A\frac{d - C}{d + B} \tag{3}$$

where the values of parameters *A*, *B*, *C* are calculated from the conditions $A = \lim_{d\to\infty} \beta(d) = 6{,}25$, $\beta(H \cdot KG) = 1$, $\beta(H \cdot P_1) = 5{,}5(5)$.

Figure 1. Examples of scales of safety for different values of coefficient *H*.



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For example, the scales of safety with $KG = 200\,000$ EUR and $H = 1$ or $H = 0{,}5$ determined by formula (2) and designated respectively as mw(H=1), mw(H=0,5) and defined by formula (3), designated as s(H=1) and s(H=0,5) are depicted in Figure 1. The graphs of scales mw(H=1) and mw(H=0,5) overlap for $0 \le bH \le 5\,000\,000$. Scales s(H=1) and s(H=0,5) are less restrictive than, respectively, scales mw(H=1) and mw(H=0,5) in the case of insurance companies with a very small premium, stricter for medium-sized companies and almost identical for large companies.

3. THE SOLVENCY MARGIN (SM)

3.1. EXTENDED SOLVENCY MARGIN (ESM)

Insurance activities can be described as a production process with a reversed production cycle, one that conforms to set norms. The solvency margin model employs the reference insurance process (i.e. a process that conforms to the norms that have been set), and the adopted scale of safety. The risk connected with the activities of the insurance company is measured in terms of the value of the capital required to protect those activities at a specific range and level, and determined by the maximum amount of the premium, resulting from the divergence of the actual running process from the reference process. Another view of the theoretical foundations of the solvency margin has been presented in the work by (Kastelijn, Rammerswaal 1986).

Let us look at an insurance company which deals in non-life insurance as a joint stock company, that is to say whose goal is to attain profit. The available capital U_t at point in time *t* equals:

$$U_t = U_{t-1} + F(t) - D(t) + U_N(t), \tag{5}$$

where:

$F(t)$ denotes the financial result for year *t*,

$D(t)$ - the dividend paid in year *t,*

$U_N(t)$- new capital invested in year *t.*

The variables $D(t)$ and $U_N(t)$ belong to the group of decision variables determined by the relevant authorities of the insurance company.[8]

The financial result for year *t* may be presented as the following equation:

$$F(t) = B(t) - X(t) - K(t) - O(t) - B_R(t) + X_R(t) + K_R(t) + I(t) - L(t), \tag{5}$$

where:

$B(t)$- gross earned premium in year *t*,

$X(t)$- gross claims incurred in year *t*,

$K(t)$- acquisition and administrative costs in year *t*,

$O(t)$- balance of remaining costs and income on the technical account in year t,

$B_R(t)$- reinsurance premium earned in year *t*,

$X_R(t)$- reinsurers' share in claims incurred in year *t*,

$K_R(t)$- reinsurers' provisions and share in the profits of reinsurers in year *t.*

$I(t)$- net income from investments, including changes in the value of assets and the cost of investment activities in year *t*,

$L(t)$- the balance of remaining costs and income in year *t*, including extraordinary profits and losses.

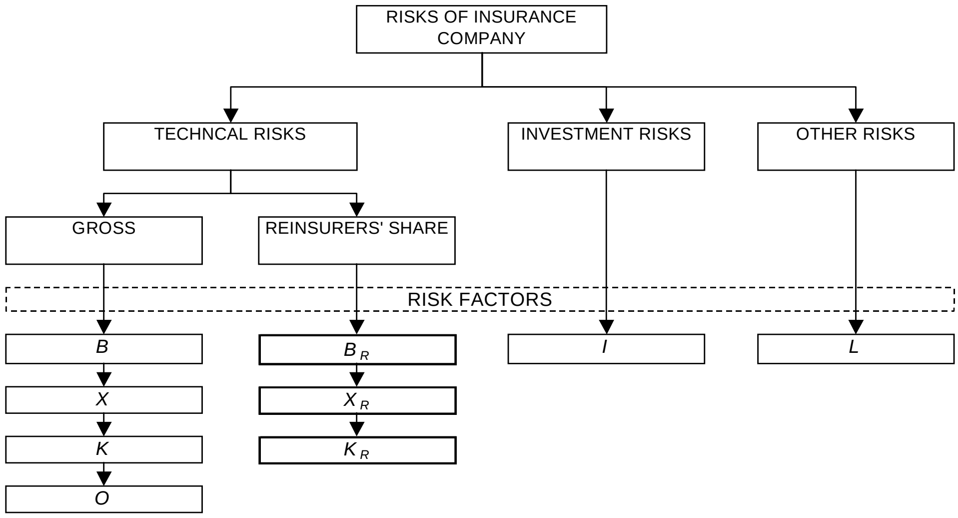
Equation (5) shows that the financial result $F(t)$ does not include taxation. The aim of the model introduced here is to create a number of safety norms for the operations of an insurance company, and therefore, in the remaining parts of this paper, it will be assumed that that the expected financial result equals zero, or otherwise remains at an acceptable negative level. This means that for all purposes connected with these norms, one can omit taxation.[9]

The structure (taxonomy) of risks of an insurance company resulting from equation (5) is shown in the diagram below.

[8] In the version of the model presented here, these variables have been omitted, i.e. the assumption has been made that the dividend is not being paid, and that the requirement for new capital is only a result of the conditions that determine the solvency of the insurance company.

[9] Analogous models created for the purpose of managing the company's risk must take into account taxation (paid, overpaid, due, remissions etc.), since they form a key element of the company's financial balance policy.

Diagram 1. The adopted taxonomy of risk in the ESM model



Source: author's materials

Equation (5) can be given an equivalent form:

$$B(t)= X(t)+ K(t)+ O(t)+ B_R(t)- X_R(t)- K_R(t)- I(t)+ L(t)+ F(t). \qquad (6)$$

Equation (6) is an equation of the production function (insurance activity) with a reversed production cycle. It shows what costs are covered by the premium and what amounts allow the size of the premium to be reduced. The variable $F(t)$ belongs to the category of balance variables. The variables in equation (6) are random variables.

Let us determine the expected value of the premium. Using the properties of the operator of the expectation and denoting the expected values of the relevant random variables with lower-case letters with a horizontal dash, equation (6) can be written in the following form:

$$\bar{b}(t)= \bar{x}(t)+ \bar{k}(t)+ \bar{o}(t)+ \bar{b}_R(t)- \bar{x}_R(t)- \bar{k}_R(t)- \bar{i}(t)+ \bar{l}(t)+ \bar{f}(t). \qquad (7)$$

Let us now introduce the following coefficients:

$$\alpha_1 = \frac{\bar{x}(t)}{\bar{b}(t)},\ \alpha_2 = \frac{\bar{k}(t)}{\bar{b}(t)},\ \alpha_3 = \frac{\bar{o}(t)}{\bar{b}(t)},\ \alpha_4 = \frac{\bar{b}_R(t)}{\bar{b}(t)},\ \alpha_5 = \frac{\bar{x}_R(t)}{\bar{b}_R(t)},\ \alpha_6 = \frac{\bar{k}_R(t)}{\bar{b}_R(t)},$$

$$\alpha_7 = \frac{\bar{i}(t)}{\bar{b}_N(t)},\ \alpha_8 = \frac{\bar{l}(t)}{\bar{b}_N(t)},\ \alpha_9 = \frac{\bar{f}(t)}{\bar{b}_N(t)}$$

The quantity $\bar{b}_N(t)= E[B_N(t)]= E[B(t)- B_R(t)]= \bar{b}(t)- \bar{b}_R(t)$ denotes the expected value of the earned premium net of reinsurance $B_N(t)= B(t)- B_R(t)$.

From the form of equation (7) it follows that there exist an infinite number of configurations for the coefficients $\alpha_1,...,\alpha_9$ which satisfy it.

Any vector in the form $[1,\alpha_1,...,\alpha_9]$ for which condition (7) for any expected level of the gross earned premium $b(t)$ is satisfied, shall be called the insurance process.

By way of theoretical and statistical analysis, one can differentiate the reference insurance process, i.e. a process to which the insurance processes of individual insurance companies in their consecutive years of activity will be compared. The reference insurance process determines the conditions for equilibrium in a given period in time (e.g. annually), where by ‘equilibrium’ one understands that the insurance company performs according to what is expected, as measured by its financial result. For the aims of analyzing solvency, one can assume that the expected financial result should be equal zero or remain negative at the level of the acceptable loss ($E[F(t)]=0$ or $E[F(t)]=\gamma<0$).

Let us denote the reference insurance process as the vector:

$$[1,\hat{\alpha}_1,\ldots,\hat{\alpha}_9]. \tag{8}$$

Equation (7) for the reference insurance process can be written in the form:

$$\begin{gathered} b(t)=b(t)[\hat{\alpha}_1+\hat{\alpha}_2+\hat{\alpha}_3]+\hat{\alpha}_4 b(t)[1-\hat{\alpha}_5-\hat{\alpha}_6]+ \\ -(1-\hat{\alpha}_4)b(t)[\hat{\alpha}_7-\hat{\alpha}_8]+(1-\hat{\alpha}_4)b(t)\hat{\alpha}_9 \end{gathered} \tag{9}$$

or in the form of the equation of the expected financial result:

$$\begin{gathered} b(t)[1-\hat{\alpha}_1-\hat{\alpha}_2-\hat{\alpha}_3]-\hat{\alpha}_4 b(t)[1-\hat{\alpha}_5-\hat{\alpha}_6]+ \\ +(1-\hat{\alpha}_4)b(t)[\hat{\alpha}_7-\hat{\alpha}_8]=(1-\hat{\alpha}_4)b(t)\hat{\alpha}_9 \end{gathered}. \tag{10}$$

It follows from equation (10) that within the insurance process one can distinguish the gross insurance process $[1,\hat{\alpha}_1,\hat{\alpha}_2,\hat{\alpha}_3]$, the reinsurance process $[1,\hat{\alpha}_5,\hat{\alpha}_6]$ linked with the insurance process by coefficient $\hat{\alpha}_4$.[10]

Let $y_i(t), i=0,1,\ldots,9$ denote respectively the values of variables $B(t)$, $X(t)$, $K(t)$, $O(t)$, $B_R(t)$, $X_R(t)$, $K_R(t)$, $I(t)$, $L(t)$, $F(t)$ which characterize the activities of the examined insurance company for the set period t. We shall designate vector $\mathbf{y}=[y_i(t)]$, $i=0,1,\ldots,9$ as the actual activity of the insurance company.

Any vector $\hat{\mathbf{y}}=[\hat{y}_i(t)]$, $i=0,1,\ldots,9$ with at least one of its coordinates equal to the relevant coordinate of vector $\mathbf{y}$, and which satisfies equation (10), shall be called the effective insurance activity. The effective insurance activity, therefore, denotes the hypothetical activity that satisfies the condition of equilibrium posited by the reference insurance process.

The effective insurance activity can be determined on the basis of the i-th ($i=0,1,\ldots,9$) coordinate of vector $\hat{\mathbf{y}}$. For set i let us make the assumption that $\hat{y}_i(t)=y_i(t)$. Making use of the parameters of the reference insurance process, one can determine $\hat{y}_0(t)=\dfrac{\hat{y}_i(t)}{\hat{\alpha}_i}$, followed by the remaining coordinates of vector $\hat{\mathbf{y}}$.

From equation (10) it follows that the conditions that determine the safety of insurance activities can be established, in the case of the reference insurance process, on the basis of the gross earned premium. One can, for instance, adopt the scale of safety $\beta(b(t))$ which is calculated using formula:

$$\beta(b(t))=A\frac{b(t)-C}{b(t)+B}, \tag{11}$$

[10] Likewise, one can distinguish between the investment process and other operational processes. For the sake of simplicity, this model does not distinguish between investment activities and other forms of operational activity as separate processes.

where the values of parameters *A*, *B*, *C* are set basing on conditions $A = \lim_{b \to \infty} \beta(b(t)) = \frac{6{,}25}{G}$, $\beta(KG) = 1$, $\beta(P_1) = \frac{5{,}55}{G}$, where *G* denotes the share of the earned premium net of reinsurance in the gross earned premium.

Let us assume that the reference insurance process is constant in time (within a set time-span). The condition of equilibrium for the effective insurance activity in year *t*+1 at a forecast gross earned premium of $b(t+1) = v(t+1)\beta$ can be written in the form of the following equation:

$$\begin{aligned} v(t+1)\beta[1-\hat{\alpha}_1-\hat{\alpha}_2-\hat{\alpha}_3] - v(t+1)\beta\hat{\alpha}_4[1-\hat{\alpha}_5-\hat{\alpha}_6] + \\ + v(t+1)\beta(1-\hat{\alpha}_4)[\hat{\alpha}_7-\hat{\alpha}_8] = v(t+1)\beta(1-\hat{\alpha}_4)\hat{\alpha}_9 \end{aligned}. \tag{12}$$

The definitions of the coordinates of the reference insurance process yield conditions that determine the capital requirements in relation to the respective variables:
$v_0(t+1) = \frac{y_0(t+1)}{\beta}$, $v_i(t+1) = \frac{y_i(t+1)}{\beta\hat{\alpha}_i}$, $i = 1,2,3,4$, $v_i(t+1) = \frac{y_i(t+1)}{\beta\hat{\alpha}_4\hat{\alpha}_i}$, $i = 5,6$, $v_i(t+1) = \frac{y_i(t+1)}{\beta(1-\hat{\alpha}_4)\hat{\alpha}_i}$, $i = 7,8$.

The reinsurance process allows reducing the technical risk of the insurance company. Assuming the same scale of safety for the processes of insurance and reinsurance, and the rule of caution (i.e. protection against the worst possible event that may take place), the capital requirement can be calculated from the condition for determining the amount of the extended solvency margin (ESM), $v'(t+1)$:

$$v'(t+1) = \max\{v_i(t+1); i = 0,1,2,3,7,8\} - \min\{v_i(t+1); i = 4,5,6\}. \tag{13}$$

The insurance company will be considered as facing the risk of insolvency if:

$$v'(t+1) > u_t. \tag{14}$$

Condition (13) proves the importance of forecasting the values of the individual variables for the solvency margin model. It seems that the best solution would be to resort to variant forecasts (worst, average and best forecast) or interval forecasts.

3.2. AN INTERPRETATION OF EU SOLUTIONS

The solvency margin model that has entered European law on the basis of Council directive 73/239/EEC, and Polish law on the basis of the regulation of the Minister of Finance of October 17, 1995, makes use of the following elements:

1. the reference process: $[1, \hat{\alpha}_1] = [1,\ 0{,}7]$,[11]
2. the scale of safety determined by the formula (2),

[11] It follows from legal regulations that coefficient $\hat{\alpha}_1$ takes on values from a right open interval with the ends approximately equal 0,6914 and 0,6957. This is a result of approximating the values of the parameters of the scale of safety to two decimal points. Given that accuracy, one can arrive at the same parameter values by adopting $\hat{\alpha}_1$=0,7.

3. factors determining the capital requirement, equal $\frac{1}{\beta}$, $\frac{1}{\beta\hat{\alpha}_1}$,
4. naive forecasts of the premium and claims, that is to say, $b(t+1)=b(t)$ and $x(t+1)=\frac{1}{3}\sum_{i=t-2}^{t}x(i)$ or $x(t+1)=\frac{1}{7}\sum_{i=t-6}^{t}x(i)$, depending on the accepted insurance risks,
5. reinsurance through a coefficient dependent on the reinsurers' share in claims incurred.

The European Parliament and Council Directive 2002/13/EC did not introduce major changes to the form of the scale of safety. Only the knot points and threshold values have shifted. Knots and threshold values are subject to indexation. The directive has contributed other factors, which have allowed the security scale to be individualized in relation to the composition of the insurance portfolio (the premium and claims factor being equal to 1 or 1,5 depending on the insurance group).

3.3. AN EMPIRICAL EXAMPLE OF THE USE OF THE ESM

The example presented here, describing the applications of the ESM, is based on the financial statements of Polish insurance companies for the years 1995-2002, published in the official journal "Monitor Polski B". Only joint stock companies have been taken into account. The reference insurance process has been calculated using data for companies which, as of the date of the statement, had not been in operation for less than 8 years (reference set of companies). The parameters of the reference insurance process are presented in Table 1.

Tab. 1. Parameters of the reference insurance process

1	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\alpha}_5$	$\hat{\alpha}_6$	$\hat{\alpha}_7$	$\hat{\alpha}_8$	$\hat{\alpha}_9$
100%	73,4%	35,4%	1,1%	62,4%	69,0%	26,3%	13,9%	2,0%	-6,8%

Source: author's materials

The parameters of the adopted scale of safety, established through formula (11), have been presented in Table 2.

Tab. 2. Parameters of the scale of safety

Year	***KG* in PLN**	**P_1 in PLN**	***G***	**A**	**B**	**C**
1995	674 175	33 708 730	0,5	12,5	2 269 499	428 868
1996	723 657	36 182 855	0,5	12,5	2 436 073	460 346
1997	768 054	38 402 722	0,5	12,5	2 585 530	488 589
1998	818 124	40 906 184	0,5	12,5	2 754 080	520 440
1999	833 780	41 689 000	0,5	12,5	2 806 784	530 400
2000	770 880	38 544 000	0,5	12,5	2 595 042	490 387
2001	704 380	35 219 000	0,5	12,5	2 371 180	448 083
2002	804 040	40 202 000	0,5	12,5	2 706 669	511 481

Source: author's materials

The forecast for the values of variables in 2003 has been assumed to be at the level of 2002 (naive forecast).

The conformity of assessments regarding the danger of insolvency in 2003, obtained on the basis of the valid solvency margin (SM), and those relating to the extended solvency margin (ESM), are presented in Table 3. Class of risk 0 denotes insurance companies that are not at risk, whereas class 1 those that face the risk of insolvency.

Tab. 3. The correspondence of assessments as to the risk of insolvency obtained on the basis of SM and ESM

	Method	Extended solvency margin			
	Set of companies	**Reference set**		**Set of joint stock companies in the period 1995-2002**	
Method	Class of risk	0	1	0	1
Solvency margin	0	59,7%	9,0%	68,9%	9,3%
	1	3,0%	28,4%	3,1%	18,7%

Source: author's materials

Table 4. shows the distribution of insurance companies according to factors that determine the size of the ESM.

Tab. 4. Percentage of companies according to factors determining the size of ESM

Variable	**Reference set**	**Set of joint stock companies in the period 1995-2002**
Insurance activity		
B	14,9%	8,3%
X	20,9%	16,6%
K	14,9%	28,0%
O	0,0%	2,1%
I	38,8%	37,8%
L	10,4%	7,3%
Reinsurance		
B_R	1,5%	3,6%
X_R	50,7%	55,4%
K_R	47,8%	40,9%

Source: author's materials

The results presented in Table 3. show that the assessment of the risk of insolvency to an insurance company performed using the proposed ESM is stricter than using the applicable SM. This might be caused by taking into account a greater number of risk factors and adopting a stricter (more restrictive) scale of safety in the model.

4. CONCLUSIONS

The area of research presented in this article is limited to insurance companies operating as joint stock companies in the non-life insurance. Extending the analysis to mutual insurance companies does not pose any significant problems. There are many methods in which one can take into account the specific nature of the activities of mutual insurance companies (by modifying the scale of safety, assuming the expected financial result to be nil, etc.).

The model of the extended solvency margin can be easily generalized by taking into account other risk factors connected with e.g. the insurance portfolio and its product and geographic diversity, the investment portfolio and various aspects of operational activities. Likewise, the form of the safety scale can be more complex. One can use different production functions to measure the overall risk of an insurance company using the premium.

An individualized approach to determining the solvency of insurance companies can also be achieved by adopting weaker assumptions and using the proper techniques for estimating the parameters of the models. It is worth pointing out that the data in question have the character of panel-data. This fact can be used to determine the specific factors for each company or specified sub-group of companies.

The results presented in this paper show that one can create an entire spectrum of insolvency risk measures which, in practice, give consistent results. Such a conclusion is relatively optimistic in that it allows one to view constructing models and measures of solvency from the point of view of their complexity, the cost and amount of work needed to create and maintain them.

The basic aim in constructing models, methods and measures of solvency is to indicate the point when the organs managing the company or insurance supervisory bodies have to make the decision to intervene in the activities of the insurance company, or otherwise, when the relevant actions have to be taken by the authorities evaluating the company or by the company's clients. The more difficult part lies in achieving the goal of determining the actual level of risk in the activities of the insurance company. The ESM presented in this paper shows how many arbitrary assumptions have to be made in order to perform an assessment of the risk of insolvency. It is easier to realize the first of the aims mentioned above if one uses publicly-available data. The latter aim, if at all possible, can only be realized in approximation.

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