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Empirical Risk Analysis of Pension Insurance: The Case of Germany

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Abstract

The book reserve system is the most widespread method of financing occupational pension plans in Germany. The pension liabilities are mutually insured by the Pensions-Sicherungs-Verein VVaG (PSVaG) against bankruptcy. The PSVaG recently stated that the insurance system needed to be reformed. In the future, risk-adjusted premiums as foreseen for the newly established Pension Protection Fund in the United Kingdom could become feasible. We perform a credit portfolio analysis to determine the risk profile of the PSVaG. The magnitude of a tail risk event suggests that under the current financing system it can only be smoothed out over decades. Under an expected loss pricing plan insurance premiums would vary greatly. In a marginal risk contribution approach the variation of the premiums would be less pronounced.

Introduction

Occupational pension plans vary widely in design and importance across countries. However, specific institutions to insure defined benefit pension plans against bankruptcy of the sponsoring company exist only in a few countries. Sweden and Finland were the first to establish pension insurance systems in the early 1960s, followed by the United States and Germany in 1974 and Japan in 1989. In the United Kingdom, the first such insurance system was introduced in 1995 as a consequence of

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the Maxwell scandal, in which 30,000 employees lost their pensions when the pension fund assets were pledged as collateral. As a result of the severe underfunding of many pension plans and several large bankruptcies, the U.K. government established the Pension Protection Fund (PPF), which became operational in April 2005.

The United Kingdom's PPF is consequently based on risk-adjusted premiums according to the insured firms' default probabilities and funding status. By contrast, the Pension Benefit Guarantee Corporation (PBCG) in the United States charges a flat premium per insurant, to which a supplemental variable premium for underfunding was only added in 1987. In 2006, the insurance premium per participant was increased from $19 to $30 to cover the severe underfunding of the insurance plan. In Germany, the premiums of the Pensions-Sicherungs-Verein VVaG (PSVaG) are based on the annual costs of the pension insurance plan and are not risk-adjusted.

The financial literature is almost exclusively focused on the PBGC. Since its inception, several authors have pointed out the moral hazard problems created by non-risk-sensitive premiums and the pricing problem that can be linked to a conditional put option (Niehaus, 1990; Sharpe, 1976; Treynor, 1977). Several articles apply the option pricing framework developed by Black and Scholes (1973) and Merton (1973) to approximate the cost of insurance under numerous simplifications. They provide illustrative solutions for hypothetical pension plans (Bodie and Merton, 1993; Pennacchi and Lewis, 1994; Seow, 1995) or apply their models to a sample of insured plan sponsors (Marcus, 1987; Hsieh, Chen, and Ferris, 1994; Lewis and Pennacchi, 1999). VanDerhei (1990) uses a large sample of plans and sets premiums directly equal to the product of the risk of an insufficient termination times the amount of exposure. Many of the risks involved are exemplified by the savings and loan crisis of the late 1980s (Bodie and Merton, 1993; Bodie, 1996).

In Germany, the PSVaG has almost completely been ignored in financial research. The only empirical study has been carried out by Grünbichler (1990), who exemplarily calculated risk-adjusted insurance premiums for a sample of 22 large listed corporations using a Merton-type approach (Merton, 1973, 1977).

Attempts to measure the overall long-term risk of the PBGC were made by Estrella and Hirtle (1988) and Lewis and Cooperstein (1993). The full conceptual complexity of the pension insurance system is addressed within an integrated framework by Boyce and Ippolito (2002), who use the stochastic Pension Insurance Modeling System (PIMS) introduced by the PBGC in 1998 to analyze the risk profile as well as a variety of pricing plans. The PSVaG currently does not use any stochastic modeling techniques to capture its counterparty risk.

In this article, we use credit risk techniques to analyze the PSVaG's risk structure. We focus on two central questions.

First, how risky is the current portfolio of the PSVaG in terms of expected and unexpected losses? We directly relate the risk faced by the PSVaG to the riskiness of the individual members. Our empirical research is based on Deutsche Bundesbank's extensive balance sheet database, which allows us to directly cover 70 percent of all insured pension liabilities. What we find is a highly skewed loss distribution. There is a small, yet nonnegligible probability for the occurrence of portfolio losses that substantially exceed historical levels.

Second, how can pension insurance pricing reflect the discrete risk contribution by individual corporations to the PSVaG? In an expected loss (EL) pricing plan similar to that of the PPF, insurance premiums would vary widely. However, the current practice of cross-subsidization appears to be less distinctive in a marginal risk contribution to catastrophic losses approach.

This article is organized as follows. In the following section, we briefly outline the German pension insurance system. The next two sections describe the data and our method. In the subsequent section, we analyze the loss distribution faced by the PSVaG. Thereafter, we show the effects of the different pricing plans, and finally we conclude.

THE GERMAN PENSION INSURANCE SYSTEM

Germany is one of the few countries where the internal funding of pension obligations via book reserves is an accepted standard. The German system of internally financed pension plans emerged in the aftermath of the Second World War. Like all other economic sectors, the banking industry was devastated and the capital market defunct. External financing was hardly available. In addition, the Allied forces imposed marginal tax rates of up to 90 percent on company profits. By disclosing a liability for future pension payments, taxation (as well as wages) could be deferred and the retained funds could be used for reconstruction. In many cases, pension plans were negotiated with work councils in large corporations and established through collective agreements. Thus, from today's perspective, the internal financing of pensions can be regarded as an important component of the "Wirtschaftswunder."

When pensions are internally financed, the companies accrue book reserves corresponding to the present value of pension commitments as liabilities in their balance sheets and write off the accruals from their taxable income.[1] The reporting of pension liabilities follows strict rules. They are calculated using a uniform discount rate of 6 percent and standardized biometric assumptions. They fully appear as pension provisions on the liability side of the balance sheet and are unsecured debt. Thereby, the pension plan is integrated in the corporate financial structure. Pension provisions on the liability side account as book reserves for future pension payments. However, no separate funding is required. Instead, book reserves are systematically considered as a way to keep cash flows as long as possible within the firm to finance the own original business.

In principle, a company running a (Anglo-Saxon-type) funded pension plan could sell off the pension fund assets, use the proceeds to repay corporate debt and draw the present value of its pension liabilities on balance sheet. Thereby, it moves to a (German type) book reserve system. The opposite process is also possible.[2] The book

[1] Income tax does not fall due until the pensions are actually paid and the book reserves are drawn down. The overall very complex tax effects have been controversially discussed in the German finance literature.

[2] Treynor (1977) shows within an augmented balance sheet approach that pension liabilities and pension fund assets should be added to the corporate balance sheet for an economic analysis. In this way, business risk and investment risk affect corporate equity. In the German book reserve system only business risk matters. Whether the bankruptcy risk resulting from

reserve system can also be interpreted as a form of funding with an extreme asset allocation. It is comparable to a pension fund that only holds unsecured bonds issued by the sponsoring company.

Today, the accrual of book reserves is still the most widespread method of financing occupational pension plans in Germany, accounting for almost 60 percent of total pension liabilities in 2004. In our sample, book reserves make up an average of 10.8 percent of the balance sheet total. Large firms tend to have a higher portion of pensions provisions on balance sheet, reaching as much as 25 percent in some cases.

For many years, pensions were not protected in the event of bankruptcy. In theory, funding insures against this risk as, in the event of bankruptcy, the pension fund is used to pay out what is due to the pensioners. However, in a book reserve system only the remaining corporate assets can be used to serve pension obligations. Therefore, an obligatory bankruptcy insurance system was set up in 1974 and institutionalized through the PSVaG. The insurance system was a way to maintain the necessary public support for the German book reserve system where pension liabilities are unsecured and no assets are set aside.

The PSVaG is the German counterpart to the PBGC in the United States.[3] The PSVaG was founded in the same year when extensive new legislation governing occupational pension plans was passed in both countries. Like in the United States, the setup of the system in Germany was very much influenced by the failure of a car manufacturer (Studebaker in the United States and Borgward in Germany). However, the PSVaG is not a federal agency. It was established by the Confederation of German Employers' Associations (BDA), the Federation of German Industries (BDI), and the Association of German Life Insurance Corporations. The PSVaG operates as a private mutual insurance association with compulsory membership for all firms running pension plans that might be adversely affected in the case of bankruptcy.[4] It can, at least in theory, be dissolved by its members' vote. In this case, the KfW Bankengruppe would, by law, assume responsibility for organizing an alternative pension insurance plan. About 90 percent of all insured pension liabilities are related to book reserves.[5] The PSVaG is regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin), the German federal financial supervisor.

In 2004, the PSVaG protected the pensions of 8.5 million employees and retirees with a total notional value of insured pensions of €243 billion. About 440,000 individuals received monthly payments of €55.2 million. Four out of 10 employees in the private sector benefit from occupational pension schemes. The payments amount to 5 percent

the two financing strategies is higher or lower, other thing being equal, crucially depends on the risk, return, and correlation characteristics of the pension fund assets (Gerke, Mager, and Röhrs, 2005).

[3] From 2002 on, some companies from Luxembourg have also been covered by the PSVaG. They account for less than 1 percent of all insurants.

[4] The insured event is bankruptcy. The Employee Retirement Income Security Act of 1974 in the United States originally used a termination insurance concept.

[5] The PSVaG also insures support funds that are often only partially funded and, in principle, allow for reinvestment in the sponsoring company. Life insurance contracts that are pledged as collateral or are revocable are also insured but play nearly no role.

TABLE 1
Descriptive Statistics on the PSVaG for the Period 1975–2004

	Mean	Median	Min	Max	Std. Dev.
Annual insurance premium	0.22%	0.20%	0.03%	0.69%	0.14%
Defaults per year	333.4	330.0	154	705	143.8

Source: Pensions-Sicherungs-Verein VVaG (2005a).

of the overall retirement income. The low rate in Germany compared to the United States and United Kingdom can be attributed to the relative generosity of the public pension system.

Unlike the PBGC or the newly established PPF in the United Kingdom, the PSVAG does not meet the payments from a central fund.

In case of a bankruptcy, the PSVaG purchases annuities from a consortium of private life insurance companies covering the present value of all pensions, which are already paid. In 2004, the consortium was made up of 59 insurance companies. The investment risk is transferred to the insurance industry. But entitlements are not prefinanced until they are due. The original idea of not prefinancing entitlements was again to keep the assets as long as possible within the companies, where they could be used more efficiently. The cost of a bankruptcy case is thereby smoothed over up to 30 years. The present value of entitlements to be financed in the future amounts to approximately 1 percent of all insured pensions. Additionally, the PSVaG operates an equalization fund with a target funding level of the moving 5-year average cost of annual pension insurance. It is drawn on in years with high pension insurance costs.

The PSVaG is financed by *ex post* insurance premiums, which cover the annual costs of the insurance plan and ensure the ongoing solvency.[6] The rates are calculated by dividing the annual costs of the previous 12 months by the amount of insured pension liabilities, which leads to volatility in premiums. Currently, the insurance premiums do not reflect the individual bankruptcy risk. Therefore, the book reserve system provides long-term financing at costs independent of the business risk. There is no cap on annual premiums. It is generally assumed that the taxpayers provide no implicit hedge function and that a catastrophic loss can be smoothed out in the long run as pension liabilities can also be met on a pay-as-you-go basis (see, e.g., Heubeck, 1985). From 1975 to 2004, the annual insurance premiums ranged from 0.03 percent to 0.69 percent, averaging 0.22 percent of the insured liabilities (Table 1).[7] With some exception, most claims involved small and medium sized companies (SMEs).

[6] At the beginning of each year a rough estimate based on recent experience is made and an initial premium is charged in advance.

[7] The pension insurance system was not affected by the German reunification in 1990. Occupational pension schemes did not exist in Eastern Germany and are even today by far less common. Direct pension promises are vested and insured only after 10 years. In fact, we could identify only about 30 corporations from Eastern Germany with pension provisions above €100,000.

In the United States, premiums are charged on a flat rate basis ($30 per participant), which had to be raised several times in the past. Additionally, there is a variable component of $9 per $1,000 of underfunded vested benefits as a risk component. Although the PBGC is not funded by tax revenues, it is a federal agency, and thereby a contingent liability of the government and the taxpayer. In the United Kingdom, 80 percent of the premiums are risk adjusted based on the firms' default probabilities and the funding status of the pension plan.

Similar to the PBGC and the PPF, the PSVaG seeks to limit the risk of moral hazard by several measures. The maximum pension in 2004 was limited to €7,245 per month or a lump sum of €869,400. Increases granted within 2 years prior to bankruptcy are generally not insured, and the insurance can be withdrawn if benefits were committed during a period of impending bankruptcy. In this way, business owners, although generally allowed to use the book reserve system to finance their own pension, are usually not covered.[8]

Throughout its history, the PSVaG has always maintained a low loss profile. To the general public its existence is almost unknown, even to those who receive their pension through the consortium of life insurance companies. The safety of occupational pension plans in Germany is generally not questioned by the public. This might be attributed to the PSVaG's successful and inconspicuous mode of operation, which has given companies ongoing and unquestioned access to internal financing via the book reserve system in the past.

However, most recently the legislation governing occupational pension plans and private pension contracts was reformed comprehensively, mainly to reduce dependency on the public pay-as-you-go pension system, which is being increasingly strained by an aging population. In addition, pension funds were introduced in 2002 as an alternative way to finance pension obligations. They allow a maximum underfunding of 5 percent, and only 5 percent of their assets may be invested in the sponsoring corporation. If properly funded, book reserves can be outsourced to pension funds nontaxably. Pension funds are also covered by the PSVaG, but the premiums are reduced to one-fifth of those of (unfunded) pension provisions due to the vastly different exposure of the PSVaG. Many large and cash-rich companies have the funding of their pension liabilities high on their agenda, which in part can be attributed to a more critical assessment of pension provision by international rating agencies.[9] Currently, pension funds are primarily used for new commitments often financed by employees themselves who can convert parts of their wages into pension entitlements utilizing tax advantages. The main reason is the discount rate for pension obligations, which was originally 2.75 percent as in the insurance industry. Since mid-2005, however, it has been possible to apply a discount rate in line with international accounting standards. Meanwhile, several firms have established contractual trust agreements (CTAs) to fund their pension liabilities and cancel them in their balance sheets

[8] The PSVaG vigorously resists claims that do not fit the statutory requirements.

[9] Until 2003, Standard & Poor's, for example, disregarded pension provisions when calculating financial ratios. Since then, pension provisions are added to debt in the same way as funding deficits of pension funds. The calculated leverage ratios of many German corporations noticeably increased. In some cases, companies were downgraded.

according to US-GAAP or IAS/IFRS.[10] Within the changing institutional environment, adverse selection effects can be expected, as firms that can afford funding will tend to do so, leaving the other group to deteriorate in quality.

In May 2005, the management board of the PSVaG declared that the financing system needed to be changed. The proposed reforms include the immediate prefinancing of all entitlements in the case of bankruptcy, an enforced prefinancing of existing entitlements and an additional mechanism to smooth annual premiums. In the long run, the reformed system could be the basis for risk-adjusted premiums. The management board has justified the proposed reforms by pointing to the risk of declining premiums and to the fact that funding of pensions is now widely accepted in Germany (Pensions-Sicherungs-Verein VVaG, 2005b; Gerke and Heubeck, 2002).

DATA

What sets the PSVaG apart from other financial institutions is that its insurance portfolio can be observed "from the outside." The pension liabilities appear as pension provisions on the liability side of insured corporations' balance sheets. They are calculated in a uniform manner and can be treated as standardized loans. Pension provisions are not funded by nature. They are not backed by separated assets and are unsecured debt. In fact, the PSVaG does not follow a rigorous workout process and the recovery rate is typically below 5 percent. Therefore, we can directly link the risk faced by the PSVaG to the bankruptcy risk of the insured corporations.

In order to analyze the PSVaG's risk profile, we use the comprehensive balance sheet database of Deutsche Bundesbank. First, we selected all corporations with pension provisions. We excluded companies with book reserves of less than €100,000 from the analysis as they contribute negligibly to portfolio risk.[11] The remaining data set has been edited in order to match the PSVaG portfolio as best as possible. The mapping is based on historical insurance losses over the 1975–2004 period, the annual total volume of insured pensions, and the size and default information structure of the PSVaG portfolio. Our final data set consists of 145,347 balance sheet data sets from the period of 1989–2002 including 839 bankruptcies.[12] Table 2 shows descriptive statistics of the pension liabilities of the bankruptcy cases and compares them to the

[10] The most prominent example is the Siemens Pension Trust, with assets in excess of 10 billion Euros. In the case of CTAs, the pension liabilities still appear on the pension sheet under German accounting rules.

[11] Corporations with pension liabilities of less than €100,000 account for about one-third of all insured firms and for about half of all bankruptcies, but they represent less than half of a percent of the total exposure of the PSVaG.

[12] Direct subsidies to stave off bankruptcies, particularly of large firms, can lead to a potential misspecification of our default model. We therefore carefully considered this issue. In recent years, German politicians have become extremely reluctant in granting subsidies to stave off insolvencies. The socialist government of Gerhard Schröder (1998–2005), for example, refused to rescue the building company Holzmann in 2002 despite public protest. In fact, for the second half of our sample period we are not aware of any subsidies granted to avoid bankruptcy. For the earlier period of our analysis such cases are more likely. We are aware of the shipbuilder Bremer Vulkan, for example, which received subsidies of approximately €300 million from the late 1980s on. Finally, the company went bankrupt in 1996. We decided to keep Bremer Vulkan in our sample as it is part of the universe of the PSVaG.

TABLE 2
Descriptive Statistics on Pension Liabilities

	Observations	Mean	Std. Dev.	Min.	Max.
Bankruptcy cases	838	2.5	12.3	0.1	213.8
Rest of the sample	144,443	10.3	127.3	0.1	10,400

Note: All figures are displayed in million euros.

rest of the sample (i.e., the solvent cases). Accordingly, it becomes evident that the defaulted firms tend to be smaller than an average firm insured by the PSVaG.

By means of the final data set, we can directly observe about 70 percent of all book reserves insured by the PSVaG.[13]

METHOD

In this section, we will outline the underlying methodology for measuring the credit portfolio risk of the PSVaG and the risk contribution by each firm.

We regard the PSVaG's members as counterparties, which may default.[14] Unlike a typical credit portfolio, the recovery of PSVaG's exposure is usually negligible, and the severity of losses hence considerable. In order to monitor the inherent risk of a credit portfolio, financial institutions usually refer to an *ex ante* forecast of the portfolio loss probability distribution function (loss PDF). For our study, we refer to a Merton-type one-factor model. We calculate the EL and unexpected loss (UL) for the PSVaG portfolio. While the first ratio reflects the average portfolio loss to be expected *ex ante*, the UL is usually defined as the difference between a particular quantile value of the loss distribution and the EL. In this study, we used the value at risk (VaR) and the expected shortfall (ES) as suggested by Artzner et al. (1999) as quantile values of the loss distribution. We refer to confidence levels similar to those used in the banking and insurance industry and to a time horizon of 1 year.

Let PD_i denote the annual default probability of an insured PSVaG firm and LGD_i (loss given default) the portion of the pension provisions (EAD_i, exposure at default) lost in a default event. Then the expected loss of the portfolio (EL_p) may be written

When excluded, the logit coefficients did not exhibit a material change. Tax breaks to avoid a looming insolvency do not exist in the German tax system.

[13] When cross-checking the portion of bankruptcy cases in the Bundesbank database against the corresponding portion of defaults of the PSVaG, we found that the Bundesbank database contains a disproportionate number of bankruptcies. To account for this fact and to prevent estimation bias we applied weighted default probabilities.

[14] The notion default refers to bankruptcy; that is, the PSVaG becomes liable for the payment the pensions once an insured firm is bankrupt. This default definition is identical to the one used in the balance sheet database of Deutsche Bundesbank.

as the sum of the firms' expected losses:

$$EL_p = \sum_{i=1}^{n} PD_i \bullet LGD_i \bullet EAD_i. \tag{1}$$

The EL_p is by definition not affected by credit correlations and can therefore be determined analytically. The unexpected loss of a credit portfolio, by contrast, depends on the correlations of the exposures in the portfolio.[15] We will determine the PSVaG's UL by means of Monte Carlo simulation. This allows us to calculate the UL risk contribution of each firm i, $RCB_i(z)$, as

$$RCB_i(z) = \frac{\partial RM(z)}{\partial z_i} \bullet z_i, i = 1, \ldots, n, \tag{2}$$

where $RM(z)$ is the portfolio risk measure and z_i represents each firm i's pension provisions.[16] We refer to the Euler allocation principle to determine the premium that should be paid by each firm and use the VaR and the ES as portfolio risk measures.

The credit risk default process is modeled based on a stylized Merton-type asset value model (Merton, 1974) with one common systematic risk factor and the remaining disturbance being idiosyncratic. We assume that each firm's creditworthiness is represented by its asset value, which fluctuates over time and reflects the actual state of the firm's creditworthiness. We control for asset values falling below a certain barrier (usually the liabilities of a firm) during a 1-year time horizon, which indicates a default event. The asset values of larger firms tend to have a higher correlation with the systematic factor, that is, implying that they are more strongly influenced by macroeconomic developments.[17] Rather than using a continuous relationship between the firm size and the correlation with the systematic factor, we refer to three discrete size groups.

Let us suppose that a firm defaults if its asset value x_i falls short of a specific default barrier y_i. We assume that each firm's default barrier can be inferred via its default probability (PD_i):

$$x_i \leq y_i = \Phi^{-1}(PD_i), \tag{3}$$

where Φ^{-1} is the inverse cumulative standard normal distribution.

We randomly draw a systematic factor Z and an idiosyncratic shock ε_i for each firm and thereby determine the asset returns of the firms in the sample (x_i):

$$x_i = \rho_i Z + \sqrt{1 - \rho_i^2}\varepsilon_i, \tag{4}$$

[15] The portfolio UL may also be determined by means of analytical approximations, for example, following the CreditRisk + framework.

[16] The pension provisions are taken from the firm's balance sheets.

[17] This is a common assumption and has been incorporated also in the Basel II framework, for example (BCBS, 2006).

where ρ_i is the correlation of the firm's asset return with the systematic factor. The asset correlation equals the squared correlation of the firm's asset returns with the systematic factor. Following this procedure we arrive at the portfolio loss probability distribution function (loss PDF).

THE LOSS DISTRIBUTION FACED BY THE PSVaG

We determine the annual default probability of each borrower (PD_i) with a binary logit model, which is calibrated based on the sample data set in a cross-sectional context, that is, by using pooled data from 1989 to 2002.[18]

The binary logit model takes the common form:

$$PD_i = \frac{1}{1 + \exp(-a - \sum_j b_j y_{i,j})}, \tag{5}$$

where (PD_i) is the default probability of firm i. We use six regression variables ($y_{i,j}$): four financial ratios and two sector dummies to distinguish the default industry, industrials, from the trade sector and the remaining industry sectors.[19] We also included year dummies in order to control for macroeconomic effects. For the default data subsample, we use balance sheet data with a time gap of 12 to 24 months prior to default. Due to missing bankruptcy data equation (5) is estimated using a weighted logit procedure to correct the bias toward underreporting bankruptcies.[20]

Table 3 shows the regression result. We observe that all variables are highly significant and that the signs of the variables are as expected.[21]

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[18] We additionally ran a panel regression. As this exercise revealed similar results, we omitted the longitudinal case.

[19] We initially distinguished between industrials, trade firms, the construction sector, and other firms. However, it turned out that construction firms were very similar to firms from the sector "other," so we have assigned them to the latter one. A similar distinction has been referred to by many other authors in the credit risk literature, starting with the seminal work by Altman (1968).

[20] As outlined in footnote 14, we run a population-to-sample default probability weighted logit regression, in line with Boyce and Ippolito (2002, footnote 31), as our results would otherwise have been biased. In addition, we considered that firms might have merged before defaulting. To account for these cases, we first included all data when estimating the logit model and predicting the PDs. Next, we identified all CCC-rated or worse rated cases, which were subject to mergers afterward. It turned out that their total exposure of the PSVaG portfolio was less than 0.1 percent of the average annual exposure of the PSVaG. In particular, no large case occurred in our sample period. Subsequently, we reestimated our model ignoring them and the coefficients did not change compared to the original specification. Hence, we decided to keep these cases in the sample as mergers shortly before potential bankruptcy cases are integral parts of the universe of the PSVaG.

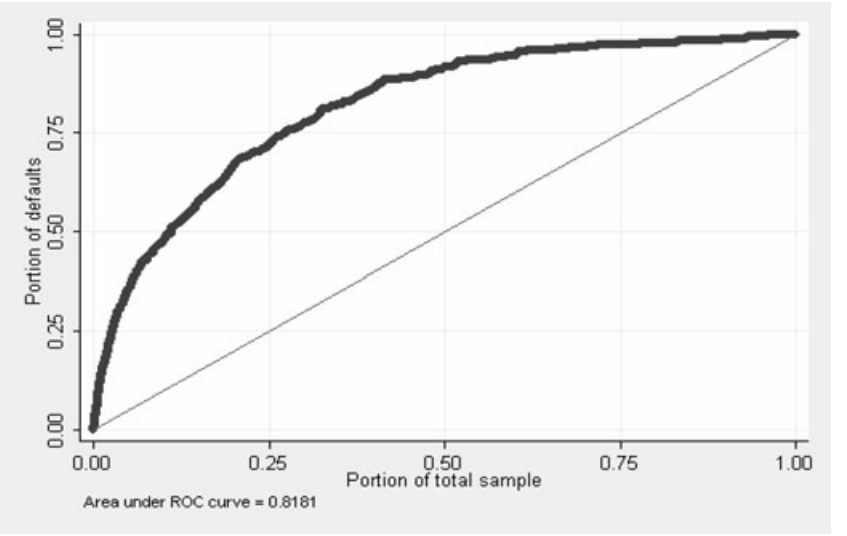
[21] The regression result remains stable when year dummies are included. Most year dummies are highly significant and their sign tends to be negative for the first part of the observation period and zero or positive for the second part of the observation period. A negative coefficient implicates a lower PD and vice versa. However, the magnitude of the coefficients is relatively low. For the current analysis, we sought for a through-the-cycle PD in order to

TABLE 3
Logistic Regression

Variable	Coef.	Std. Err.	$p > \|z\|$
Constant	−3.4794***	0.10002	0.000
Equity/assets	−4.6610***	0.3746	0.000
Log assets	−.11557***	0.02699	0.000
Short-term assets/short-term liabilities	−1.6456***	0.11960	0.000
Result from ordinary operations	−5.6924***	0.27496	0.000
Trade	−0.50999***	0.11001	0.000
Other	0.51713***	0.13569	0.000

Note: The significance and robustness of the outcome are supported by the pseudo R^2 (0.1622), the Wald test, and the likelihood ratio test.
***, **, and * indicate statistically significant results at the 1%, 5%, and 10% levels.

FIGURE 1
Performance Measure of Rating Models: The ROC Curve

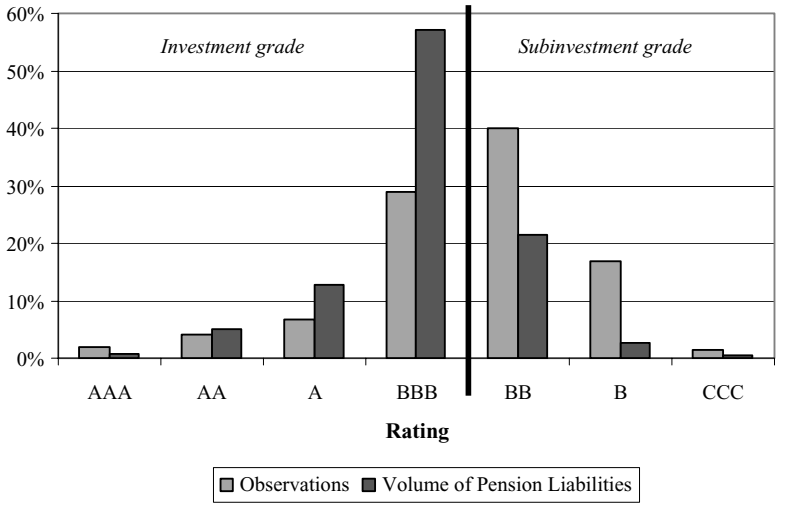


A receiver operation characteristic (ROC) curve to evaluate the outcome of the logistic regression model is shown in Figure 1.[22] The discriminatory power of the calibrated

highlight a general impact of default risk on the PSVaG. Given that the sign for 2002 is also weakly negative, our estimates are conservative.

[22] The graph shows the cumulative percentage of the total sample according to the estimated logit-PD (in decreasing order starting with the highest PD) on the x-axis and the cumulative percentage of the defaulted firms in the sample on the y-axis. An ideal model would assign higher logit-PD scores to all defaulted firms than to nondefaulted firms. A random model would produce roughly the linearly increased line.

FIGURE 2
Distribution of Observations and Pension Provisions According to Rating Classes



logit model yields an area under the ROC curve of 0.8181. The figure shows the cumulative percentage of the total sample according to the PD_i of the logistic regression model on the *x*-axis, estimated *ex ante*, and the cumulative percentage of the borrowers who have defaulted *ex post* on the *y*-axis (see, e.g., Moody's, 2000).

We classify the firms into common rating categories, AAA, AA, A, BBB, BB, B, and CCC. In line with international practice, firms are clustered into grade AAA if their regression-based PD is below 0.01 percent. For the AA segment, the upper bound is 0.04 percent and for the other segments (A, BBB, BB, and B) the upper bounds are 0.1 percent, 0.5 percent, 2 percent, and 10 percent, respectively. A firm is assigned to the rating grade CCC if its PD exceeds 10 percent. Figure 2 shows the percentage of observations and the respective volume of pension liabilities in each rating class.

Forty-two percent of the observations and 75 percent of the pension provisions of the PSVaG refer to the investment grade segment. This indicates that PSVaG has a better risk structure than many bank credit portfolios.[23] The fact that a considerable share of large firms with high pension provisions tends to be rated above average has a visible impact on this outcome. Nevertheless, there is also a number of top-rated smaller firms. In the subinvestment grade we predominantly find small- and medium-sized companies.

Table 4 compares the categories of predicted bankruptcy probabilities implied by the estimated coefficients against real default data of Standard & Poor's from 1981 to 2003

[23] Moody's (2001, p. 6), for example, underlies average net loan provisions of 0.77 percent for German banks during the period 1989–1999, which is more than two times the average loss of the PSVaG during the same period.

TABLE 4
Historical Defaults and Estimated Bankruptcy Probabilities

Rating	Historical Defaults in %	Estimated Bankruptcies in %[a]	Observations
A	0.05	0.07	44
BBB	0.37	0.28	252
BB	1.36	0.92	131

[a]Companies with pensions provisions in excess of €500 million.

(Standard & Poor's, 2004). The pattern of predicted bankruptcy rates follows historic default rates quite closely across rating classes.[24]

In a default event, we assume a fixed recovery rate of 5 percent of the pension provisions based on past experience of the PSVaG. Pension provisions are unsecured debt and the PSVaG does not follow a rigorous workout process.[25] The credit exposure is equal to the firms' pension provisions.[26]

As to credit dependencies, we use three different correlations of the firms' asset values with the single systematic risk factor. More specifically, we apply asset correlations of 20 percent for the largest firms (sales > €50 million), 10 percent for SMEs (sales > €10 million and < €50 million) and 5 percent for retail firms (sales < €10 million). The assumption that larger firms exhibit higher asset correlations considers empirical findings (e.g., Lopez, 2004). The asset correlation levels are consistent with assumptions and estimates made by other authors and closely in line with the asset correlations applied in Basel II (BCBS, 2006).[27]

Next, we analyze the 1-year credit portfolio risk of the current PSVaG for 2004.[28] The EL is 0.39 percent of the insured pension provisions at their actuarial value. The annual premium paid to the PSVaG was 0.36 percent in 2004 and is therefore very close to our sample EL.[29]

[24] The probability of bankruptcy is generally lower than the probability of default as measured by the rating agencies.

[25] The use of a stochastic LGD will, given the low average recovery rate, only give the results marginally greater precision, if at all.

[26] In the case of one large corporation we scaled down the exposure to 20 percent, as the pension liabilities were already funded in 2002. This is in line with the PSVaG's premium policy, which charges only one-fifth for pension liabilities financed through pension funds. At present, there is no empirical evidence available concerning the funding status in the case of bankruptcy. For convenience, we did not introduce a stochastic LGD in this specific case.

[27] See, for example, Bluhm, Overbeck, and Wagner (2003).

[28] We use the portfolio of 2002 to distinguish between defaulted and nondefaulted firms. We consider the balance sheet 12 to 24 months prior to bankruptcy to be balance sheets related to default events.

[29] The two figures cannot be directly compared for two reasons. First, the annual premium to the PSVaG did not fully reflect the cost of pension insurance, as financing was partly deferred to future periods. Second, the expected loss is calculated based on the notional value of pension provisions. Due to lower discount rates in the insurance industry, the EL understates the true costs of pension insurance.

TABLE 5
Credit Portfolio Loss Based on Different Settings

No.	Credit Risk Parameters				Outcome		
	Confidence Level	PDs	Exposures	Correlations	EL (%)	VaR (%)	ES (%)
Reference case	99.9%	Indiv.	Indiv.	5/10/20	0.39	9	11.5
1	99.0%	Indiv.	Indiv.	5/10/20	0.39	4.1	6.2
2	99.9%	Indiv. + 50%	Indiv.	5/10/20	0.58	10.9	13.3
3	99.9%	Flat (1.3%)	Indiv.	5/10/20	1.3	20	23.9
4	99.9%	Indiv.	1	5/10/20	1.09	7.3	8.8
5	99.9%	Indiv.	Indiv.	2.5/5/10	0.39	7.5	8.5
6	99.9%	Indiv.	Indiv.	0	0.39	7.3	7.7

In order to determine the portfolio's risk, we perform Monte Carlo simulation with 100,000 runs. We thereby carry out sensitivity analysis for the credit risk parameters: the PD, the exposures, and the asset correlations, while keeping the other parameters constant, in order to determine their relative importance and the impact of cyclical effects.

Table 5 shows the results for seven different credit risk parameter settings. The specific setting of the simulations with respect to the credit risk parameters is displayed in columns 2 to 5, and the portfolio risk in terms of EL, VaR and ES are shown in the last three columns. As the reference case we use a confidence level of 99.9 percent, which refers to the regulatory capital level used in the Basel II framework.

At a confidence level of 99.9 percent, the VaR is 9 percent and the ES is 11.5 percent for the PSVaG portfolio. Next, we test the sensitivity of the portfolio loss by applying six additional specifications. Case 1 is a proxy for the worst portfolio loss to be expected if the next year would be the worst of 100 years. While cases 2 and 5 may be regarded as scenarios that can occur if the macroeconomic situation changes, the purpose of the stylized (extreme) cases 3, 4, and 6 are used to test the overall sensitivity of portfolio risk to PDs, the size distribution and correlations.

In sum, we can conclude that for all specifications the VaR (and the ES) exceed the EL by a considerable amount; that is, the PSVaG faces the risk of very high losses if losses accumulate in an unfavorable year. For a confidence level of 99 percent (case 1), the VaR is 10 times the EL (4.1 percent vs. 0.39 percent). On the 99.9 percent percentile (reference case), the VaR is even more than 20 times the EL (9 percent vs. 0.39 percent.). This result indicates that the occurrence of a tail risk event might question the existence of the PSVaG, as such a loss event would be more than 10 times higher than the highest historical losses incurred over the last 30 years.

However, pension insurers have a higher degree of flexibility than deposit insurers, for example. In case of the occurrence of an insured event (i.e., bankruptcy) it is not the full pension liability that falls due but merely monthly pension payments. Hence, the PSVaG does, in principle, have the policy option to stop buying annuities and

to switch to a pay-as-you-go system. A tail risk event could thereby be smoothed out over decades. Alternatively, the PSVaG could prefinance extreme losses up to a certain confidence level by building up a reserve fund. The target funding level could be the difference of the VaR of the 99.0 percent and the 99.9 percent confidence level, for example. Accordingly, the corresponding loss could be added to the annual premium over a reasonable lengthy time period.[30] An additional *ex ante* policy option would be reinsurance. The PSVaG could, for example, issue a catastrophic bond, where the principal is lost for the investors in case the loss of the PSVaG exceeds a certain predefined level.

Subsequently, we analyze the sensitivity of the outcome of the reference case to various scenarios (cases 2 to 6). One of the most relevant issues for the PSVaG is the occurrence of cyclical up- and downturns, which lead to lower and higher average default probabilities. For instance, in an unfavorable cyclical scenario the default probability can exceed the average by 50 percent. In this scenario, assuming that the cyclical effect hits all companies in the same way (i.e., all PDs increase by 50 percent) we observe that the EL increases from 0.39 percent to 0.58 percent and the VaR from 9 percent to 10.9 percent (case 2).

Next, we set all PDs to a flat level of 1.3 percent (case 3). By consequence, portfolio risk increases substantially and roughly doubles compared to the reference case. This result shows that the larger PSVaG firms exhibit lower than average PDs, which reduces both the EL and the fatness of the tail.

A test of the effect of the heterogeneous size distribution (case 4, setting all exposures to one unit) results in a reduction of the portfolio risk by approximately 17 percent. However, the average expected loss would almost triple, which in the aggregate would have an even more negative impact on the PSVaG than the relatively low reduction in the tail risk. Nevertheless, the PSVaG exhibits a concentration risk by default, so that this outcome is an indicator of the extent of this effect rather than a scenario that may occur.

If the asset correlations are 50 percent lower than the correlations in the reference case (case 5), which might be caused by cyclical effects, for example, the VaR falls by approximately 17 percent compared to the reference case, and would only be 0.2 percentage points higher than for the case in which all PSVAG firms are independent (case 6).

Figure 3 shows the loss probability distribution function (loss PDF) for the PSVaG (with the parameters as in the reference case) with all portfolio losses above 3 percent treated as a tail cluster. The loss PDF is highly skewed to the right, what indicates that there is a high probability of low losses around the EL and a low, yet nonnegligible probability of very high losses (tail risk) that may threaten the PSVaG if the fund is faced the worst year in 100 years, for example.

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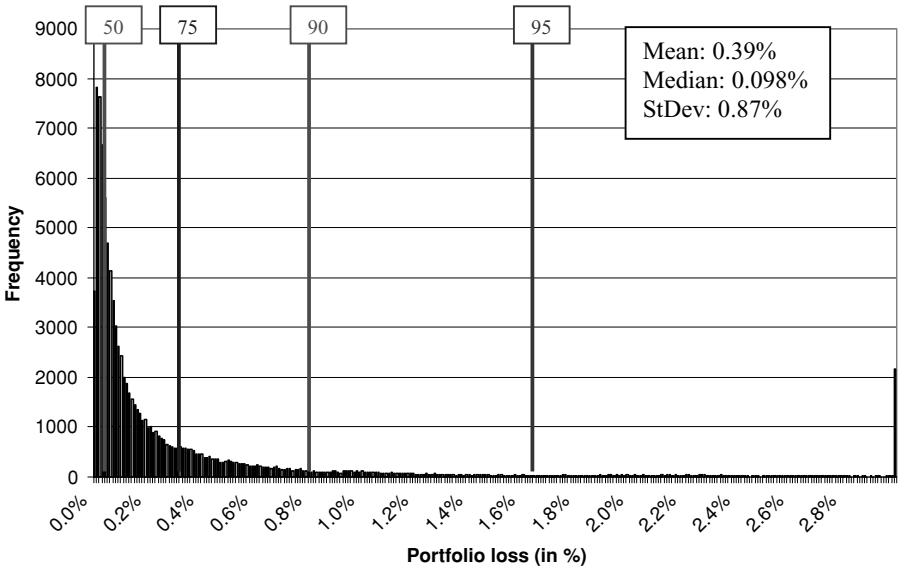
[30] The latter approach has been followed by Sweden, for example. Its pension insurer being similar to the PSVaG has built up a reserve of about 10 percent of all insured pension liabilities to cover extreme losses. This amount can be justified by the high concentration risk inherent in the Swedish economy. The equalization fund of the PSVaG has only a target funding level of the moving 5-year average costs of the insurance scheme.

FIGURE 3
Loss Probability Distribution Function for the PSVaG Portfolio.



Note: The vertical lines indicate the x% quantiles of the PSVaG losses. The red line ("50"), for example, refers to the median loss.

Although the premiums to the PSVaG are smoothed by its specific financing mechanism, which moves premiums to the mean of the loss distribution, a comparison with the historical premiums underpins the robustness of the loss distribution. Over the past 30 years, the historical premiums ranged from around the 15 percent loss quantile (0.03 percent) to the 87 percent loss quantile (0.69 percent) of the loss distribution. Had AEG's looming bankruptcy not been averted by a out-of-court settlement in 1982, the corresponding loss of more than 2 percent would have exceeded the 95 percent quantile.[31]

RISK-ADJUSTED PREMIUMS

The PSVaG's current uniform pricing plan cross-subsidizes firms and thereby distorts a fair competition, as pointed out by the Monopolkommission (2004). Furthermore, risk-adjusted premiums can mitigate adverse selection problems. Such premiums can provide a strong incentive for those corporations having a high counterparty risk to the PSVaG to fund their pension obligations. A recent example of how risk-adjusted premiums can be implemented is the insurance plan of the cooperative banks in Germany.

[31] The PSVaG follows a very restrictive policy concerning out-of-court settlements. The purpose of the PSVaG is not to help restructuring companies but only to guarantee pensions. In Germany, out-of-court settlements are only successful in very few cases.

TABLE 6
Specification of the Three Pricing Options and Their Properties

Approach	Risk-Adjusted	Risk Drivers and Their Effect for Portfolio Loss
Uniform pricing	No	Exposure (+)
Expected loss pricing	Yes	Exposure (+), probability of default (−)
Marginal risk contribution based pricing[a]	Yes	Exposure (+), probability of default (−), Correlation (+)

[a]The marginal risk contribution pricing refers to catastrophic losses only.

We compare the non-risk-adjusted, uniform pricing plan with two potential risk-adjusted pricing methods: EL-based pricing and pricing based on marginal risk contributions to catastrophic losses. One general difference between the PSVaG insurance premium and credit pricing is that the former is determined *ex post*, when the losses have occurred, whereas risk-adjusted credit pricing is based on *ex ante* expectations about potential losses. Nevertheless, one might argue that it is reasonable to allocate the *ex post* losses in a risk-adjusted way to the PSVaG members in order to avoid cross-subsidization.[32]

In the case of EL-based pricing, the aim is to cover the average expected costs based on each firm's default risk. Marginal risk contribution-oriented pricing, instead, focuses on tail risk events within a portfolio context. Premiums are charged according to each firm's contribution to the catastrophic losses that can occur. Table 6 shows an overview of the three different pricing options.

EL-Based Pricing

Applying EL-based pricing to the PSVaG portfolio reveals that the premium for investment grade firms is reduced substantially compared to uniform pricing, whereas the non-investment-grade firms face much higher premiums than before. For the AAA segment, for example, the reduction would be 99 percent, while the premium for the CCC-rated segment would increase by more than 15 times as shown in Table 7.

The average impact of EL-based pricing is quite different for small and large firms. SMEs[33] have an average PD of 1.38 percent while the largest 30 exhibit an average PD of 0.41 percent. The insurance premium for an average SME would increase by 195 percent, while the 30 largest firms would contribute 35 percent less than under the uniform pricing regime. Grünbichler (1990) finds very similar results for

[32] The purpose of this section is to highlight different premium contributions when referring to expected losses and catastrophic losses. It is not directly comparable to common pricing schemes, for example for credit risk. A premium scheme oriented on credit risk pricing would comprise an administrative cost premium as well as an expected loss component and an unexpected loss component alongside the portfolio loss distribution function. The application of the latter framework will be subject to further analysis.

[33] Firms with a turnover of less than €50 million.

TABLE 7
Uniform Pricing Versus EL-Based Pricing

		Portfolio Loss Contribution in %		
Rating	PD in %	Uniform	EL-Based	Change in %
AAA	<0.01	0.65	0.007	–99
AA	0.01–0.04	3.46	0.24	–93
A	0.05–0.1	17.24	3.56	–84
BBB	0.1–0.5	58.07	34.26	–36
BB	0.5–2	18.75	44.08	+156
B	2–10	1.78	15.85	+460
CCC	>10	0.05	1.99	+1,560
		100.00	100.00	

a sample of 22 corporations. For two-thirds of the firms he calculates substantially lower premiums. In some cases, the risk-adjusted premium is reduced by more than 99 percent. However, the premium increases more than six-fold for the riskiest company.

Although risk-adjusted premiums may be more efficient from an insurance point of view it can be questioned whether they are preferable in a broader socio-economic context. A first implication of risk-adjusted premiums could be that particularly SMEs with sub-investment-grade rating cut down their occupational pensions schemes. However, given that the German public pay-as-you-go pensions system is increasingly strained, this is in contrast to the political interest in favor of an expansion of occupational pensions. Second, risk-adjusted premiums might have the potential to directly increase the default probability of firms; that is, PSVaG-insured companies could even become insolvent because of an obligation to pay risk-adjusted premiums.[34]

The pricing plan of the PPF in the United Kingdom is based on expected losses and uses 100 risk bands. The risk-adjusted premium for a firm in the highest risk band is 203 times that of a firm in the lowest, both pension plans having the same funding status. For the reasons listed above, the pricing scheme of the PPF in the United Kingdom limits the maximum annual risk-adjusted premium to 0.5 percent of the pension liabilities. The deposit insurance systems of the private banks and cooperative banks in Germany use risk-based pricing system since 1998 and 2004. The maximum premiums are limited to 2.5 times and 1.5 times, respectively, of those banks in the lowest risk bracket.

Marginal Risk Contribution-Oriented Pricing

Risk-adjusted premiums based on the marginal risk contribution of each PSVaG firm additionally take into account the dependence structure in the portfolio besides the creditworthiness and the size of a firm. It is the most comprehensive pricing approach.

[34] In fact, we identified several cases of small corporations in our sample where risk-adjusted premiums would exceed their equity.

TABLE 8
Comparison of the Two Risk-Adjusted Pricing Plans

	Pricing Contribution (Relative to Uniform Pricing)		
Pricing Plan	SMEs	Larger Firms	30 Largest Firms
EL-based	+195%	+15%	−35%
Marginal risk contribution	+46%	+26%	−31%

We refer to the 90 percent confidence level and calculate the marginal risk contribution of each firm to catastrophic losses.

The impact of marginal risk contribution-based pricing on the premium is again calculated for small and large firms in order to compare them to the EL-based pricing regime. This is done as follows. We calculate the loss contribution of each firm for all cases where the portfolio loss exceeds the 90 percent quantile. Subsequently, we take the corresponding average loss contribution of each firm. As shown in Table 8, the average premium for the largest 30 corporations decreases by 31 percent relative to the uniform pricing plan (EL: –35 percent), whereas the premium paid by SMEs increases by only 46 percent (EL: +195 percent). A pricing scheme based on the marginal risk contribution supports a much lower spread in the premium variation than expected loss pricing.

To demonstrate the effect of the different pricing methods we exemplarily calculated the premiums for Linde AG, which is listed in the DAX 30. Under EL-based pricing, the premium for 2004 decreases by 61 percent (from €2,027,864 to €788,614). Based on the marginal risk contribution the premium decreases only by 43 percent (€1,150,771).

CONCLUSION

In this article, we analyze the portfolio risk structure of the PSVaG with a benchmark data set provided by the Deutsche Bundesbank. Specifically, we compare the risk faced by the PSVaG as a mutual insurance organization directly to the riskiness of the individual members in its portfolio. With an average of more than 10,000 corporations per year we directly observe about 70 percent of all insured pension provisions.

In line with best practice methods applied in credit risk (e.g., in the context of Basel II and Solvency II), we estimate the portfolio loss distribution function of the PSVaG. We find a highly skewed loss distribution with an expected loss that is lower than in an average credit portfolio of a bank. The reason is that many large firms have low default probabilities and high exposures, as the PSVaG does not set an upper limit to individual exposures. However, the PSVaG portfolio conversely faces a substantial tail risk, that is, implying that there is a small but nonnegligible probability of portfolio losses substantially in excess of historical levels. In a catastrophic scenario, the PSVaG does, in principle, have the policy option to stop buying annuities and to switch to a pay-as-you-go system. A tail risk event could thereby be smoothed out over decades.

In 2005, the management board of the PSVaG expressed the need to change the financing system. In the long run, the reformed system could be the basis for risk-adjusted premiums. The management board justifies the reform with the risk of a declining insurance volume and the fact that nowadays the funding of pensions is widely accepted.

We analyze two risk-adjusted pricing methodologies. First, we apply an expected loss pricing regime that recognizes each firm's default risk and the volume of pension provisions. The results show that for investment-grade corporations the premiums would substantially decline. For some top-rated companies they would almost vanish. However, for sub-investment-grade firms they would multiply.

Second, we calculate risk-adjusted premiums based on marginal risk contributions to catastrophic loss scenarios, thereby taking into account the fact that pension provisions and asset correlations increase with firm size, leading to an increasing severity of the highest losses. Under this pricing regime, variation of premiums would be less pronounced than under expected loss pricing.

We are currently seeing a shift in the financing of occupational pension plans. The German capital market is well developed. The original idea for building up book reserves by investing the necessary assets in the own corporation might become obsolete in the future. Many large corporations that can afford to do so are putting the outsourcing of pension provisions high on their agenda. If properly funded, pension provisions can be canceled out of their balance sheets. In 2002, the PSVaG reduced the insurance premium for the newly introduced pension funds to one-fifth due to the vastly different exposure given default. The long-term existence of the PSVaG as a mutual insurance organization crucially depends on how it is accepted by its members. An adverse selection problem may arise when large, cash-rich corporations fund their pension liabilities while the remaining corporations deteriorate in quality. Risk-adjusted premiums, taking into account the probability of default and the funding status, are one way to mitigate adverse selection effects and are consistent with generally higher risk awareness among financial institutions. A risk-based pricing scheme with limited maximum premiums as used by the German deposit insurers, for example, can increase the awareness of the firms and especially of the SMEs that pensions remain unfunded and thereby help to maintain the support for the insurance system.

The newly established PPF in the United Kingdom, for example, is currently implementing a risk-adjusted premium structure. Sweden is taking another approach: corporations that cannot maintain investment grade status are simply forced to fully cover their pension liabilities by buying annuities.

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