A PROPOSAL FOR A CAPITAL MARKET-BASED GUARANTY SCHEME FOR THE FINANCIAL INDUSTRY

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Proposal for a Capital Market-Based Guaranty Scheme for the Financial Industry

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Abstract

In this paper, we introduce a capital market-based financial guaranty system as an alternative to current insurance guaranty funds and deposit insurance systems. The guaranty system secures clients’ claims for the event of default by the financial company using a special purpose vehicle which issues bonds to investors. The proposed system, analogous to a credit-linked note, consists of one guaranty vehicle for each financial company. In a first step, we present equations in order to derive the two main input parameters of the special purpose vehicle: the premium and the principal. Subsequently, we analyze the impact of different investment actions taken by the financial companies protected by the guaranty vehicle on various shortfall measures. We find that it will be necessary to restrict the investment volume of investors from the financial industry in order to avoid systematic risk within the proposed guaranty scheme. By deriving practical implications, we show that the capital market-based solution has some key benefits compared to current deposit insurance and insurance guaranty schemes.

Key words: Deposit Insurance, Insurance Guaranty System, Insolvency Protection

JEL Classification: G21, G22, G28, G33

1 Introduction

High losses at numerous financial institutions and major insolvencies during the recent financial crisis have raised the questions whether current financial guaranty systems can really protect clients against defaults by financial companies in the event of major economic downturns. Especially bail-outs which occurred in various countries, e.g., certain banks in Ireland and the US or the insurance company AIG, gave rise to discussion as to whether and to what extent taxpayers and society should pay for the economic turmoil suffered by financial companies. Thus, a reconsideration of both, i.e. current deposit insurance systems in the banking sector and insurance guaranty systems operated by the insurance industry, appears to be necessary. In the European Union, reviews of deposit insurance systems have

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led to higher coverage levels in the last year. While these coverage levels will be harmonized by the end of 2011 (see, e.g., ECOFIN Council (2008), European Commission JRC (2010), European Commission (2010)), the landscape of existing guaranty schemes in the insurance industry is still very heterogeneous in terms of practical implementation, scope and coverage (see, e.g., Oxera (2007)).

In this paper, we propose a capital market-based guaranty system as an alternative to current insurance guaranty funds and deposit insurance systems. The proposed framework has a structure which is equivalent to a credit-linked note and similar to catastrophe or other insurance-linked bonds: A special purpose vehicle or financial guaranty vehicle for each company is established to which investors contribute a principal and financial companies a risk-adequate premium. If the financial company defaults, the capital in the guaranty vehicle is used to cover the claims of the company’s clients. Note, however, that the proposed market-based guaranty system exhibits one key difference versus catastrophe bonds, namely that catastrophe bonds cover insurance risks whereas financial guaranty systems solely focus on credit risk.¹ The described market-based solution overcomes the problem of current guaranty systems that wealth transfers generally occur between clients of different financial companies (for a discussion of current bank deposit guarantees or insurance guaranty funds see, e.g., Rymaszewski et al. (2012)). In addition, the capital market-based funding element might allow guaranty systems to even cover defaults by major financial companies as it provides access to very large amounts of capital from investors in all sectors of the market (instead of focusing solely on contributions from insurance companies). Even if the proposed structure is closely related to insurance-linked bonds, i.e., investments in risk-free assets linked to the company’s default, the proposed scheme represents a regulated form of credit insurance for companies that as yet have no such insurance (credit default swaps are for instance not available to most financial companies). Furthermore, if such a system were made compulsory for all companies through market regulation, it might constitute a step forward in establishing a new financial product designed uniformly for all market players within the financial industry.

In the following, we provide a brief overview of the most relevant literature on deposit insurance and insurance guaranty systems and point out major similarities, differences and current trends. Insurance guaranty and deposit insurance systems are similar in their basic characteristics. Both are designed to provide customer protection in the financial services industry and require compulsory membership by the respective financial institutions. As banks and insurance companies are usually perceived to be system-relevant, these guaranty schemes additionally aim at enhancing financial stability. The studies by Oxera (2007), Schmeiser and Wagner (2012), Feldhaus and Kazenski (1998), Demirgüç-Kunt et al. (2008), Cariboni et al. (2008), and Frolov (2004) provide an overview of existing systems and their practical implementation in the insurance and banking industry. While Schmeiser and Wagner (2012, Sect. 2) give a worldwide outline of existing insurance guaranty funds, Oxera (2007) provides a thorough review of the existing schemes in the European Union. A detailed description of the U.S. insurance guaranty fund can be found in Feldhaus and Kazenski (1998). Demirgüç-Kunt et al. (2008) provide a comprehensive overview of different deposit insurance systems around the world as of 2003. A more recent outline of

¹Nevertheless, insurance risks may have a significant impact on credit risk as insurance risks like catastrophes can cause financial companies, particularly insurers, to default.
European systems, as of 2007, can be found in Cariboni et al. (2008). In addition, Frolov (2004) gives a literature review of deposit insurance designs, analyzing basic approaches and practical choices.

Major differences between deposit insurance and insurance guaranty systems can be observed with regard to several characteristics:

- **Compensation payments.** Deposit insurance systems usually incorporate only one form of compensation in the event of insolvency, namely cash equivalent to the current value of insured deposits up to a predefined cap. By contrast, compensations in insurance guaranty schemes differ depending on the insurance sector and the regulatory framework. An overview of the different compensation mechanisms in European insurance guaranty funds can be found in, e.g., Oxera (2007, pp. 23-26). In some cases, losses are compensated in cash for insured events that occurred before insolvency and during a certain period afterwards. That is to say, as soon as insolvency occurs, the client can take out an insurance contract with another insurance company in order to be insured without interruption. In cases, it may be more appropriate in certain insurance sectors to continue insurance contracts rather than providing cash compensation, e.g., in the case of life or health insurance contracts, which are usually of long-term nature. This is the case, for instance, in German health and life insurance guaranty funds which secure the continuation of insurance contracts in insolvency.

- **Coverage.** Deposit insurance systems usually cover 100% of each deposit account up to a certain cap (maximum coverage). And, as the name implies, they only focus on deposit accounts. The European Commission JRC (2010) discusses the harmonization of coverage within the European Union. However, insurance guaranty systems are very heterogeneous in this regard. They cover either 100% or less whereas some involve a cap and some do not (see, e.g., Schmeiser and Wagner (2012)). In addition, insurance guaranty schemes are often related to different kinds of insurance products.

- **Premium calculation.** Another key difference is the current state of practice and research with regard to risk-based premium calculation. Practice in the area of deposit insurance appears to be more advanced: Whereas eight risk-based bank deposit insurance systems are operated in the European Union (see European Commission JRC (2008)), risk-based insurance guaranty funds, to a minor extent, can only be found in Germany and in Japan (Oxera (2007); Schmeiser and Wagner (2012)). The situation is similar when looking at the state of current research. In the context of deposit insurance schemes, the European Commission JRC (2009) proposes three different risk-based models, the first one building on a single indicator (capital adequacy), the second one on multiple indicators (capital adequacy, asset quality, profitability, liquidity), and a market-based one. Building on these, Bernet and Walter (2009) describe the deposit insurance premium as a function of systematic risk, specific risk, and the eligible deposit amount of the respective bank. Another risk-based premium approach (by means of risk-neutral valuation) can be found in Duffie et al. (2003). By contrast, only a few risk-based models are available in the area of insurance guaranty funds. Cummins (1988) calculates risk-adequate premiums based on option pricing theory in a one period context. This model is usually extended by others, see, e.g., Duan and Yu (2005) who expand the model to multiple periods.
• **Funding.** Regarding the funding of these systems, neither detailed proposals nor models can be found which incorporate a market-based funding of deposit insurance or insurance guaranty funds. However, there are detailed discussions as to whether a market-based funding of deposit insurance systems is realizable and certain models exist that propose reinsurance solutions. For example, the European Commission JRC (2010) investigates different funding mechanisms in the European Union and discusses a harmonization of contribution computations. Moreover, the U.S. deposit insurer, the Federal Deposit Insurance Corporation (FDIC), is actually allowed to transfer up to 10% of its risk exposure to the market (see, e.g., Sheehan (2003)). One reinsurance solution can be found in Plaut (1991) who provides a conceptual framework under the assumption that deposit insurance is a reinsurance of different banks, i.e., the deposit insurer is only responsible for securitization and action in the event of default. Another reinsurance framework is provided by Madan and Unal (2008) who present a framework to price excess-of-loss reinsurance contracts on deposit insurance losses.

The possibility of a market-based funding of deposit insurance based on catastrophe bonds or credit derivatives is briefly discussed by Bernet and Walter (2009) and by the International Association of Deposit Insurers (IADI) (2009). Sheehan (2003) discusses advantages and disadvantages of reinsurance or securitization of deposit insurance risks. His key argument in favor of securitization is the access to a larger pool of liquid capital which makes it possible to cover larger losses. However, he points out that moral hazard, transaction costs, and structuring costs are problematic issues in this context. Pennacchi (2009) presents advantages and disadvantages of applying CDS spreads. While CDS spreads are likely to incorporate systematic and firm-specific risk factors, they can lead to excessive volatility in deposit insurance premiums. Thus, since current literature on market-based guaranty systems is limited, this provides the starting point for the proposed market-based guaranty framework.

It is interesting to note that practitioners and researchers are currently discussing the question of whether the loss-absorbing buffer should be increased by higher solvency capital requirements. Here, mezzanine capital instruments like contractual contingent convertible bonds (CoCos) and preferred equity are in focus. By contrast, our analysis will concentrate on the situation where a given solvency capital exists and on the question how to secure clients’ claims in the event of a financial company’s default by means of a run-off system. Thus, the proposed system does not aim at preventing a financial company’s default and at system protection but rather at client protection. As a consequence, it does not focus on increasing capital requirements but rather on providing a fair system which steps in whenever a financial company defaults.

In a first step, we introduce the conceptual framework of our capital market-based financial guaranty system. The model developed here envisages one guaranty vehicle for each financial company. It thus represents a major difference to existing deposit insurance systems and insurance guaranty schemes where only one entity exists which is responsible for guaranteeing protection to all financial companies’ clients. After describing the basic design of the scheme in detail, the key players and their interactions are
identified. Next, we outline the characteristics of the guaranty bonds and the positions of all relevant key players. A first analysis illustrates the size of the clients’ premium and the investors’ principal in an exemplary parameter setting. These are discussed with respect to different coverage levels. If capital markets were perfect, one would not need any guaranty system as clients could secure their claims on their own under fair conditions. However, clients may not be aware of the fact that their financial company can default or are not able to secure potential losses on their own.

Subsequently, we analyze the impact of two different actions which might be taken by the financial companies protected by the guaranty vehicle: First, the financial company might purchase guaranty bonds of its own guaranty vehicle. Second, it might purchase guaranty bonds of another financial company where both companies’ assets have a certain positive correlation. Effects of these actions on major stakeholders, namely clients, regulator, and investors, are measured by means of six different risk measures: The spread received by investors, individual shortfall probabilities, expected shortfalls conditional upon default, joint shortfall probabilities, probabilities that the guaranty vehicle cannot cover all clients’ claims, i.e., that the coverage of the guaranty vehicle is not sufficient, and the expected amount of this insufficient coverage. Results for these different risk figures, which we classify into four groups, are generated by means of a numerical simulation of a (worst) case scenario. The main conclusions are that investments in the company’s own guaranty vehicle defeat the purpose of the guaranty system and that investments in an outside one might lead to the same result depending on the correlation structure. In addition, contagion effects might occur. Finally, we discuss resulting practical implications for the design of such a guaranty system in detail. Especially where self-investments are limited, the capital market-based financial guaranty systems could be a good solution for clients in the context of the described default problem of a financial institute.

The contribution of our analysis is twofold. For one, a detailed proposal how to set up a capital market-based financial guaranty system is introduced. For another, we assess the effectiveness of the proposed system by means of analyzing the actions that financial companies might take that could render the guaranty system ineffective. By deriving practical implications from the numerical analysis, new insights for regulators and financial companies into whether a transfer of default risk to capital markets might be feasible are provided.

The remainder of this paper is organized as follows. Section 2 introduces the model framework and the design of the proposed guaranty scheme. Key players’ positions are valued under the assumption of perfect, frictionless and complete markets. The influence of financial companies’ actions on the guaranty system is analyzed in Section 3. In Section 4 we derive practical implications from our results. Section 5 concludes.

2 Conceptual Framework

In this section, we present a framework outlining how a guaranty system that requires financial institutions to transfer their default risk to capital markets could look like. We present a proposal for the actual design which is often not detailed in the discussion of capital market solutions. The model framework is
presented in detail and considers the stakes of all involved players. This system can either be applied to insurance companies or banks (whereas the application to banks is subject to some restrictions which we discuss in Section 2.1).

The model structure is similar to that currently found in capital markets in the context of catastrophe or other insurance-linked bonds (see, e.g., Cummins (2008)). Generally speaking, one guaranty vehicle is established for each financial company to which the company pays a premium for default protection and for which investors provide the corresponding principal. Premium and principal are invested risk-free. If no default takes place, investors receive the principal, premium and the risk-free rate earned on them as their investment return. In the event of default, clients receive an indemnity payment which can be as much as the entire amount in the guaranty vehicle, i.e., principal, premium, and the risk-free rate earned on them.

2.1 Basic Design of a Capital Market-Based Guaranty Scheme

In what follows, we introduce the general framework of our proposed capital market-based financial guaranty scheme by identifying key players and their periodical interactions. Furthermore, the related guaranty bonds are described and the positions of the involved parties are analyzed.

Key Players

There are six key players in our model framework, namely the financial company, its clients, the guaranty vehicle, the organizer of the guaranty vehicle, the investors in the guaranty vehicle, and the capital market. An overview of the key players and cash flows is given in Figure 1. A detailed illustration including a formal description of the cash flows is given later in Figure 3.

Figure 1: Illustration of cash flows in the basic model framework. Solid lines represent cash flows at inception \((t = 0)\), dashed lines represent cash flows at the end of the year or period \((t = 1)\).
• **Financial company.** The financial company can be an insurance company, a bank, a pension fund, or any other financial organization which is relevant in the context of customer protection. It should be noted, however, that a complete securitization of all claims in a bank or pension fund would not be feasible since this would correspond to a simple risk-free investment (and banks would thus not be needed any more). Rather, the guaranty system should focus on certain kinds of liabilities (i.e., deposit accounts) and not on the financial company as a whole. This is not necessary but clearly possible with regard to insurance companies. Hence, in what follows, the term financial company denotes either a bank that only has deposit accounts or any kind of insurance company. In a further step the system can easily be applied to a bank with different liability classes – of which only some are to be protected.

• **Clients.** The aim of the financial guaranty system is to protect clients against the financial company’s default. Clients protected by the system can be individuals, small and medium-sized enterprises, companies in general, and all other potential investors.

• **Guaranty vehicle and organizer.** In the event of default, protected clients receive a compensation payment from the guaranty vehicle. In order to establish the financial guaranty system, the organizer structures a special purpose vehicle, hereafter called financial guaranty vehicle, and places the corresponding bonds in the capital market. This organizer may be an independent party, e.g., an investment bank, part of the financial company itself, or a special division of the regulatory authority.

• **Investors.** The established guaranty vehicle receives a premium payment from the financial company for the default protection and a principal payment from investors. In return, investors receive a risk-adequate return for providing this capital. The investors might either be *external* investors, for instance, individuals and other financial companies, or *internal* investors, i.e., the financial company itself, in which case the company provides the required capital on its own. The basic idea behind the inclusion of internal investors is that the scope of investors can hardly be limited if the guaranty bonds are publicly traded. As a consequence, the financial company will clearly be able to invest in its own guaranty vehicle. However, the question remains whether such a self-investment leads to undesirable results. In Section 3, we analyze this aspect in detail.

• **Capital market.** The guaranty vehicle invests premium and principal in the capital market. The capital market consists of all other potential market participants offering investments to the guaranty vehicle.

**Interactions between Key Players**

Since periodical funding of the system is necessary in order to adjust premium and principal to the changing risk structure of the financial company, a one-period setting is employed. The six key players introduced above mainly interact with each other at two points in time: First, when the guaranty vehicle is established and, second, when it is dissolved. Figure 2 shows these interactions. The left column
interactions in $t=0$

- organizer establishes guaranty vehicle
- financial company provides external organizers
- guaranty vehicle issues guaranty bonds to financial company
- financial company pays guaranty vehicle premium
- financial company charges premiums back to clients
- guaranty vehicle invests in capital market

interactions in $t=1$

- capital market provides risk-free return to guaranty vehicle
- guaranty vehicle provides indemnity payment to clients
- external investors provides investment return to financial company
- organizer dissolves guaranty vehicle

Figure 2: Illustration of the interactions between key players in a market-based financial guaranty system. The left column displays interactions which take place at inception in $t=0$, the right column those in $t=1$. The dotted line marks transactions which only take place in case of default of the financial company.

In $t=0$, the organizer establishes the guaranty vehicle. In return, the organizer receives a fee payment. For illustrative purposes, we do not include these fee payments (transaction costs) in our subsequent model framework and will thus, for the sake of simplification, leave aside the organizer in the sequel (see also Figure 3). However, the implementation is straightforward. Subsequently, the guaranty vehicle issues guaranty bonds which are purchased by external investors and the financial company itself. Simultaneously, the financial company pays a premium to the guaranty vehicle for the default protection and charges this premium payment back to its clients. Next, the guaranty vehicle invests all proceeds, i.e., principal and premium payment, risk-free in the capital market.

In $t=1$, the guaranty vehicle retrieves principal and premium from the capital market, both compounded with the risk-free rate of interest. In the event of default by the financial company between times $t=0$ and $t=1$ (dotted line), the guaranty vehicle provides an indemnity payment to the financial company’s clients. If no capital remains in the guaranty vehicle after the indemnity payment, the orga-
nizer dissolves the guaranty vehicle and the investors go away empty-handed. Otherwise, the remaining capital is distributed to the investors. If the financial company does not default, all capital is transferred to the investors, after what the guaranty vehicle is dissolved.

**Description of Guaranty Bonds**

Following the presentation of all key players and interactions relevant in the conceptual framework, we give a description of the guaranty bond issue with its underlying parameters. At time \( t = 0 \), the guaranty vehicle issues bonds with a principal of \( M_0 \), of which the amount \( M_0^{(\text{ext})} \) is purchased by external investors and \( M_0^{(\text{int})} \) by the financial company itself, so that

\[
M_0 = M_0^{(\text{ext})} + M_0^{(\text{int})}. \tag{1}
\]

For the purpose of our subsequent discussion, it is convenient to express both parts \( M_0^{(\text{ext})} \) and \( M_0^{(\text{int})} \) relative to the total principal \( M_0 \). Hence, we introduce the percentage \( \alpha, 0 \leq \alpha \leq 1 \), of the principal \( M_0 \) which is purchased by external investors, whereas the remaining part, \( (1-\alpha) \) is purchased by the financial company itself. Thus we have,

\[
M_0^{(\text{ext})} = \alpha M_0, \quad \text{and} \quad M_0^{(\text{int})} = (1-\alpha) M_0. \tag{2}
\]

There are two general types of investments the guaranty vehicle could issue to investors which are known from the insurance-linked securities literature (see, e.g., Cummins (2008)). On the one hand, an issue of the type principal-at-risk means that investors can lose their capital invested, i.e., \( M_0 \). On the other hand, a coupon-at-risk issue is principal protected and, thus, only coupon payments may be lost (corresponding to a money-back-guaranty). In what follows, we assume that investors can lose their total capital invested (principal-at-risk) as a coupon-at-risk framework would require much more capital to be raised in order to cover potential compensation payments. In this sense, Cummins (2008, p. 26) argues that ”principal-protected tranches have become relatively rare, primarily because they do not provide as much risk capital to the sponsor as a principal-at-risk bond”.

At time \( t = 0 \), the financial company pays a premium \( P_0 \) to the guaranty vehicle to cover the spread between the risk-free rate of interest and the interest rate required by investors. In general, one can expect that this premium payment will be charged back to the company’s clients. In return, clients receive an indemnity payment in the event of the financial company’s default. The financial company defaults if its assets \( A_1 \) are not sufficient to cover its liabilities \( L_1 \) at \( t = 1 \), i.e., if \( A_1 < L_1 \). Then, clients’ claims arise in the amount of the positive difference between assets and liabilities,

\[
S_1 = (L_1 - A_1)^+, \tag{3}
\]

where \(( \cdot )^+ \) stands for \( \max(\cdot, 0) \). Here, note that liabilities \( L_1 \) at \( t = 1 \) will be stochastic for an insurance company but will generally be deterministic for banks. In what follows, we work with stochastic liabilities
so that results can be applied to insurers and banks.

Given default by the financial company, i.e., if $S_1 > 0$, clients receive the compensation (indemnity) payment $I_1$. This indemnity payment has a certain cap $S_1^{(β)} \geq 0$, i.e., a given maximum claims amount which can be covered, as the capital held by the guaranty vehicle is limited. That is to say, clients receive the lower of their actual claims $S_1$ and the cap $S_1^{(β)}$. Thus, the compensation payment is determined by

$$I_1 = \min\left(S_1^{(β)}, S_1\right).$$

(4)

The financial guaranty vehicle invests the principal $M_0$ as well as the premium payment $P_0$ at the risk-free rate of interest $r_f$. Subsequently, given that investors receive all the capital available after making the compensation payments to the company’s clients, the investors’ rate of return $r_s$ can be expressed as

$$r_s = \frac{(M_0 + P_0) (1 + r_f) - I_1}{M_0} - 1.$$

(5)

Hence, the investors’ return equals the principal and the premium payment both compounded with the risk-free rate of interest minus possible indemnity payments, the whole divided by the initial capital investment $M_0$. Next, the principal $M_0$ which has to be invested in order to exactly match the maximum claims amount covered $S_1^{(β)}$ in all states of the world can be calculated as

$$S_1^{(β)} = (M_0 + P_0) (1 + r_f) \geq 0$$

$$\Leftrightarrow M_0 = \frac{S_1^{(β)}}{1 + r_f} - P_0.$$  

(6)

Equation (6) shows that the principal equals the coverage cap $S_1^{(β)}$ discounted at the risk-free rate of interest minus the initial premium payment.

**Clients’, Investors’, and the Financial Company’s Stakes**

We now turn to the stakes of clients, investors, and the financial company in order to show and interpret their formal composition. This provides the basis for the calculation of principal and premium in a perfect, frictionless, and complete market setting. Figure 3 provides an overview of cash flows at times $t = 0$ and $t = 1$. Based on the latter and given Equations (4)-(6), the aggregate positions of the different players at $t = 0$ can be derived.

At inception, clients pay the premium $P_0$ and receive the present value of the indemnity payment $PV[I_1]$. Thus, the aggregate clients’ position in $t = 0$ is given by

$$W_0^{(c)} = -P_0 + PV[I_1]$$

$$= -P_0 + PV\left[\min\left(S_1^{(β)}, S_1\right)\right]$$

$$= -P_0 + PV\left[S_1\right] - PV\left[\max\left(S_1 - S_1^{(β)}, 0\right)\right].$$

(7)

In the derivation of Equation (7), the present value of the indemnity payment $PV[I_1]$ can be subdivided,
by applying Equation (4), into the present value of the actual claims amount \( \text{PV}[S_1] \) from which the present value of the claims amount exceeding the coverage cap is subtracted \( \text{PV}[\max(S_1 - S_1^{(2)}, 0)] \). The latter can be interpreted as the present value of the guaranty vehicle’s default put option (hereafter DPO) which expresses the marginal or fair premium which would be required for a risk management measure to completely secure all clients’ claims \( S_1 \).

External investors provide the amount \( \alpha M_0 \) to the guaranty vehicle and receive a rate \( r_s \) on this investment in return (cf. Equations (2) and (5)). Subsequently, we can express the aggregate position of external investors at \( t = 0 \) as follows:

\[
W_0^{(i)} = -\alpha M_0 + \text{PV}[\alpha M_0 (1 + r_s)]. \tag{8}
\]

Equation (8) can be decomposed by means of Equations (4) and (6) to

\[
W_0^{(i)} = \alpha \left( -M_0 + \text{PV}\left[ (P_0 + M_0) (1 + r_f) - I_1 \right] \right) \\
= \alpha \left( -M_0 + \text{PV}\left[ S_1^{(2)} \right] + \text{PV}\left[ \max(S_1 - S_1^{(2)}, 0) \right] - \text{PV}[S_1] \right). \tag{9}
\]
Equation (9) shows that the external investors’ position consists of four elements (multiplied with the coefficient $\alpha$): the initial payment of the principal $M_0$, the present value of the coverage cap $\text{PV}[S_1^{(\beta)}]$, and the present value of the guaranty vehicle’s DPO $\text{PV}[\max(S_1 - S_1^{(\beta)}, 0)]$, minus the present value of actual claims payments $\text{PV}[S_1]$.

The financial company’s position consists of two different parts. On the one hand, the financial company itself might be an investor and thus have a similar position like the external investors. On the other hand, the financial company pays the premium and charges it back to its clients. Hence, the aggregate position of the financial company at $t = 0$ is

$$W_0^{(f)} = (1 - \alpha) \left( -M_0 + \text{PV}[M_0 (1 + r_s)] \right) - P_0 + P_0$$

$$= (1 - \alpha) \left( -M_0 + \text{PV}[S_1^{(\beta)}] + \text{PV}[\max(S_1 - S_1^{(\beta)}, 0)] - \text{PV}[S_1] \right).$$

Comparing Equations (9) and (10), we note that the financial company’s position only differs from the external investors’ one due to the coefficient $\alpha$ as premium payments are supposed to be completely transferred to clients.

### 2.2 Clients’ Premium, Investors’ Principal and Guaranty Vehicle Coverage

In this paragraph, we derive formulas for the above-defined premium $P_0$ and principal $M_0$. Furthermore, we specify the financial guaranty vehicle’s coverage cap $S_1^{(\beta)}$ and analyse the values of the clients’ premium and investors’ principal in a reference situation illustrating different coverage levels. This will provide an indication of the size of premium and principal and lays the basis for further analyses in different market settings (e.g., when $\alpha < 1$). The previously introduced Figure 3 provides an overview of cash flows at times $t = 0$ and $t = 1$.

We assume a perfect, frictionless, and complete market setting, where the net present value of each investment should equal zero. Thus, we get for the market participants:

$$W_0^{(c)} = W_0^{(i)} = W_0^{(f)} = 0.$$ \hspace{1cm} (11)

Subsequently, we can calculate the required premium $P_0$ by combining Equations (7) and (11)

$$P_0 = \text{PV}[I_1] = \text{PV}[S_1] - \text{PV}[\max(S_1 - S_1^{(\beta)}, 0)].$$ \hspace{1cm} (12)

Equation (12) shows that the premium equals the present value of the claims minus the present value of the guaranty vehicle’s DPO.

Combining Equation (11) with Equation (9) for $\alpha \neq 0$, or Equation (10) for $\alpha = 0$, the corresponding principal $M_0$ can be calculated with

$$M_0 = \text{PV}[S_1^{(\beta)}] + \text{PV}[\max(S_1 - S_1^{(\beta)}, 0)] - \text{PV}[S_1].$$ \hspace{1cm} (13)

That is to say, the principal equals the sum of the present value of the coverage cap and the present value
of the guaranty vehicle’s DPO, minus the present value of the actual claims. Given Equation (12) the principal can further be expressed as follows

\[ M_0 = \text{PV}\left[ S_1^{(\beta)} \right] - P_0 \]  

which corresponds to Equation (6).

In the following and in order to specify the concepts, we define the coverage cap \( S_1^{(\beta)} \) of the financial guaranty vehicle. Existing guaranty schemes (see, e.g., Schmeiser and Wagner (2012, Table 1) for an overview) typically aim to protect a certain share of the liabilities. The idea is to set the guaranty vehicle volume so that it will be able to secure on average a certain percentage of the liabilities. We parameterize this percentage by the coverage parameter \( \beta \), with \( 0 \leq \beta \leq 1 \). Thus, we express the coverage cap \( S_1^{(\beta)} \) relative to the expected value of the liabilities in \( t = 1 \) as follows:

\[ S_1^{(\beta)} = \beta \cdot E[L_1]. \]

For all illustrations, we use the definition in Equation (15) throughout the remainder of this paper.

The main purpose of the remainder of this paragraph is to give a basic illustration of the magnitude of the key variables in the present framework. Our aim is to provide an indication of the size of the premium \( P_0 \) and the principal \( M_0 \) in the event that the guaranty vehicle is solely funded by external investors, i.e., \( \alpha = 1 \). In addition, we show how and to what extent the required coverage ratio \( \beta \), introduced in Equation (15), influences the values of the latter. In particular, we would like to mention that “real world” market prices and risk premiums will most probably differ from the results of the neoclassical setup used in this section. However, we see one advantage of the proposed guaranty scheme: no particular pricing model is needed in order to derive the contributions of the participating financial companies as is generally needed in deposit insurance systems or insurance guaranty funds. More precisely, in the proposed framework, charges for the companies and corresponding risk premiums will be determined by the capital market.

In the current framework and the Equations (12), (13), and (15) defining the premium \( P_0 \), the principal \( M_0 \) and the guaranty vehicle coverage \( S_1^{(\beta)} \) respectively, no closed-form solutions can be derived in general when assets and liabilities are stochastic. However the latter are considered stochastic in order to reflect changes in valuation. We suppose that the firm is not adding or reducing liabilities during the period in consideration, thus there are no inflows or outflows from the firm’s assets.

In the remainder of this paper, we assume that assets \( A_t \) and liabilities \( L_t \) of the financial company follow a geometric Brownian motion with drifts, \( \mu_A \) and \( \mu_L \), and volatilities, \( \sigma_A \) and \( \sigma_L \). Thus, the asset and liability processes are described by

\[ dA_t = \mu_A A_t dt + \sigma_A A_t dW_{A,t}, \]  
\[ dL_t = \mu_L L_t dt + \sigma_L L_t dW_{L,t}, \]
where $W_{A,t}^{P}$ and $W_{L,t}^{P}$ are correlated standard P-Brownian motions with correlation coefficient $\rho_{A,L}$, defined by $dW_{t}^{(A)}dW_{t}^{(L)} = \rho_{A,L}dt$. Under the risk-neutral martingale measure $Q$, the drift changes to the risk-free rate of interest $r_{t}$. The solutions of the stochastic differential equations, Equation (16) and (17), at $t = 1$ under the risk-neutral measure are given by (see, e.g., Björk (2004))

$$A_{1} = A_{0} \exp \left[ \left( r_{t} - \frac{\sigma_{A}^{2}}{2} \right) + \sigma_{A} W_{A,1}^{Q} \right], \quad (18)$$

$$L_{1} = L_{0} \exp \left[ \left( r_{t} - \frac{\sigma_{L}^{2}}{2} \right) + \sigma_{L} W_{L,1}^{Q} \right]. \quad (19)$$

For our illustrations, we fix the model parameters as follows. We consider a financial company with initial assets $A_{0} = 100$ and liabilities $L_{0} = 80$, whereas both quantities are expressed in million currency units. The asset volatility is set to $\sigma_{A} = 0.15$, while the volatility of liabilities is fixed at $\sigma_{L} = 0.05$. We set the correlation between assets and liabilities equal to $\rho_{A,L} = 0.1$ and the risk-free rate of return to $r_{t} = 0.02$. We employ a Monte Carlo simulation using 1000000 paths.

Table 1 shows the present value of actual claims $\text{PV}[S_{1}]$, the present value of the guaranty vehicle’s DPO $\text{PV}[(S_{1} - S_{1}^{(\beta)})^{+}]$, the present value of the coverage cap $\text{PV}[S_{1}^{(\beta)}]$, the principal $M_{0}$, and the premium $P_{0}$ for different coverage ratios $\beta$. In addition, we calculate the ratio $P_{0}/L_{0}$ which expresses the premium relative to liabilities at $t = 0$.

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>$\text{PV}[S_{1}]$</th>
<th>$\text{PV}[(S_{1} - S_{1}^{(\beta)})^{+}]$</th>
<th>$S_{1}^{(\beta)}$</th>
<th>$M_{0}$</th>
<th>$P_{0}$</th>
<th>$P_{0}/L_{0}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.4432</td>
<td>0.4432</td>
<td>0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.00%</td>
</tr>
<tr>
<td>0.05</td>
<td>0.4432</td>
<td>0.1992</td>
<td>4</td>
<td>3.7560</td>
<td>0.2440</td>
<td>0.31%</td>
</tr>
<tr>
<td>0.10</td>
<td>0.4432</td>
<td>0.0793</td>
<td>8</td>
<td>7.6361</td>
<td>0.3639</td>
<td>0.45%</td>
</tr>
<tr>
<td>0.15</td>
<td>0.4432</td>
<td>0.0275</td>
<td>12</td>
<td>11.5843</td>
<td>0.4350</td>
<td>0.52%</td>
</tr>
<tr>
<td>0.20</td>
<td>0.4432</td>
<td>0.0082</td>
<td>16</td>
<td>15.5650</td>
<td>0.4412</td>
<td>0.54%</td>
</tr>
<tr>
<td>0.25</td>
<td>0.4432</td>
<td>0.0020</td>
<td>20</td>
<td>19.5588</td>
<td>0.4420</td>
<td>0.55%</td>
</tr>
<tr>
<td>0.30</td>
<td>0.4432</td>
<td>0.0004</td>
<td>24</td>
<td>23.5572</td>
<td>0.4428</td>
<td>0.55%</td>
</tr>
<tr>
<td>0.35</td>
<td>0.4432</td>
<td>0.0001</td>
<td>28</td>
<td>27.5569</td>
<td>0.4431</td>
<td>0.55%</td>
</tr>
<tr>
<td>0.40</td>
<td>0.4432</td>
<td>0.0000</td>
<td>32</td>
<td>31.5568</td>
<td>0.4432</td>
<td>0.55%</td>
</tr>
<tr>
<td>0.45</td>
<td>0.4432</td>
<td>0.0000</td>
<td>36</td>
<td>35.5568</td>
<td>0.4432</td>
<td>0.55%</td>
</tr>
<tr>
<td>0.50</td>
<td>0.4432</td>
<td>0.0000</td>
<td>40</td>
<td>39.5568</td>
<td>0.4432</td>
<td>0.55%</td>
</tr>
</tbody>
</table>

Table 1: Illustration of the premium $P_{0}$, its two constituents $\text{PV}[S_{1}]$ and $\text{PV}[(S_{1} - S_{1}^{(\beta)})^{+}]$, the present value of the coverage cap $\text{PV}[S_{1}^{(\beta)}]$, and the principal $M_{0}$ for different coverage ratios $\beta$. Values calculated are in million currency units.

Table 1 illustrates that the value of the guaranty vehicle’s DPO, $\text{PV}[(S_{1} - S_{1}^{(\beta)})^{+}]$, converges relatively rapidly to zero for increasing coverage ratios $\beta$. The last column, which expresses the premium required relative to the initial liabilities $P_{0}/L_{0}$, clarifies that the premium which would have to be paid by the financial company – and thus by its clients – appears to be relatively low for all reported volatilities. For
comparison, compulsory charges in existing insurance guaranty schemes are on average around 1% of the premiums (see, e.g., Schmeiser and Wagner (2012, Table 1)). See also the application using industry data in Section 4, which details this aspect. Table 1 shows that the present value of the guaranty vehicle’s DPO, \( PV[(S_1 - S_1^{(\beta)})^+] \), is very low, especially for higher levels of \( \beta \). If the default of the guaranty vehicle is low, this leads to a situation where the share \( \beta \) of the liabilities is close to a full securitization.

3 Financial Companies’ Influence on the Guaranty System

The analyses presented in the previous section provide an illustration for the premium \( P_0 \) and the corresponding principal \( M_0 \). Next, we turn to certain problems which might arise when implementing such a financial guaranty system in practice. In particular, we intend to analyze whether the financial companies themselves might be able to influence the effectiveness of the guaranty system by taking certain investment actions. In doing so, we focus on a worst case scenario in order to illustrate our results.

3.1 Financial Company Invests in Own Guaranty Vehicle

In the illustrative example in Section 2.2, we assume that the financial company does not invest in the guaranty vehicle, covering its own defaults by setting \( \alpha = 1 \). Thus, the question arises as to what happens if the financial company invests in its own guaranty vehicle, i.e., if \( (1 - \alpha) > 0 \). For the financial company, this investment will provide stable returns as long as its financial situation remains stable, i.e., if no shortfall occurs. However, as soon as the company is in distress and the guaranty vehicle must secure clients’ claims, the company’s asset value will further deteriorate as the guaranty bonds will experience substantial loss in value.

In the extreme case, the financial company would provide the entire capital of the guaranty vehicle, i.e., \( \alpha = 0 \). Then, no additional capital would be provided by the guaranty vehicle. On the other hand, the asset volatility of the financial company’s portfolio would decrease since the guaranty vehicle invests in the risk-free rate of interest and, thus, more capital of the financial company would ceteris paribus be invested risk-free. This course of action and its effects are then comparable to increasing the amount of assets held in risk-free investments, corresponding rather to a decision on asset allocation requirements.

In the following, we formalize this discussion and derive equations describing the value of the assets and resulting asset volatility where a company makes investments in its own guaranty vehicle. Where assets are invested in the company’s own guaranty vehicle, i.e., for \( 0 \leq \alpha < 1 \), the asset process becomes a combination of the geometric Brownian motion initially followed by the company’s assets and the development of the investment in and payoff of the guaranty vehicle. Subsequently, and in general, assets at \( t = 1 \) are expressed in general by

\[
A_1^* = \left(1 - \frac{(1 - \alpha) M_0}{A_0}\right) A_1 + (1 - \alpha) \left(S_1^{(\beta)} - I_1\right).
\]

(20)

Where no investments in the own guaranty vehicle are made (case with \( \alpha = 1 \)), Equation (20) reduces
to the asset value based on the geometric Brownian motion, i.e., \( A_1^* = A_1 \). For \( 0 \leq \alpha < 1 \), the fraction \((1 - \alpha) M_0/A_0\) of all assets will be invested in the company’s own guaranty vehicle and, thus, the fraction \((1 - \alpha)\) of the guaranty vehicle’s payoff at \( t = 1 \), \( S_1^{(3)} - I_1 \), is attributable to the financial company’s assets. Note that where assets are invested in the company’s own guaranty vehicle, the assets \( A_1^* \) do generally no longer follow a geometric Brownian motion.

As long as the financial company does not default \((S_1 = 0)\), the indemnity payment \( I_1 \) will be zero. Simultaneously, it is given that \( S_1^{(3)} \) is positive and provides a return above the risk-free rate relative to the invested capital \((1 - \alpha)M_0\) (cf. Equation (6)). As a consequence, the variance of the asset value at \( t = 1 \) will decrease (given no default) since

\[
\sigma^2(A_1^*) = \left(1 - \frac{(1 - \alpha) M_0}{A_0}\right)^2 \sigma_A^2, \quad \text{if } I_1 = 0,
\]

which is smaller than \( \sigma_A^2 \) for all \( 0 \leq \alpha < 1 \).

However, Equation (20) shows that losses faced by clients will become more severe in the case of default since indemnity payments will take place (i.e., \( I_1 > 0 \)) as soon as \( A_1^* < L_1 \) which will additionally lower the asset value \( A_1^* \).

### 3.2 Financial Company Invests in Other Guaranty Vehicle

Similarly, the question arises whether contagion effects might occur if one financial company invests in the guaranty vehicle of another financial company. Here, results will depend on the correlation structure. Generally, one can expect that the higher the correlation between assets and liabilities of the two different companies, the closer results will get to investments in the company’s own guaranty vehicle.

In order to analyze these aspects in more detail, a second financial company is introduced. Both companies, denoted by \( i = 1 \) and \( i = 2 \) and the respective variables with superscripts \((i)\), are supposed to be identical, meaning that their assets and liabilities follow the same process, i.e.,

\[
\begin{align*}
A_0^{(1)} &= A_0^{(2)}, & \sigma_A^{(1)} &= \sigma_A^{(2)}, & \mu_A^{(1)} &= \mu_A^{(2)}, \\
L_0^{(1)} &= L_0^{(2)}, & \sigma_L^{(1)} &= \sigma_L^{(2)}, & \mu_L^{(1)} &= \mu_L^{(2)}, \\
\rho_{A^{(1)}L^{(1)}} &= \rho_{A^{(2)}L^{(2)}}.
\end{align*}
\]

Assuming that both companies do not invest in their own guaranty bonds (i.e., \( \alpha = 1 \)), assets at \( t = 1 \) can be described by

\[
\begin{align*}
A_1^{(1)*} &= \left(1 - \frac{\gamma^{(1)} M_1^{(1)}}{A_0^{(1)}}\right) A_1^{(1)} + \gamma^{(1)} \left(S_1^{(3)} - I_1^{(2)}\right), \\
A_1^{(2)*} &= \left(1 - \frac{\gamma^{(2)} M_1^{(2)}}{A_0^{(2)}}\right) A_1^{(2)} + \gamma^{(2)} \left(S_1^{(3)} - I_1^{(1)}\right),
\end{align*}
\]

\( \text{Eq. (21)} \)
whereas the parameter \(0 \leq \gamma^{(i)} \leq 1, \ i \in \{1, 2\}\), defines which percentage of the other company’s guaranty bonds is purchased. Similar to Equation (20), \(\gamma^{(i)} M^{(i)}_0 / A^{(i)}_0\) defines the proportion of assets that is invested in the other company’s guaranty vehicle.

One important observation with regard to Equations (22) and (23) is that the default of one financial company will have a negative effect on the asset value of the other one. This indicates that contagion effects can occur.

To clarify the previously mentioned point that a high correlation between both companies’ assets and liabilities will yield results similar to those seen when one company invests in its own guaranty vehicle, we consider the following: Both financial companies purchase the same share of the other’s financial guaranty bonds. That is to say, company 1 purchases a fraction \(\gamma^{(1)} > 0\) of company 2’s guaranty bonds and company 2 purchases \(\gamma^{(2)} = \gamma^{(1)} > 0\) of company 1’s guaranty bonds. Then, if the correlation between the assets (and liabilities respectively) of companies 1 and 2 is perfectly positive, i.e., \(\rho_{A^{(1)}, A^{(2)}} = 1\), results will be the same as if the companies invested in their own guaranty vehicles, and the formulas from the previous paragraph hold with \((1 - \alpha) = \gamma\).

### 3.3 Stakeholders and Relevant Risk Figures

So far, our discussion has shown the form and direction of the influence both kinds of action have. However, to illustrate size and relevance, we provide different numerical examples. To do so, we analyze the two different actions which might be taken by the financial companies described above:

1. The financial company purchases guaranty bonds of its own guaranty vehicle.
2. The financial company purchases guaranty bonds of another financial company where both companies’ assets have a certain positive correlation.

In order to measure the effects of these actions, we determine relevant stakeholders and define risk figures describing to what extent the individual stakeholders are actually affected. Based on Figure 3, three major stakeholders, which could be affected by the above actions of the financial companies, are identified:

- First, the clients who seek default protection and are interested in the safety of their investment. As mentioned, the possible investment actions might influence default probabilities and the extent of an actual default by the financial company. Assuming that clients are mainly interested in the losses they might actually face, they will be interested in whether the guaranty vehicle is unable to cover all its claims given default \(P(S^{(β)}_1 < S_1)\) and the expected amount of this insufficient coverage \(E[(S_1 - S^{(β)}_1) | S^{(β)}_1 < S_1]\).

- The second group of stakeholders affected are the external and internal investors who seek to make profitable investments. This group of stakeholders will not be the main focus but we include them for the sake of completeness. To them, the expected spread they receive on their investment \(E[r_s - r_f]\) and, additionally, the shortfall probabilities \(P(S_1 > 0)\) will be relevant.
Finally, the regulator whose mission it is to enhance financial stability and ensure customer protection is another major stakeholder. In the context of financial stability, shortfall probabilities $P(S_1 > 0)$, expected shortfalls $E[S_1 | S_1 > 0]$, and, in particular, joint shortfall probabilities $P(S_1^{(1)} > 0 \cap S_1^{(2)} > 0)$ are key risk figures. With regard to customer protection, the same figures as are relevant to clients appear to be important, i.e., the probability that the guaranty vehicle might be unable to cover all its claims and the corresponding expected shortfall amount.

In summary, and with regard to the three major stakeholders, we focus on four groups of (risk) measures which we recapitulate in Table 2.

<table>
<thead>
<tr>
<th>Figure</th>
<th>Stakeholders</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Expected spread received by investors</td>
<td>Investors</td>
</tr>
<tr>
<td>2</td>
<td>Single shortfall (default) probabilities</td>
<td>Investors, Regulator</td>
</tr>
<tr>
<td></td>
<td>Expected shortfall conditional upon default</td>
<td>Regulator</td>
</tr>
<tr>
<td>3</td>
<td>Joint shortfall probabilities</td>
<td>Regulator</td>
</tr>
<tr>
<td>4</td>
<td>Probability that the guaranty vehicle cannot cover all clients’ claims</td>
<td>Clients, Regulator</td>
</tr>
<tr>
<td></td>
<td>Expected amount of this insufficient coverage</td>
<td>Clients, Regulator</td>
</tr>
</tbody>
</table>

Table 2: Summary of the four groups of (risk) measures relevant to stakeholders (investors, clients, regulator) which might be affected by the financial company’s actions. The first column describes the figure, the second column the stakeholders for which the measure might be relevant, and the last column displays the corresponding formulas.

### 3.4 Numerical Illustration

In this paragraph we perform an analysis of the impact of the two different actions that might be taken by the financial company protected by the guaranty vehicle, on the four general groups of measures defined in Table 2.

For the numerical analysis and illustration, we fix the input parameters, unless otherwise stated, as provided in Table 3. Recall that assets $A_0$ and liabilities $L_0$ are expressed in million currency units. Our calibration corresponds to a worst case scenario, i.e., the asset volatility $\sigma_A$ and, hence, the coverage parameter $\beta$ are higher than regular empirical data. Numerical results are derived by means of a Monte Carlo simulation using 1 000 000 paths. Each path solves iteratively for the asset value $A_1^*$ along Equation (20) and Equations (22) and (23) respectively.

---

2We work with this case scenario for illustrative purposes and present sensitivity analyses for selected variables. Changes in the values of the parameters typically have an impact on the resulting values of the risk measures. For example, there are settings where a relatively high asset allocation volatility combined with adequate correlation with the liabilities (e.g., hedging strategy) may be better, i.e. more risk-minimizing, in comparison to a setting where assets are invested risk-free.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Denotation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial assets</td>
<td>$A_0$</td>
<td>100</td>
</tr>
<tr>
<td>Asset drift</td>
<td>$\mu_A$</td>
<td>0.05</td>
</tr>
<tr>
<td>Volatility of assets</td>
<td>$\sigma_A$</td>
<td>0.15</td>
</tr>
<tr>
<td>Initial liabilities</td>
<td>$L_0$</td>
<td>80</td>
</tr>
<tr>
<td>Liability drift</td>
<td>$\mu_L$</td>
<td>0.03</td>
</tr>
<tr>
<td>Volatility of liabilities</td>
<td>$\sigma_L$</td>
<td>0.05</td>
</tr>
<tr>
<td>Correlation between assets and liabilities</td>
<td>$\rho_{A,L}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Risk-free rate of interest</td>
<td>$r_f$</td>
<td>0.02</td>
</tr>
<tr>
<td>Coverage parameter</td>
<td>$\beta$</td>
<td>0.3</td>
</tr>
<tr>
<td>Percentage purchased by external investors</td>
<td>$\alpha$</td>
<td>[0;1]</td>
</tr>
</tbody>
</table>

Table 3: Parameter combinations applied in the numerical analysis.

**Premium and Principal**

In order to base our simulation results on appropriate values of premium and principal, we calculate the fair values of premium and principal for all investment fractions $(1 - \alpha)$ and $\gamma^{(i)}$ considered, given the parameter combinations provided in Table 3. To do so, we numerically solve for the asset value $A_1^*$ and for the corresponding premium $P_0$ and principal $M_0$ under the risk-neutral measure $Q$ along Equations (22), (12) and (6) (for each $\alpha$ and $\gamma^{(i)}$). In the following we present and discuss numerical results under the assumption that $\gamma^{(1)} = \gamma^{(2)}$. Thus, and in order to make notation easier, we set $\gamma = \gamma^{(1)} = \gamma^{(2)}$ in the remainder of this paper.

Figure 4 provides the values obtained: Figure 4(a) shows the calculated fair premiums, Figure 4(b) the fair principals corresponding to the different investment situations.

As seen in Table 1 (recall with $\beta = 0.3$), if $\alpha = 1$ and $\gamma = 0$, this procedure leads to a premium of $P_0 = 0.44$ and a principal of $M_0 = 23.56$. For all other $\alpha$ and $\gamma$, the premium $P_0$ is highest if the financial company invests in its own guaranty bonds and lowest if the financial company invests in guaranty bonds of another company with low correlation ($\rho_{A^{(1)},A^{(2)}} = 0.2$). The reverse is true for the principal since the sum of premium and principal is constant in all cases, $P_0 + M_0 = S_1^{(\beta)} = 24$, which follows from Equations (6) or (14).

Figure 4(a) shows that the premium either decreases or increases when $(1 - \alpha)$ and $\gamma$ increase. For instance, if $\rho_{A^{(1)},A^{(2)}} = 0.5$, the premium first decreases and then increases again. This is due to two opposing effects. On the one hand, shortfall probabilities decrease with increasing $(1 - \alpha)$ and $\gamma$ which lowers the premium $P_0$ — recall the already discussed decrease in asset volatility $\sigma^2(A_1^*)$ due to the higher amount that is actually invested risk-free (see Equation (21)). On the other hand, occurring defaults will yield larger losses with increasing $(1 - \alpha)$ and can yield larger losses with increasing $\gamma$. This raises the premium $P_0$. Here, consider again Equations (20) and (22). As soon as a financial company defaults,
indemnity payments will take place (i.e., $I_1 > 0$) which will lower the asset value $A_1^*$ or $A_1^{(i)}$ of the financial company investing in the guaranty bonds. The subsequent analysis of the different shortfall measures will clarify these points.

**Financial Company Invests in Own Guaranty Vehicle**

Now, we turn to the measures introduced in Table 2 and move to the real-world measure $P$. First, we focus on the case where the financial company invests in its own guaranty vehicle. Figure 5 shows the expected spread over the risk-free rate of return $E[r_s - r_f]$ investors receive for different values of $(1 - \alpha)$. The expected spread appears to be relatively stable for all $(1 - \alpha)$. For increasing values of $(1 - \alpha)$, the expected spread increases marginally. Results directly correspond to the different underlying premiums reported in Figure 4(a).

Figure 6 displays different shortfall measures for varying $\alpha$. Figure 6(a) displays the probability that the financial company defaults $P(S_1 > 0)$ and Figure 6(b) the expected loss conditional upon default $E[S_1 | S_1 > 0]$. Figure 6(c) shows the probability that the guaranty vehicle cannot cover the complete loss incurred by clients $P(S_1^{(3)} < S_1)$ and, corresponding to these probabilities, Figure 6(d) displays the expected amount by which the actual loss exceeds the maximum coverage where the loss exceeds this maximum coverage $E[(S_1 - S_1^{(3)}) | S_1^{(3)} < S_1]$. Note that values calculated in Figure 6(d)
correspond to the probabilities reported in Figure 6(c). As probabilities for low \((1 - \alpha)\) are comparably low, we observe slight approximation errors for low \((1 - \alpha)\).

The default probability decreases if the fraction of guaranty bonds purchased by the financial company itself \((1 - \alpha)\) increases. This can be explained by the reduced asset volatility as long as the company does not default – recall that the higher the investment in own guaranty bonds, the higher the portion of the financial company’s assets which is actually invested risk-free. However, the expected loss in the event of default by the financial company increases extensively the higher the investment by the financial company \((1 - \alpha)\). This is due to indemnity payments to clients if the financial company defaults, which will additionally lower the asset value \(A^*_1\) of the already bankrupt financial company. Thus, though a purchase of financial guaranty bonds by the financial company itself reduces the probability of default, occurring defaults will become more severe.

In line with these results, the probability of the loss exceeding the maximum coverage increases the higher the investment by the financial company. The expected amount which cannot be covered by the guaranty vehicle slightly increases for increasing \((1 - \alpha)\).

Finally we can draw an important conclusion from the numerical analyses: In the reference scenario and the sensitivity analyses presented, a purchase of own guaranty bonds leads to a reduction in the probability of default, an increase in the probability that the guaranty vehicle cannot cover all claims, and larger losses when defaults occur. We will discuss this in detail in Section 4.
Figure 6: Effects on shortfall measures when the financial company purchases the fraction \((1-\alpha)\) of its own guaranty bonds. Panel (a) shows the shortfall probability \(P(S_1 > 0)\) and panel (b) the expected shortfall given default \(E[S_1 \mid S_1 > 0]\). Panel (c) displays the probability that the guaranty vehicle cannot cover all losses \(P(S_1^{(\beta)} < S_1)\) and panel (d) the expected amount of insufficient coverage \(E[(S_1 - S_1^{(\beta)}) \mid S_1^{(\beta)} < S_1]\).
Financial Company Invests in Other Guaranty Vehicle

Next, we allow both financial companies to purchase a stake of the other’s financial guaranty bonds. That is to say, company 1 purchases a fraction $\gamma^{(1)}$ of the second company’s guaranty bonds, and company 2 purchases a part $\gamma^{(2)}$ of company 1’s guaranty bonds. For our numerical analysis, we always assume that $\gamma = \gamma^{(1)} = \gamma^{(2)}$. We focus on three different correlations between the assets of the two companies, namely $\rho_{A^{(1)}, A^{(2)}} \in \{0.20, 0.50, 0.80\}$, and assume the same correlation coefficients for liabilities, i.e., $\rho_{A^{(1)}, A^{(2)}} = \rho_{L^{(1)}, L^{(2)}}$.

Figure 7 displays the expected spread over the risk-free rate $E[r_s - r_f]$ investors receive for increasing $\gamma$. Note that we always show numbers for one of the two financial companies. As the companies are homogeneous, results for both are the same. The expected spread is always lowest with a low correlation (curve for $\rho_{A^{(1)}, A^{(2)}} = 0.2$) and highest with a high one (curve for $\rho_{A^{(1)}, A^{(2)}} = 0.8$). The calculated spreads can be directly related to the different underlying premiums reported in Figure 4(a).

In Figure 8(a) we plot shortfall probabilities $P(S_1 > 0)$ and in Figure 8(b) the expected shortfall given default $E[S_1 | S_1 > 0]$ of one of the two financial companies for increasing $\gamma$. Shortfall probabilities decrease for increasing $\gamma$ whereas the decline is highest with low correlation ($\rho_{A^{(1)}, A^{(2)}} = 0.2$). Expected shortfalls given default are highest with a high correlation and lowest with a low one. With $\rho_{A^{(1)}, A^{(2)}} = 0.8$ and $\rho_{A^{(1)}, A^{(2)}} = 0.5$, expected shortfalls increase for increasing $\gamma$, with $\rho_{A^{(1)}, A^{(2)}} = 0.2$ the expected shortfall first decreases slightly and then increases again. With regard to Figure 6, these results can generally
Figure 8: Effects on shortfall measures of financial company 1 (or 2) if financial company 1 purchases fraction $\gamma^{(1)}$ of company 2’s financial guaranty bonds and financial company 2 purchases fraction $\gamma^{(2)}$ of company 1’s financial guaranty bonds, with $\gamma = \gamma^{(1)} = \gamma^{(2)}$. Panel (a) shows the shortfall probability $P(S_1 > 0)$ and panel (b) the expected shortfall given default $E[S_1 | S_1 > 0]$. Panel (c) displays the probability that the guaranty vehicle cannot cover all losses $P(S_1^{(\beta)} < S_1)$ and panel (d) the expected amount of insufficient coverage $E[(S_1 - S_1^{(\beta)}) | S_1^{(\beta)} < S_1]$. 

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be explained by a decreasing volatility of the asset portfolio and indemnity payments that will lower the asset value \( (A_1^{(i)})^* \) of the financial company investing in the guaranty bonds of the bankrupt one. The decrease in expected shortfalls with a low correlation \( (\rho_{A_1^{(i)},A_2^{(j)}} = 0.2) \) can be explained by diversification effects.

Figure 9 shows the corresponding joint shortfall probabilities \( P(S_1^{(1)} > 0 \cap S_1^{(2)} > 0) \) and shortfall probabilities of company 1 (2) conditional on shortfall of company 2 (1) \( P(S_1^{(1)} > 0 | S_1^{(2)} > 0) \) for different values of \( \gamma \). Naturally, joint shortfall probabilities are highest with a high correlation between the two companies’ assets and lowest with a low one. For increasing \( \gamma \), joint shortfall probabilities decrease for all reported correlation coefficients. Here, remember that single shortfall probabilities also decrease. However, the conditional shortfall probabilities show that the probability of a financial company defaulting once another financial company has already defaulted increases sharply with increasing \( \gamma \) (contagion). Consider, for example, the extreme case in which \( \gamma = \gamma^{(1)} = \gamma^{(2)} = 1 \). The probability that the second financial company will default once the other one has already defaulted is 15.7% with a low correlation and even 63.5% with a high correlation.

Figure 9: Joint shortfall probabilities of financial company 1 and 2 and conditional shortfall probabilities of company 1 (2) given default of company 2 (1) if financial company 1 purchases fraction \( \gamma^{(1)} \) of company 2’s financial guaranty bonds and financial company 2 purchases fraction \( \gamma^{(2)} \) of company 1’s financial guaranty bonds, with \( \gamma = \gamma^{(1)} = \gamma^{(2)} \).

Next, Figure 8(c) shows the probability that the guaranty vehicle cannot cover all losses faced by the financial company’s clients \( P(S_1^{(\beta)} < S_1) \) and Figure 8(d) the expected shortfall amount if not all claims can be covered \( E[(S_1 - S_1^{(\beta)}) | S_1^{(\beta)} < S_1] \). Note that values calculated in Figure 8(d) correspond to the
comparably low probabilities reported in Figure 8(c). As a consequence, we observe a small approximation error in Figure 8(d). The probability that not all claims can be covered generally increases with increasing γ for all correlations whereas the highest probabilities can be observed with high correlation and lowest with low correlation. The expected amount that cannot be covered increases with increasing γ for high and medium correlation but first decreases and then increases with low correlation. Again, this decrease with a low correlation \((\rho_{A^{(1)},A^{(2)}} = 0.2)\) can be explained by diversification effects. The other results can generally be explained by a decreasing volatility of the asset portfolio and indemnity payments that will lower the asset value \(A^{(i)*}\).

To conclude this section, let us point out that, under the considered parameterization and sensitivity analyses, if both companies purchase financial guaranty bonds of the other financial company in the same amount, probabilities of default decrease, losses in the event of default are larger (except for low correlation between the two companies’ assets), the probability that not all claims can be covered generally increases, and the expected shortfall amount increases as well (except for low correlation between the two companies’ assets). The effect on joint shortfall probabilities depends on the participation, but contagion effects appear to increase with increasing investments in the other’s guaranty vehicle. Note that we also analyzed the case in which only one financial company invests in the guaranty vehicle of another financial company, whereas the other financial company does not change its behavior. Results, however, are very similar and do not markedly deepen the insights.\(^3\)

4 Practical Implications and Further Comments

The numerical analysis presented in Section 3.4 shows that financial companies can significantly influence the effectiveness of our proposed capital market-based guaranty scheme. In what follows, we first discuss our numerical results with regard to their practical implications and derive conclusions. Then, we further comment on advantages and drawbacks of the proposed system.

4.1 Practical Implications

In the following we discuss the results of the numerical analysis from Section 3.4 both in cases where the company invests in its own and in another guaranty vehicle.

Financial company invests in own guaranty vehicle. At first sight, this action might even appear to be advantageous as probabilities of default decrease. However, in fact, the financial company renders the guaranty system ineffective as the capital which should be additionally raised in the system is not raised. Instead, the financial company imposes more or less restrictions on its own capital investments as the guaranty vehicle invests all proceeds at the risk-free rate. This effect could be achieved more easily by just imposing capital allocation requirements for financial companies. As a consequence, if defaults occur,\(^3\)

\(^3\)Further analysis results are available upon request.
they become more severe than without any *self-investments*. From a client’s perspective, one of the most important questions is whether and to what extent the guaranty vehicle with the corresponding cap might not be able to cover clients’ claims. Our numerical analysis shows that the probability of such events and the magnitude of these events increases with an increasing amount of investment in the company’s own guaranty vehicle. Thus, self-investments appear to be highly problematic as they counteract regulatory intentions. Nevertheless, prohibiting these self-investments is straightforward since companies already have to account for holdings of own stocks and bonds in their balance sheet. However, a regulation of self-investments in the financial guaranty vehicle reduces the opportunity for a financial company to use self-investments as a signal to the capital markets. More precisely, by investing in their own guaranty vehicle, a financial company can send the signal that its default risk is low, or that market spreads are too high compared to the company’s own internal knowledge of its safety level.

**Financial company invests in another guaranty vehicle.** Results depend on the actual correlation between assets and liabilities of the different financial companies. Generally, low correlations between the financial companies’ portfolios might lead to positive effects on shortfall probabilities and expected shortfalls due to diversification effects. However, the higher the correlation, the closer results get to our observations about investments in a company’s own guaranty vehicle. And, importantly, contagion effects seem to increase with increasing investments in another company’s guaranty vehicle. Thus, investments in other guaranty vehicles can be problematic, especially if correlations between the respective financial companies are high. On the other hand, investments in the guaranty vehicle of a financial company with low correlation, e.g., in another business segment, might generate additional diversification effects. The question remains whether a supervisor can restrict what kind of investors may invest if a product is publicly traded, especially if guaranty bonds are part of a diversified fund that financial companies would typically invest in. Here, clear investment limits (caps regarding investments in guaranty vehicles) need to be established in supervisory law.

Finally, it is interesting to give a further illustration of the results by applying them to figures of a selected European insurance company. For this we consider a large firm featuring assets of €23bn, gross written premiums of €9bn and liabilities / technical reserves of €17bn. We take the latter value as a proxy for the size of the company’s liabilities (liabilities related to insurance activities). We use the same parameterization as introduced previously regarding the assets and liabilities; see Table 3 for a summary of the assumed performance, volatility and correlations. This corresponds to a rather bad case scenario. The objective of the following is to evaluate on the one hand the insurer’s shortfall probability and the expected policyholder deficit, and on the other hand the size of the investors’ principal and insurer’s premium with respect to the discussed guaranty vehicle. This will allow us to compare the guaranty vehicle premium with the premium paid today in the established industry-wide guaranty scheme. We define the insurer’s ruin probability at time $t = 1$ by $\text{Prob}(A_1 < L_1)$ and introduce the expected policyholder deficit, which corresponds to the present value of the default put option $\text{PV}((L_1 - A_1)^+)$, calculated as $E^T[(L_1 - A_1)^+] / (1 + r_f)$. For the above insurance company, we numerically obtain a shortfall probability of 2% and an expected policyholder deficit of €20mn. The principal $M_0$ necessary to secure a share
\( \beta = 50\% \) of the liabilities is equal to \( \mathbf{8.5bn} \). The premium \( P_0 \) to be paid by the insurer equals \( \mathbf{28mn} \). The ratio of the premium to the liabilities is \( P_0/L_0 = 0.2\% \). Comparing the premium \( P_0 \) to the company’s premium volume we obtain that the insurer’s payment to the vehicle in order to secure 50\% of the liabilities corresponds to 0.3\% of the premium volume. This can be put in relation to the current practice of insurance guaranty schemes in force often levying 1\% of the premiums (see Schmeiser and Wagner (2012)).

### 4.2 Challenges and Advantages of the Proposed Framework

In the following we discuss some further challenges concerning the proposed framework which need to be considered:

- **Transaction costs:** Transaction costs and organization fees – which have been put aside in the model illustration – might make the proposed guaranty system highly expensive. Especially the establishment of one guaranty vehicle per financial company might appear problematic in this regard. However, instead of establishing various vehicles, one could structure one large credit-linked note per company which would be held by a trust company. Results and implications would remain the same but structuring costs would decrease. Besides, as already mentioned, our proposed framework issues bonds focusing on credit risk and the credit market is already well established (CDS, CDOs, etc.).

- **Spreads and volume:** There might not be enough investors willing to invest in this kind of financial product. This could limit the liquidity or lead to exaggerated spreads. This problem could be solved by raising capital through a stepwise increase in the principal starting from zero. For example, if a certain share \( \beta \) of the expected liabilities \( E[L_1] \) is to be secured by a financial company’s guaranty vehicle, one might define a multi-step sequence starting from zero and reaching the level \( \beta \) after a couple of periods only. Increasing the capital raised involves increasing the coverage parameter, i.e., the principal \( M_0 \) (see also Table 1).\( ^4 \) This mode of financing and establishing a guaranty fund has been chosen, for instance, in the German life insurance guaranty fund where the funds required are collected over a period of five years.\( ^5 \) In addition, the market for credit risks is well established and apparent risks should be comprehensible to investors. Thus, investors should, in general, be willing to invest into the guaranty bonds as long as an adequate risk premium is provided.

Besides, spreads might change considerably on a year to year basis. Thus, if a financial company is already in financial distress, its premiums can be expected to rise and might even aggravate this distress. Similarly, as seen in the recent financial crisis, the default of one financial company might lead to increasing spreads for other ones so that contagion effects might occur. Nevertheless, as long as bankruptcy is declared on time, the capital market-based guaranty system can secure clients’ claims – recall that system protection is not the focus of the proposed framework. In addition, if spreads become too high, a financial company might still take other risk management measures to reduce the spread required.

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\( ^4 \)For example, if \( \beta = 30\% \) is aimed, one could start by setting first \( \beta = 5\% \), increasing this value stepwise to reach the target.

Impact on the market: We assume that the guaranty vehicle invests all proceeds risk-free in the capital market. Here, the question arises whether the capital market can provide enough risk-free capital and whether this capital is actually risk-free. Again, this issue could be solved by a stepwise increase in the principal over time. Besides, current insurance guaranty and deposit insurance systems have a similar fund volume which is currently invested in the capital market (and would be dissolved if our proposal was implemented). In order to ensure that the capital provided is actually risk-free, a swap arrangement could be used as is currently in use with insurance-linked securities.

Although there are some challenges concerning the implementation of the proposed capital market-based financial guaranty system, the discussion above shows that most of them can be solved. Then, the capital market-based financial guaranty systems provides various advantages:

- **High liquidity:** Firstly, the proposed guaranty system offers access to the substantial volume of capital available in financial markets. Compared to existing guaranty systems which are mostly funded by compulsory contributions from the financial companies, the set of possible investors and, thus, the funding sources are widespread. As a result, the structure of debt financing is optimized and, since investments in the company’s own guaranty vehicle are possible, this sends additional encouraging signals to the market participants. Hence, capital market-based guaranty systems can be structured to even cover shortfalls of major financial companies whose weight in existing schemes is often too large to be covered by them alone. Therefore, ultimate help from the state is currently needed, i.e., from taxpayers. The major bail-outs which occurred during the recent financial market crisis underscored this point. Similarly, our proposed system enables all potential clients to be protected, from privates to large companies, in contrast to current systems that often only protect private customers and, sometimes, small and medium-sized enterprises.

- **Risk-adequate premiums:** The market-based funding concept ensures, secondly, that market-driven, risk-adequate premiums are applied. Thus, unlike the various financial guaranty systems currently in use (see, e.g., current deposit insurance and insurance guaranty funds), financial companies pay premiums in line with their risk situation – not their volume. As briefly mentioned in the introduction and as reported in, e.g., Oxera (2007), existing guaranty schemes often target a fund volume by imposing sourcing via volume-based contributions. These costs as discussed in Rymaszewski et al. (2012), can create various adverse incentives among the different market players. Market-based funding, by definition, incentivizes risk-adequate costs which will be determined by the capital market. In conclusion, this constitutes an important advantage of the proposed scheme since no particular pricing model is needed to derive the contributions as is the case in deposit insurance systems or insurance guaranty funds.

- **No cross-subsidization:** Recall that existing guaranty schemes with ex post charges can never be organized in a truly risk-based way nor avoid cross-subsidization effects due to the fact that an insolvent financial company, which may have been the riskiest one, is typically not charged at all (see, e.g., Han et al. (1997, pp. 1119)). Furthermore, in current systems with ex ante contributions, premiums are pooled among all participants, and, if these contributions are not risk-adequate,
some financial companies are better off than others, or, at least, companies do not profit to the same extent from the guaranty scheme (see, e.g., Rymaszewski et al. (2012)). The capital market-based guaranty scheme presented here does not generate any cross-subsidization effects between clients of different financial companies as each financial company has its own guaranty vehicle. As a consequence, the clients’ incentive to enter into contracts with the worst performing financial company (offering the lowest premiums) under current guaranty schemes, which do not involve separate accounts for each company, is absent.

- *Regulatory tool*: In analogy to the discussions in Basel III, the new regulatory standard on bank capital adequacy and liquidity, which categorizes banks with respect to their systemic relevance, and requires higher standards for the latter, the proposed guaranty system could be required by the regulator for systemically relevant financial institutions only. This will help to provide effective protection for customers particularly in those companies carrying a sizable risk. This aspect seems to be important in light of the fact that credit derivative contracts are currently not available for many financial companies, including, e.g., mutual companies and companies not listed on the stock market. Hence, by making such guaranty vehicles compulsory for all market players, such a system would generate new regulated products for investors while at the same time offering additional protection to customers of all companies in the financial services industry.

To conclude, there are some challenges involved in the implementation of our capital market-based financial guaranty system – self-investments, transactions costs, spread and volume, impact on the market. However, we show how these challenges can be solved and highlight key advantages of the proposed framework compared to current deposit insurance and insurance guaranty schemes.

5 Conclusion

We propose a capital market-based financial guaranty system and examine whether investment actions taken by the respective financial companies might affect the effectiveness of the system. The described market-based solution comprising one guaranty vehicle for each company overcomes the problem of current guaranty systems that systematic wealth transfers between clients of different financial companies take place.

In the first step of our analysis, we introduce the conceptual framework of our capital market-based financial guaranty scheme. We calculate the values of the clients’ premium and the investors’ principal under the assumption of perfect, complete, and frictionless capital markets, which provides the starting point for our following analysis. In the second step, we analyze the impact of two different actions which might be taken by the financial companies protected by the guaranty vehicle: First, the financial company might purchase guaranty bonds of its own guaranty vehicle. Second, it might purchase guaranty bonds of another financial company where both companies’ assets have a certain positive correlation. We measure the effects of these actions on major stakeholders by means of various risk measures. By deriving practical

\[^6\text{See, e.g., Bank for International Settlements, http://www.bis.org.}\]
implications, we provide new insights for regulators and financial companies as to whether a transfer of default risk to capital markets might be feasible.

We find that investments in the company’s own guaranty vehicle defeat the purpose of the guaranty system and that investments in another one might lead to the same result depending on the correlation structure. In addition, contagion effects might occur. We identify other major challenges – transaction costs, spread and volume, and impact on the market – and propose possible solution. Finally, we show that capital market-based financial guaranty systems provide various advantages: They are highly liquid, ensure risk-adequate premiums for the guaranty scheme, and eliminate potential cross-subsidization effects.

Although there are challenges inherent in the implementation of this proposal, we show how these can be solved. The analysis of advantages of the proposed framework indicates that the capital market-based solution has a number of key benefits compared to current deposit insurance and insurance guaranty schemes.

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