

Risk-sharing benefits and the capital structure of insurance companies

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Abstract

Providing risk-sharing benefits to risk-averse policy holders is a primary function of insurance companies. We model that policy holders are paying a fee over the present value of indemnifications (i.e., technical provisions) to enjoy these risk-sharing benefits. This fee implies that a capital structure largely consisting of technical provisions is optimal for insurance firms, making the traditional Modigliani-Miller logic inappropriate for them. To support the issuance of technical provisions with socially desirable properties, insurance firms hold a surplus to absorb losses. We show that the Modigliani-Miller logic applies to the composition of this loss-absorption capacity. This explains why insurance companies may use, next to equity and technical provisions, financial debt in supporting their activities.

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1. Introduction

The funding structure of financial institutions has been heavily debated since the global crisis of 2007-2009. Advocates asking for a greater reliance on capital argue that the high indebtedness of financial institutions is harmful for the broader economy, without serving any useful purpose. At the basis of this premise lies the traditional Modigliani-Miller logic and the leverage related distortions as proposed in the pecking-order and trade-off theories (e.g., Admati and Hellwig (2013)). Advocates for more deposit-based funding structures, as currently observed, postulate that relying solely on deposits is optimal for banks because of the associated socially beneficial liquid-claim production, making Modigliani-Miller argumentations flawed (e.g., DeAngelo and Stulz (2015)).

While the debate has mostly focused on banks, this paper extends the discussion by analyzing the funding structure of insurance firms. Thereby, contrary to the preceding debate, our focus is not on the appropriateness of regulation to impose high solvency levels; rather it develops a unifying logic for the capital structure choice by insurance firms which explains the choice between equity, financial debt and technical provisions.

Insurers constitute a large share of the financial sector. They hold about 12% of global financial assets, or \$24 trillion (IMF (2016)), while with a worldwide market share of 35 respectively 29 percent, Europe and the US are the two most important markets for insurer services (Insurance Europe (2015)). Insurers have a socially beneficial role in supplying risk-sharing benefits to their policy holders (e.g., Insurance Europe (2014)). They are also unique in providing such risk-sharing benefits as policy holders cannot otherwise trade in these risks. In this way insurers show similarity to banks as the latter play a socially valuable role by supplying liquid claims to depositors. Banks and insurers are, thus, both characterized by production activity on the liability side of their balance sheet. It is this characteristic that makes them so different from other businesses.

In earlier work, financial theory has been applied to the pricing of insurance contracts (e.g., Doherty and Garven (1986), Kraus and Ross (1982), Cummins (1990), Shimko (1992)). However, such a complete capital markets' approach is inconsistent with the existence of profitable insurance companies having substantial operating expenses (e.g., Myers and Cohn

(1987), Cummins and Danzon (1997), Eling and Luhn (2010), Cummins and Weiss (2013)). The literature therefore turned to allowing for market imperfections in the trading of insurance risks and giving a reason d'être for insurance firms (e.g., Mayers and Smith (1982) and Williamson (1988)).

An insurance contract specifies that for an insurance premium paid today, the policy holder is indemnified when a prespecified random event occurs that generates a loss for the initial risk-bearer (Eeckhoudt et al. (2005)). Insurance contracts thus allow to transfer risks by risk-sharing and smooth consumption across states of nature. Furthermore for these individual risk-bearers there is no financial market in which they can trade their unique risk (e.g., they meet with a car accident or a fire within their home) because - although the risk is important for the individual - it is too small and too costly to create a market for it. Insurance companies therefore step in as an intermediary by providing insurance contracts that allow individuals to pool their risks, and obtain (near) risk-free claims on the insurer when their individual risk materializes. Given their inability to trade their unique risks in the open market, risk-averse individuals are willing to pay for this risk-sharing benefit as provided by an insurance firm a fee above the present value of the loss associated with their individual risk. Our model shows that the fee for providing this risk-sharing benefit largely determines the relative amount of technical provisions in the capital structure of insurance companies rather than the traditional debt-equity neutrality logic of Modigliani-Miller.

In a first instance the argumentation makes use of the correspondence between banks and insurance firms. In particular, bank deposits share important similarities with insurance contracts: they also require an initial outlay by the depositor, and offer consumption smoothing over time as depositors may be uncertain about when to consume. This is referred to as the liquid claims production by a bank (e.g., Gorton and Pennacchi (1990), Diamond and Dybvig (1983)). Our model is most closely related to DeAngelo and Stulz (2015) who show that liquid claim production leads to a fully deposit funded bank. We borrow from DeAngelo and Stulz (2015) the notion of debt production with socially desirable properties and investigate how this could influence the logic of capital structure choice in insurers. In particular, we argue that risk-averse individuals demand insurance products from an insurer as the latter adds value to society by

pooling these individual risks in a portfolio. Moreover, this business of underwriting risks and issuing technical provisions must be profitable as it is the sole business activity of an insurer.² Within this context, our model shows that an insurer maximizes its capacity to issue technical provisions that it will honor with (near) certainty. This is somewhat similar to a bank maximizing its capacity to issue deposits as in DeAngelo and Stulz (2015).

However, there are important differences between banks and insurers. Contrary to deposits, technical provisions are a contingent form of debt (e.g., Cummins and Lamm-Tennant (1994)), implying that an insurer is not able to prefix with certainty the future outlay for its underwriting portfolio. Hence if it is important for policy holders that the insurer lives up to its contractual obligations with (near) certainty, the insurer needs surplus funding above technical provisions to absorb unexpected losses. Therefore in order to maximize its capacity to issue technical provisions that with (near) certainty will be honored, an insurer uses the minimal level of surplus needed to achieve this goal. It follows that for the determination of the *size* of this surplus the traditional Modigliani-Miller logic does not apply. Rather it is driven by the business of reaping the fee for providing the risk-sharing benefit. Furthermore our model shows that, when we turn to the logic of the *composition* of the financing of the surplus, the traditional Modigliani-Miller logic of choice between equity and financial debt applies. As such it provides a rationale for the use of financial (hybrid) debt as a loss absorption instrument in the capital structure of insurers. As a result the capital structure of insurance firms is driven by two different forces which may result in the presence of financial debt in the capital structure, next to equity and technical provisions. As far as we know, these insights have never been presented in such a systematic way.

This paper contributes in two ways to the existing literature. First, we motivate the reliance on technical provisions of the insurance industry by pointing to the socially valuable risk-sharing benefits offered by insurance companies. This is an extension of the liquidity provision mechanism in the banking industry and shows that application of the traditional capital structure theories to insurance companies needs to be adjusted. Second, our formal approach of the

² Whereas a bank is both an asset driven business (credit creation and/or investment activities) and a liability driven business (liquidity provision), the core activity of an insurance company is liability driven (insurance provision) (e.g. Diamond (1984) and Al-Darwish et al. (2011)).

insurer's business model yields a framework to assess, in a systematic way, the composition of the loss-absorption capacity where the traditional Modigliani-Miller logic does apply. For example, it allows us to understand and motivate the presence of financial debt or other loss absorbing instruments in the capital structure of an insurer.

From the perspective of supervisory practices, our analysis stresses the idea that supervisors should closely monitor the overall risk policy of insurance firms. In case financial debt is used, it should be structured so as to avoid spillovers from financial distress caused by financial debt to policy holders.

The remainder of this paper is structured as follows. In Section 2 we develop our model of shareholder wealth optimization for an insurance firm and explain how the business drives the *size* of the surplus. Section 3 further develops the implications of our optimization model and shows that a Modigliani-Miller rationale can be used to explain the *composition* of the funding of the surplus available for loss absorption. Section 4 discusses some regulatory practices from the perspective of the insights from our model. Finally, Section 5 concludes.

2. The insurer's wealth optimization problem: a simple model

Consider a simple one period model ($t = \{0,1\}$) where an intermediary offers an insurance contract to potential policy holders. At $t = 0$ every individual is risk averse and has a unique risk, which results in a substantial loss for the individual if it materializes at time $t = 1$. Although this loss is substantial on the level of the individual, it is too small in supply to create liquidity and trading in the open market. However insurance companies assemble these contingent claims and pool risks into a portfolio. Thereby risk-averse individuals are willing to pay a fee over the present value of his/her individual contingent claim to the insurance firm if they receive the promised indemnification payments with high probability.³

Except for their portfolio of individual specific contingent claims, which remains difficult to trade, insurers trade in a capital market with little frictions. Similarly individuals also trade in

³ The notion that consumers are willing to pay a fee above present value for financial products that allows for (near) risk-free consumption smoothing has been used in the banking literature by, among others, DeAngelo and Stulz (2015), Stein (2012), Gennaioli et al. (2012), Hanson et al. (2015).

capital markets with little frictions, except for their individual specific risk for which no open market exists.

Insurance firms form their underwriter portfolio by buying up individual specific contingent claims at $t = 0$. Commensurate with the literature (e.g., Cummins (1988), Cummins and Danzon (1997), Weiss (2007), Froot (2007)) we presume that at $t = 1$ the amount of indemnification is stochastic with expected value Q . In line with e.g., Froot (2007) we presume that this amount behaves according to the stochastic process $Q * \tilde{q}$ with $\tilde{q} \sim N(1, \sigma_q^2)$, i.e., \tilde{q} represents the per unit risk of Q and follows a normal distribution.

The insurer collects at $t = 0$ insurance premia equal to $(1 + \kappa) * Q$. As we presume discount rates are zero in our simple world, the constant $\kappa > 0$ represents the fee for the provision of the risk-sharing benefit over the present value of claims. The insurance firm may use some of the collected cash received at $t = 0$ to pay out a dividend $Div > 0$; conversely it may issue extra equity $Div < 0$. At $t = 0$ the insurance company invests an amount A of the cash in a portfolio of securities which evolves from $t = 0$ to $t = 1$ according to the stochastic process $A * \tilde{a}$ with $\tilde{a} \sim N(1, \sigma_a^2)$.⁴ However, at $t = 0$ it also pays costs $C(A, Q)$ to operate its business. These represent the outlays of managing the insurer's total assets A and of providing insurance services to policy holders that are linked to their contracts Q . The cost function $C(A, Q)$ is increasing in A and Q , i.e., costs increase when more assets need to be managed and more policy holders need to be attracted. To guarantee an interior solution to the optimization problem we also presume that $C(A, Q)$ is strictly convex in A and Q . It follows that $A = (1 + \kappa) * Q - Div - C(A, Q)$. The value of the shares S of the insurance firm at $t = 0$ amounts to the present value of all current and future cash flows of the insurer. As discount rates are zero, this present value takes on the following simple expression: $S = (1 + \kappa) * Q - Div - C(A, Q) - Q = \kappa * Q - Div - C(A, Q)$.⁵

⁴ Remark that risky securities yield a zero rate of return. Although risky securities do not entail a risk premium in our simple model, we will see below that insurers may still wish to buy them because of hedging purposes.

⁵ An extension of the model could include the value of the put option implicit in the limited liability of shares. The model would then become $S = (1 + \kappa) * Q - Div - C(A, Q) - Q + Q * b$, where b is the value of the put option per unit of Q (e.g. Cummins and Danzon (1997)). However, since we only consider (near) risk-free claims, we presume for the remainder that $b \approx 0$. This brings simplicity that allows us to focus on the main aspects and to compare with models from banking such as DeAngelo and Stulz (2015).

Since the insurers' shareholders wish to maximize their initial wealth W , they maximize $W = S + Div = A - Q + Div = \kappa * Q - C(A, Q)$. However this maximization is constrained by the fact that policy holders accept only a small probability p (i.e., p is close to zero) that the insurance firm would not be able to honor its obligations at $t = 1$. Insurers therefore solve the following optimization problem to maximize shareholder wealth W with respect to the choice of the claims portfolio Q and the asset portfolio A :

$$\max_{Q,A} W = \kappa * Q - C(A, Q) \quad (1)$$

$$\text{Subject to: } \text{prob} [(A * \tilde{a} - Q * \tilde{q}) < 0] < p \text{ at } t = 1 \quad (2)$$

$$A - Q \geq 0 \text{ at } t = 0 \text{ for non negative } A \text{ and } Q. \quad (3)$$

In order to gain a better understanding of the problem and of the specificity of insurance firms relative to banks, we first consider the special case where $\sigma_q = \sigma_a = 0$. This implies that insurers fully diversify away any idiosyncratic risk in their underwriting portfolio. Afterwards we return to the situation where underwriter risks remain, notwithstanding the diversification within the underwriting portfolio. Finally note that implicitly – and typical for this kind of simple model – preceding formulation presumes that policy holders can perfectly observe the behavior of insurance firms and conclude complete contracts so that the insurance firm is committed to its initial promises. However in Section 4 below we come back on these latter assumptions.

2.1 The case of non-stochastic Q and A

Suppose that assets are risk-free (i.e., $\sigma_a = 0$) as well as the underwriting portfolio Q (i.e., $\sigma_q = 0$). Under these conditions insurance firms optimize equation (1) above under the solvency constraint (3). This problem can easily be solved by considering first the impact of a small change in the asset portfolio A on the wealth W of shareholders for some $A > Q$ while keeping Q fixed:

$$\frac{dW}{dA} = -\frac{dC}{dA} < 0 \text{ since } dC/dA > 0$$

Or as wealth W decreases in A , at the optimum insurers opt for the minimal value of A , i.e., $A = Q$. This implies that the total liability side consists of technical provisions so that the surplus of assets over technical provisions ($A - Q$) equals zero.⁶ In a next step we optimize the size of the insurer at the optimal capital structure (i.e., $A = Q$) with respect to Q :

$$\frac{dW}{dQ} = \kappa - \frac{\partial C}{\partial Q} - \frac{\partial C}{\partial A} \frac{dA}{dQ} = \kappa - \frac{\partial C}{\partial Q} - \frac{\partial C}{\partial A} = \kappa - \frac{dC}{dQ}$$

with $\frac{dC}{dQ}$ the total derivative of C toward Q when $A = Q$ (i.e., $\frac{\partial C}{\partial Q} - \frac{\partial C}{\partial A} = \frac{dC}{dQ}$). Or, not unexpectedly, we obtain the classical result that the optimal size is attained when the marginal benefit of the last unit of policy equals its marginal cost.

Overall this model with non-stochastic Q shows that the risk-sharing benefit leads to a capital structure of insurance companies which is focused on technical reserves.⁷ Put differently, the insurer's capital structure choice is the result of the intermediation activity of risk-sharing which is socially beneficial.^{8,9}

⁶ Within our model the fact that the (portfolio) management costs are increasing in A destroys equilibria in which the surplus would be increased indeterminately and invested in more (marketable) securities. In practice however, both financial and industrial firms limit their balance sheet because acquisition of external funding is costly. In fact the literature considers attracting external equity to be especially costly for insurers due to asymmetric information problems (e.g., Dhaene et al. (2016) for an overview). Furthermore in practice intermediation costs $C(A, Q)$ are considerable. Nissim (2010) for example shows that deferred acquisition costs and other operating expenses constitute around 34% of total income for US insurance companies over the period 1999-2009.

⁷ Within our simple model the insurer can only choose Q and A implying that σ_q and σ_a are fixed parameters. However note that if $\sigma_a = 0$, even if the insurer would be able to choose σ_q , the argumentation in Section 2.2 below implies that it is optimal to opt for $\sigma_q = 0$ to avoid incurring the cost of maintaining a surplus $(A - Q) > 0$.

⁸ Note that within our simple model the fee above the present value of claims κ , remains positive in a competitive equilibrium, even if competition would drive the net present value of entry of a firm into the insurance sector to zero. In order to be able to pay the intermediation costs $C(A, Q)$ and hence remain in business, insurers need to reap a strictly positive fee κ . Specifically, presume that at the optimal size and capital structure (i.e., $A^\circ = Q^\circ$), $W^\circ = 0$. Then $\kappa * Q^\circ - C(A^\circ, Q^\circ) = 0$ or $\kappa = \frac{C(A^\circ, Q^\circ)}{Q^\circ} > 0$.

⁹ In case the risk-free rate R_f is different from zero, the objective function W becomes $W = S + Div = (1 + \kappa) * Q - Div - C(A, Q) - \frac{Q}{(1+R_f)} + Div = \left(\kappa + \frac{R_f}{1+R_f} \right) * Q - C(A, Q)$. For all of the preceding logic to continue to hold it suffices to replace κ by $K = \kappa + \frac{R_f}{1+R_f}$. In the latter case K reflects next to the fee for the risk sharing benefit, also the time value of money. Note that under the pressure of perfect competition at the optimal scale and capital structure it remains true that $K = \kappa + \frac{R_f}{1+R_f} = \frac{C(A^\circ, Q^\circ)}{Q^\circ} > 0$. However, it follows from the equality between K and $\frac{C(A^\circ, Q^\circ)}{Q^\circ}$ that κ decreases as interest rates rise to reflect the benefit insurers obtain from investing the premium received upfront between $t = 0$ and $t = 1$. If in that case the ratio cost/technical reserves is low enough, κ may even become non positive.

The present case which presumes that $\sigma_a = 0$ is reminiscent of a regulator imposing that an insurance firm may only carry risk-free assets. This could be seen as the regulator requiring that insurers engage in “narrow insurance”, comparable to the concept of “narrow banking”. A narrow bank issues demandable liabilities and invests in assets that have little or no nominal interest rate and credit risk (Pennachi (2012)). A “narrow insurance” firm collects insurance premia from policy holders, diversifies away the idiosyncratic risks, and invests the collected premia in risk-free assets to cover the expected claims.

2.2 The case of stochastic Q and A.

Contrary to banking where the nominal amount of deposits that eventually has to be repaid is known with certainty, in the case of insurance, the contingent debt issued by firms through their underwriter portfolio typically causes indemnification payments that are stochastic.¹⁰ Since policy holders value the services of an insurer if the latter is able to honor its obligations with a very high probability, we now include equation (2) in the optimization. However as the objective function of this constrained maximization problem remains the same as in Section 2.1 above, the solution should be identical unless the extra constraint (2) becomes binding. The solution to this maximization problem therefore is that the surplus of assets over technical provisions ($A - Q$) at $t = 0$ is equal to the minimal amount of surplus for which the constraint $prob [(A * \tilde{a} - Q * \tilde{q}) < 0] < p$ at $t = 1$ is binding. Put differently, the surplus ($A - Q$) chosen at $t = 0$ generates sufficient loss absorption so as to guarantee that at $t = 1$ we have that $A * \tilde{a} \geq Q * \tilde{q}$ with probability $(1 - p)$.

It is important to note that the logic of this outcome - i.e., insurers minimize surplus while keeping the risk that claims would not be honored very low - stems from customers willing to pay the extra fee κ if materializing claims will be paid out with near certainty.¹¹ A direct consequence

¹⁰ Uncertain events may cause correlations between individual underwriter risks (e.g. floods, hurricanes, pandemic conditions, ...). In turn, this increases σ_q .

¹¹ In this model we opted for a VaR-approach to express the limits on risk for its simplicity; however it has also become an overarching technique for measuring risks (e.g., Doff, 2011). Other approaches that express limits on the risk would have been possible also, like classical ruin models in which the model limits the probability of bankruptcy and which is very close to the VaR-approach (e.g., Plantin and Rochet (2007)). Alternatively expected shortfall which considers the expected value of the loss given default would lead to similar insights (e.g., Hull (2015)).

of the model is therefore that adhering to a solvency risk target while minimizing surplus is a wealth maximizing strategy for the shareholders of the insurance firm. This solution also implies that wealth maximizing insurers increase surplus when the risk of their operations increases. As such it is perfectly consistent with the finite risk paradigm proposed in the literature by among others Harrington and Nelson (1986), Staking and Babbel (1995), Cummins and Sommer (1996), Baranoff and Sager (2002; 2003), Cheng and Weiss (2013).¹² This perspective posits that insurance firms tend to increase capitalization when they take on more risk. In fact Cummins and Sommer (1996) have shown formally that it is optimal for the insurer to adhere to the finite risk paradigm when the price customers are willing to pay for the services of an insurance firm falls as its solvency decreases. The current model shows that each choice of this trade-off actually also minimizes the surplus consistent with that risk level. The reason for this result derives from the introduction of the fee that customers are willing to pay to enjoy risk sharing benefits and which is central to this paper.

To further enhance our understanding of the model, we evaluate the solution for several special cases of the stochastic relationship between \tilde{q} and \tilde{a} . To that end, we first calculate the expression for the variance of the surplus at $t = 1$. Specifically, it can be shown that the variance of $A * \tilde{a} - Q * \tilde{q}$ at $t = 1$ is equal to:

$$A^2 * \sigma_a^2 + Q^2 * \sigma_q^2 - 2A * Q * \rho_{aq} * \sigma_a * \sigma_q.$$

Consider first the case where only the outlays to policy holders are stochastic while the asset portfolio A is risk-free (i.e., $\sigma_a^2 = 0$), for example, due to regulation that imposes that insurers invest in risk-free assets only. In this case the expression of the variance of the surplus reduces to $Q^2 * \sigma_q^2$. In view of the normal distribution of \tilde{q} , the latter implies that an increase in σ_q^2 requires a higher surplus ($A - Q$) at $t = 0$ to support the near risk-free payout of claims for policy holders. Hence in that case σ_q^2 and ($A - Q$) are direct complements; that is, an increase in σ_q^2 leads to a higher required ($A - Q$). Similar results hold for the opposite situation where the outlays towards policy holders are not stochastic (i.e., $\sigma_q^2 = 0$) but that the insurer's asset portfolio

¹² The empirical evidence included in some of these papers predominantly finds support for the notion that most insurers tend to act as if they apply the finite risk paradigm. Furthermore the latter has also found support in the framework of banks (Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (2001), Jokipii and Milne (2011) among others).

is risky, i.e., $\sigma_a^2 > 0$. An increase in σ_a^2 then requires a higher surplus ($A - Q$) in order to support the near risk-free payout of policy holders.

Suppose now that both the insurer's asset portfolio and outlays to policy holders are stochastic. The required surplus then hinges not only on the variances of the asset portfolio return and of the outlays to policy holders, but also on the correlation ρ_{aq} between them. An interesting question then is whether allowing to invest into risky assets always requires more surplus than imposing the requirement to invest in riskless assets only. The answer is no. Specifically when we compare these cases for a given Q , investment in risky assets may actually lead to a lower need for surplus if the following inequality is satisfied:

$$A^2 * \sigma_a^2 + Q^2 * \sigma_q^2 - 2A * Q * \rho_{aq} * \sigma_a * \sigma_q < Q^2 * \sigma_q^2$$

$$\Downarrow$$

$$\rho_{aq} > \frac{A}{2Q} * \frac{\sigma_a}{\sigma_q}$$

A sufficiently high positive correlation ρ_{aq} between asset returns and portfolio outlays implies that allowing investments into risky assets reduces the required surplus. A sufficiently high positive correlation, for example, would imply that assets provide a positive return exactly when more outlays are required. Such financial instruments then offer a natural hedge against additional outlays

Previous analysis has two important implications. First, current regulation often imposes risk weights on assets. The above suggests that these weights need to take into account the correlation with outlays on the liability side - as is the case for example under Solvency II. Otherwise regulation could incentivize insurers to compose an asset portfolio that is tilted towards assets that do not provide a natural hedge.¹³ Second, contrary to the findings in DeAngelo and Stulz (2015) where a lower risk of the asset portfolio leads to lower risk for the bank's depositors, with insurers asset risk may actually reduce the probability that the firm could not meet its obligations. Such extra risk bearing is possible because of the risky nature of the contingent debt insurers issue. Therefore, contrary to the risk management of banks within the

¹³ The risk-based capital requirements concerning capital charges imposed on insurers in the US takes selected factors and multiplies these with accounting values to produce capital charges for each item. The charges are summed and then subjected to a covariance adjustment to reflect the assumed independence of several of the main risk factors. The latter assumption is not necessarily realistic (e.g., Eling et al. (2009), Butsic (1993)).

model of DeAngelo and Stulz (2015), the risk management of insurers need not be aimed at minimizing the risk of the asset portfolio but at optimizing the matching of risks between assets and liabilities. In fact Al-Darwish et al. (2011), Swain and Swallow (2015) among others, discuss how mitigating mismatch risk between asset and liabilities is central to the risk management in the insurance business.

3. Re-introducing Modigliani-Miller

Sections 2.1 and 2.2 show how insurers choose their asset portfolio, claim portfolio and required surplus to maximize shareholder wealth. Specifically when policy holders value (near) risk-free policies, insurance firms fix the amount of surplus available for unexpected loss absorption so as to guarantee a low insolvency risk from the point of view of policy holders.

The question we now address is whether firm value is maximized if the surplus is fully funded by equity. In fact financial debt that is junior to underwriter claims could also serve as a loss absorption instrument from the perspective of policy holders. This raises the question about the composition of the funding of the surplus. To answer it, we can use the insights of Miller and Modigliani (MM). Presuming the business plan is fixed – as is typical of the MM-logic – would imply that the insurer has already chosen its asset and claim portfolio, and hence has fixed the amount of surplus. This choice was discussed earlier. Taking these latter choices as given, the insurer then still has to determine how to finance the amount of surplus in the capital market. This is summarized in the following balance sheet:

Table 1: Surplus assets and its financing

Surplus assets	Liability composition of surplus
Asset portfolio (A) – technical provisions (Q)	Equity
	Financial debt

Presuming that the business plan and hence the surplus is predetermined, the logic of MM suggests that in perfect capital markets, the funding of the latter through equity or financial debt is indeterminate. In such capital markets the composition of the buffer does not impact the

likelihood of a shortfall for policy holders as long as financial debt is junior to policy holders' claims.¹⁴ In case frictions – like taxes or bankruptcy costs - are present, an optimal choice between equity and financial debt obtains, commensurate with the classical trade-off theory.¹⁵ As such, the current model develops a logic for the funding structure of an insurance firm that, apart from technical provisions and equity, also uses financial debt. So far such a logic has been missing. In fact, in the study of the capital structure of an insurance firm the literature typically focuses on equity and technical provisions, while financial debt is ignored altogether (e.g., Dhaene et al. (2016) for an overview). We show that two different logics simultaneously drive the global capital structure of an insurance firm. Specifically, the profitable opportunities of issuing near risk-free technical provisions determine the size of the required surplus relative to total assets/technical provisions. Simultaneously, the logic of MM applies to the composition of the funding of the required surplus.

A comparison of the application of the MM-logic in industrial corporations with the current application may yield extra insight. Specifically within our model the realm of financial debt in the financial structure of insurance companies is more limited as compared to industrial firms, and therefore is likely to contribute less to the financing of operations. For insurance firms the logic of MM only plays on the level of the surplus, while in an industrial firm the logic of MM applies to the balance sheet more globally.¹⁶ Although our logic suggests that, at least relative to

¹⁴ In practice regulation typically requires that if financial debt is issued, it is subordinated to the claims of policy holders (e.g. Cummins and Lamm-Tennant (1994), De Weert (2011)).

¹⁵ As there are no bankruptcy costs in a perfect capital market, as soon as financial debt is junior to the claims of policy holders, the choice of funding of the surplus does not affect policy holders. For in a perfect capital market, the insurance firm would be instantaneously restructured financially so that operational activities would continue as before. In a capital market with frictions bankruptcy caused by the use of junior financial debt could create costs that spill over to policy holders to some extent. From the perspective of optimal capital structure choice, the consequences of such a spillover for the insurance firm should be taken into account as an extra cost to the use of financial debt in the trade-off between debt and equity. For in case policy holders can perfectly observe the behavior of insurance firms as in our setting, rational policy holders anticipate such costs and take this into account when choosing the insurance firm they contract with, which in turn may lead to a lower price/premium that the insurer can charge for its products ex ante. Such extra cost would obviously decrease the use of financial debt by an optimizing insurer. This problem is similar to the one faced by industrial firms vis-a-vis their customers, especially in case the firm sells multi-period products that may need servicing over time.

¹⁶ What may shed additional light on the similarity and differences between the capital structure of industrial firms and insurers is comparison in terms of the so called enterprise value. According to the well know discounted cash flow (= DCF) methodology of valuation in corporate finance the present value of the free cash flows produced by an industrial firm's assets determine the enterprise value, which, on the liability side is made up of equity and financial

the balance sheet total, financial debt is likely to be limited, nevertheless some empirical studies report proportions of 10% and more of total assets (e.g., Cummins and Rubio-Misas (2006) for Spanish insurers and Bikker and Gorter (2011) for Dutch insurers).¹⁷

Continuing our comparison with industrial firms, our model suggests that the capital structure choice is more complex in insurance companies as, within the latter, two different logics drive the global capital structure simultaneously. What may further contribute to the complexity of capital structure choice as compared to industrial companies, is that insurers can change their (needed) amount of surplus funding more easily as compared to the former. Specifically, in the case of industrial firms the MM-logic of using equity and debt applies to funding that is needed to finance fixed assets and (net) working capital. The findings in the literature on corporate restructuring suggests that substantial adjustments in these assets cause important adjustment costs (e.g., John et al. (1992), Kang and Shivdasani (1997), Denis and Kruse (2000)). By contrast, in case of insurers the MM-logic of using equity and debt applies to funding that is needed for loss absorption purposes. Changing the (need for) surplus is likely to entail relatively smaller costs. Even within our simple setting which allows only for a few choices this is the case. For example, the assets of the insurers within our model consist of tradeable securities that can easily be bought or sold in the open market. As documented e.g. in IMF (2016), insurers have quite a number of instruments at their disposal to relatively easily adjust their (need for) surplus in practice.

4. Some comments on supervisory practices

Our findings can easily be linked to supervisory practices and may help to add to the theoretical logic underlying the latter; in this way it may add to the scarce literature on optimal supervision of insurance firms.

Within the setting of our model, which presumes that policy holders can perfectly observe the actions of insurance firms while the latter can precommit through contracting in

debt. Preceding logic in combination with Table 1 suggests that within an insurance firm the market value of the surplus takes the role of enterprise value which consists of the equity and financial debt that makes up the surplus.

¹⁷ Worldwide studies for industrial firms report values between 30% and 40% (e.g., Fan et al. (2012), Baghai et al., (2014)).

complete markets, there are no market failures and insurers maximize value by committing to a certain solvency risk level.

In practice, asymmetric information is important and contracting opportunities are not complete. In particular the literature documents that insurers, relative to other types of financial institutions and industrial firms, are quite opaque (e.g., Morgan (2002), Babbel and Merrill (2005), Adamson et al (2014)). As a result it is hard for policy holders to monitor the actions of insurers. Nevertheless the logic of our analysis continues to hold if a supervisory body would be provided with the information necessary to follow up the actions of insurance firms sufficiently well to limit agency and moral hazard issues. Our model suggests that such a supervisor would monitor the level of surplus and the level of risk and check that surplus and risk are commensurate with a limited risk of failure. These suggestions are in line with the literature that evaluates the existing regulation and/or compares different regulatory regimes. However, as little of this argumentation builds on the outcome of a model of optimal insurer behavior, our findings might contribute to the theoretical foundation of the analysis in this literature. Specifically, from the early work of Cummins et al. (1993) that starts out from the stance that well designed risk-based capital rules should help the supervisor to identify financially weak firms in an early stage, there exists wide agreement that the use of risk-based capital requirements is a better approach than imposing a fixed minimum amount of capital. More recently, a number of papers compare the risk-based capital (RBC) regulation that was implemented in 1993 in the US with the Solvency II rules which the EU introduced in 2016. Overall most of this work highlights that Solvency II may encompass advantages relative to the regulation in the US. While the RBC-system largely focusses on a static rules-based regulation, Solvency II has implemented a more principles-based approach. This implies that under Solvency II the supervisor uses both qualitative and quantitative information, while having the flexibility to address and assess the overall risk management policy of an insurer in relation to its surplus and equity. Although the Solvency II approach is considered to be superior to the RBC-regulation by some authors (e.g., Eling et al. (2009), Eling and Schmeiser (2010), Klein (2012), Holzmüller (2009)), the adoption of Solvency II is still too recent to empirically evaluate it vis-a-vis the RBC-approach.

The logic of our model suggests that not only the size, but also the composition of the surplus is likely to be a matter of relevance for the supervisor. As we showed above, in contrast to the size of the surplus which is driven by the business itself, the traditional MM-logic holds true on the level of the financing of the surplus. Hence the costs of imposing a higher equity part in the financing of the surplus are closely linked to those considered in the traditional analysis of optimal capital structure, i.e., mainly tax disadvantages. However the well-known problems of bankruptcy costs and debt overhang (Myers (1977)) suggest that, in practice, there may be negative spillovers from the use of financial debt toward the underwriting debt holders. When such spillovers reduce the loss absorption promised by the surplus to policy holders, the supervisor could contribute by limiting them. One important way to achieve this is to impose that financial debt should be subordinated to the claims of policy holders – as is also the case in practice. Another type of measure that is likely to reduce such spillovers towards policy holders is to compose the surplus in such a way that it can easily be restructured without affecting the business. On this score it is interesting to look at the differences in stance taken on by the US and European regulators. In the US the separate state regulations usually do not, or else only to a limited extent, accept financial debt as a component of the total adjusted capital (or TAC) in calculating the minimal required capital standards (NAIC (2014), Hill (1996)). As a result, as an alternative way to lever up the surplus, US insurers place financial debt on the level of a holding firm that owns the former's shares (Cummins and Lamm-Tennant (1994)). In Europe the old Solvency I regulation as well as the new Solvency II rules allow financial debt to cover in part the minimal required capital directly within the insurance firm. To be taken into account for the capital requirements this financial debt has to have loss absorption properties, like subordination to claims of policy holders or long term availability of the debt funding to absorb losses over time (e.g., De Weert (2011), EIOPA (2016)). From the perspective of limiting spillovers towards policy holders, the practice of placing the financial debt on the level of a holding firm has the advantage that financial difficulties triggered by the financial debt may mainly remain concentrated on the level of the holding firm, while the insurance subsidiary is only indirectly affected. Loss of tax benefits is likely a disadvantage of this method. In case financial debt is placed on the level of the insurance firm, as allowed under European regulation, spillovers are likely minimized when the

debt can easily be restructured. The use of hybrids, e.g., contingent convertible bonds, may be useful in that respect and may further help the insurance firm to calibrate the risks of loss absorption over the components of the surplus. In fact it has been shown (in the framework of banks) that if properly designed, such instruments may be beneficial (e.g., Flannery (2010), Pennachi (2010), Abul et al. (2015)). Furthermore the tax advantages of such financial debt make it cheaper for an insurer to maintain surplus which, in turn, may entice insurers to opt for a larger surplus. Empirical evidence is needed to evaluate the pros and cons of different solutions.

5. Conclusions

Insurance firms provide policy holders with risk-sharing benefits they cannot obtain through financial markets. We develop an integrated model of the capital structure of insurance firms that incorporates the production of these risk-sharing benefits. In a model with exogenous demand for insurance and intermediation costs that are a function of the scale of the insurer, we show that insurance firms maximize their value by relying as much as possible on technical provisions for their funding. It is this production of risk-sharing benefits at the liability side of the balance sheet that makes insurance firms so different from other firms.

We show that the optimal capital structure of insurance firms is driven by two logics. First, the insurers' business model of providing risk-sharing benefits to policy holders largely determines their funding structure. Insurers keep a surplus of assets over technical provisions (i.e., loss absorption capacity) to maximize their capacity to issue these provisions. Optimizing insurers therefore maintain the minimal amount of surplus that is commensurate with their solvency risk choice. Second, we show that the logic of Modigliani and Miller applies in determining the composition of the surplus, implying that financial debt has a place in the loss-absorption capacity of insurance firms as long as it is junior to policy holders' claims.

Our stylized model thus shows how the capital structure of insurers is more complex as compared to industrial firms. It may also add to the clarification of the role supervisors play in monitoring insurance firms. Starting from the optimal behavior of insurers, our model stresses the need for supervisors to monitor the asset and liability risks insurance firms take on as well as

the size of the loss absorption capacity. Our model also explains the practice of some supervisors to allow for the use of financial debt to make up part of the loss-absorption capacity.

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