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Who benefits from building insurance groups? A welfare analysis based on optimal group risk management*

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Abstract

This paper compares the shareholder-value-maximizing capital structure and pricing policy of insurance groups against that of stand-alone insurers. Groups can utilise intra-group risk diversification by means of capital and risk transfer instruments. We show that using these instruments enables the group to offer insurance with less default risk and at lower premiums than is optimal for stand-alone insurers. We also take into account that shareholders of groups could find it more difficult to prevent inefficient overinvestment or cross-subsidisation, which we model by higher dead-weight costs of carrying capital. The tradeoff between risk diversification on the one hand and higher dead-weight costs on the other can result in group building being beneficial for shareholders but detrimental for policyholders.

Keywords: Insurance groups, insurer default risk, insurance pricing, consumer protection

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1 Introduction

In today's insurance markets, insurers commonly constitute one entity of a larger financial group. It is therefore important for insurance risk managers, regulators, and policymakers to understand the specifics of group risk management, shareholder incentives for group building, and the resulting welfare effects. A key issue for a financial group is the risk diversification between its subsidiaries. Diversification effects at the group level may arise if the subsidiaries' risk profiles are not perfectly positively correlated and the subsidiaries do not all fail at the same time. To utilise risk diversification, the group could implement a system of capital and risk transfer instruments, such as intra-group reinsurance contracts, guarantees, or profit and loss transfer agreements.

Filipović and Kupper (2008) analyse how combinations of these instruments are best arranged so as to minimise the group's required capital. The economic justification behind their objective function is strongly related to the assumption that firms cannot hold equity for free, but face dead-weight costs, resulting, e.g., from corporate taxes, agency issues, or regulatory restrictions.[1] According to Filipović and Kupper (2008), intra-group risk diversification allows the group to reduce the subsidiaries' equity capital levels, and thus economise on costly capital. Insurers have many options for dealing with the problem of dead-weight costs of equity capital. In line with Zanjani (2002) and Schlütter (2011), the costs of holding equity are especially determinative of the insurer's safety level, as well as of the levels of insurance premiums, which may substitute equity for the accumulation of capital. In addition to these models, which focus on stand-alone insurers, group risk management needs to answer the question of how best to allocate capital to the group's entities. As the entities could fail independently of the rest of the group, they can be provided with different safety levels.

In this paper, we set up a holistic model similar to Zanjani (2002) and Schlütter (2011), but focus on an—albeit simplified—insurance group. Our model allows us to investigate how the group will utilise risk diversification in pursuit of shareholder value maximisation. We account for shareholders' default put option and incorporate price and default-risk sensitive insurance demand. Dead-weight costs of equity are incorporated by means of a

[1] Cf. Smith and Stulz (1985); Froot (2007).

proportional carrying charge on the insurer's equity.[2] Our model illustrates that the group organises the capital allocation among subsidiaries according to the default sensitivity of insurance demand and the profitability of the insurance portfolio. In contrast to a purely arithmetical capital allocation to an insurance firm's lines of business,[3] capital allocation to the subsidiaries of a group has direct consequences for the subsidiaries' balance sheets and their safety levels. The intra-group risk diversification has three effects: (1) the group overall holds less equity capital than stand-alone insurers, and yet, (2) including the capital and risk transfer, the group subsidiaries have higher safety levels than stand-alone insurers, and (3) optimal insurance premiums are lower in the group than they are for the stand-alone insurers since the dead-weight costs of equity are less. Thus, group building has positive welfare effects for policyholders as well as for shareholders: policyholders benefit due to the reduction of counter-party default risk as well having to pay lower insurance premiums; shareholder value increases because the insurer is able to sell more insurance contracts.

However, according to agency theory, financial groups also suffer a significant disadvantage. Since groups are more complex and opaque than independent smaller entities, it is more difficult for shareholders to control the group management and avoid inefficient overinvestments or cross-subsidisation within the group.[4] The empirical literature finds a substantial discount of shareholder value in widely diversified groups, which is frequently explained by intensified agency conflicts.[5] The straightforward way to incorporate this opaqueness problem into our analysis is to allow for different carrying charges of the stand-alone insurer and the group. The group's advantage of access to capital and risk transfer instruments thus comes with the price of higher costs for holding equity. We find that a high group-specific markup on the carrying charge will induce the group to reduce the safety levels of its subsidiaries and increase premiums compared to the optimal stand-alone case. It is also possible that shareholders can increase their value through group building, while policyholder welfare is destroyed. We find that this situation is highly likely, especially if insurers have weak self-interest to hold equity, e.g., because demand

[2]Cf. Zanjani (2002); Froot (2007); Schlütter (2011).

[3]Cf. Myers and Read (2001); Ibragimov et al. (2010).

[4]Cf. Amihud and Lev (1981); Jensen (1986); Aron (1988); Jensen and Murphy (1990); Stulz (1990) and Rotemberg and Saloner (1994).

[5]CF. Berger and Ofek (1995); Laeven and Levine (2007); Schmid and Walter (2009).

is weakly sensitive to price and/or insurer default risk. To avoid an increase in default rates and the corresponding welfare reduction, regulators should explicitly monitor the group's equity capital levels under these conditions.

The remainder of this article is organised as follows. Section 2 takes a look at the relevant literature and situates this article within this body of work. Section 3 presents the model framework and the optimal risk management strategy for the stand-alone insurer. Section 4 deals with the optimal risk management strategy for a group and compares it to the results for the stand-alone case. Section 5 analyses the group's risk management strategy with consideration of a group-specific carrying charge and provides a welfare analysis. Section 6 discusses the results in light of empirical findings and derives policy implications. Section 7 concludes.

2 Literature overview

To investigate the consequences of insurance group building, we combine the methods and arguments of three streams of the literature.

The first line of reasoning addresses the incorporation of capital and risk transfer instruments into the solvency assessment and risk management of insurance groups. On the background of the Swiss Solvency Test (SST), Keller (2007) and Luder (2007) discuss how these instruments are taken into account when defining the group's solvency capital requirements. Filipović and Kupper (2008) optimise the structure of CRTI's under the objective of minimizing the group's required capital which is defined by convex risk measures. According to financial theory, the risk reduction inherent in the diversification effect implies a reduction of shareholders' limited liability protection, an increase in the market value of debt and therefore a value transfer from shareholders to debt-holders.[6] Gatzert and Schmeiser (2011) transfer this argumentation to an insurance context and explain that group building will lead to a value transfer from shareholders to policyholders if the group's capital structure is fixed. However, a fair situation can be restored by adjusting the initial equity levels.

[6] Cf. Mansi and Reeb (2002); Ammann and Verhofen (2006).

In the context of stand-alone insurance companies, several articles stress the meaning of frictional costs, e.g. corporate taxation or agency issues, for insurance pricing and insurer safety levels. Based on option pricing theory, Doherty and Garven (1986) determine fair insurance prices with a fixed safety level and by incorporating corporate taxation. This has been developed further in several directions, including reinsurance pricing,[7] multiline insurance firms,[8] jump diffusion risk processes,[9] or endogenous insurer default risk.[10]

Furthermore, agency theory stresses that diversified conglomerates might be subject to more severe agency problems than specialised entities, e.g. because shareholders have limited capabilities to avoid inefficient misallocations of capital.[11] Freixas et al. (2007) show that diversification in integrated financial conglomerates can procure higher incentives for excessive risk-taking than stand-alone firms, and thus destroy welfare. The authors argue that diversified financial conglomerates have less access to deposit insurance than more specialised firms, which could lead to a discount of shareholder value. Their model also incorporates a market-financed intermediary (MFI), which shall represent insurance or securities firms; however, by assuming that the MFI's bondholders are perfectly informed and risk neutral, their model cannot provide implications for insurance regulators.

3 Stand-alone insurance company

We start our analysis with the stand-alone insurance company, presenting our solutions analytically in this context and providing insight into the basic mechanics of our model.

3.1 Model set-up

We consider a group of consumers who can purchase insurance to cover homogeneous future risks. Policyholders face the risk of insurer default; however, they have ex ante information about this risk (provided by, e.g., rating agencies or brokers) and take it into

[7] Cf. Gründl and Schmeiser (2007).

[8] Cf. Phillips et al. (1998); Myers and Read (2001).

[9] Cf. Gatzert and Schmeiser (2008).

[10] Cf. Cummins and Danzon (1997); Gründl and Schmeiser (2002); Zanjani (2002); Froot (2007); Yow and Sherris (2008); Schlütter (2011).

[11] Cf. Aron (1988); Stulz (1990); Rotemberg and Saloner (1994).

account when making purchase decisions. The number of concluded contracts depends on the insurance premium as well as on the insurer's safety level. The insurer decides on the shareholder-value-maximizing combination of its equity capital and insurance premium by taking demand reaction into account.

We formulate the model in a one-period framework. At time 0, shareholders endow the company with equity in the amount of K. Due to frictional costs, such as corporate taxes or agency problems, a proportional amount of τ is lost. Also at time 0, the collective of y policyholders pays the insurance premium p. In total, the insurer's initial assets are comprised of $A_0 = (1-\tau) \cdot K + y \cdot p$. The time 0 value of liabilities is given by $L_0 = y \cdot \mu$, where μ measures the time value of each policyholder's claims. At time 1, policyholders report claims in the amount of L_1. They can be indemnified with the insurer's available assets, A_1. Due to the randomness of insurance claims and investment risk, A_1/A_0 and L_1/L_0 are stochastic and modelled by random variables.[12] Policyholders receive in total $\min\{A_1, L_1\}$. Shareholders receive the final equity, or maintain their limited liability in the event of insolvency; in total they receive $\max\{A_1 - L_1, 0\}$. Shareholders have access to arbitrage-free financial markets and evaluate future payoffs under the risk-neutral probability measure $\mathbb{Q}$. Hence, the net shareholder value can be formulated as

$$SHV = \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{A_1 - L_1, 0\}\right] - K, \tag{1}$$

with r the risk-free interest rate. We denote shareholders' default put option by $DPO = \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1 - A_1, 0\}\right]$, and the default ratio by $dr = DPO/L_0$. Thus, we can rewrite SHV as

$$\begin{aligned} SHV &= A_0 - L_0 + DPO - K \\ &= y \cdot [p - \mu(1-dr)] - \tau K. \end{aligned} \tag{2}$$

In accordance with Cummins and Danzon (1997), Yow and Sherris (2008), and Schlütter (2011), we consider the default ratio as the quality measure for insurer default risk and

[12]Throughout the paper, we assume that the stochasticity of A_1/A_0 and L_1/L_0 is exogenous and not subject to the insurer's decision making.

assume insurance demand to be a two-parametric function $y(dr,p)$. The stand-alone insurer's optimisation problem is completely defined by

$$(P_1)\begin{cases} SHV = y(dr,p)\cdot[p-\mu(1-dr)] - \tau K \to \max\limits_{K,p} \\ dr = \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1 - A_1, 0\}\right]/L_0 \\ A_0 = (1-\tau)K + y(dr,p)p \\ L_0 = y(dr,p)\mu \end{cases}$$

3.2 Optimal solution

Solution of the SHV-maximisation problem (P_1) can be presented analytically. To this end, we utilise the equation for initial assets, $A_0 = (1-\tau)K + yp = sy\mu$, where $s = A_0/L_0$ is the initial asset-liability ratio. Furthermore, we assume that there is a bijective relation between the default ratio dr and the asset-liability ratio s. Such a relation exists, e.g., if asset and liability risks are normally or lognormally distributed,[13] or if liabilities follow a geometric Brownian motion and a jump diffusion process.[14] We denote the relation between s and dr by $s = s(dr, \Sigma)$, where Σ is the set of parameters of the asset and liability risk distributions. For a given default ratio dr, the optimal equity-premium combination is given by:[15]

$$\begin{aligned} K^*(dr) &= y\cdot\left[\mu\cdot s(dr,\Sigma) - \mu\cdot(1-dr) - \frac{1}{1-\tau}\cdot\frac{y}{-y_p}\right], \\ p^*(dr) &= \mu\cdot(1-dr) + \tau\cdot\frac{K^*(dr)}{y} + \frac{1}{1-\tau}\frac{y}{-y_p}. \end{aligned} \tag{3}$$

Equation 3 shows that the optimal premium has three components: (1) the time 0 value of the payoff to policyholders, (2) a premium loading for the frictional costs of equity, and (3) a profit loading. Inserting $p^*(dr)$ into Equation 2 shows that $\frac{SHV}{y} = \frac{1}{1-\tau}\frac{y}{-y_p}$. Hence, the profit loading on the premium, as well as the shareholder value, will converge to zero if demand becomes perfectly price elastic. To this point, we have assumed a fixed default ratio, which is realistic if the insurer faces regulatory solvency requirements and has no

[13] Cf. Myers and Read (2001, p. 576-578).
[14] Cf. Cummins (1988, p. 831); Gatzert and Schmeiser (2008, p. 54).
[15] Cf. Schlütter (2011, p. 9).

incentive to hold additional capital. According to empirical studies,[16] insurers typically achieve optimal safety levels determined by insurance buyer preferences. In our model, the optimality condition for dr is given by:[17]

$$\mu - \tau \cdot \mu \cdot \left(1 + \frac{\partial s}{\partial dr}\right) = \frac{y_{dr}}{y_p} \tag{4}$$

The left-hand side of Equation 4 reflects that shareholders derive two benefits from a marginal increase of the default ratio achieved by holding less equity: greater limited liability protection and lower frictional costs of equity. The right-hand side of the equation represents the corresponding costs: fewer insurance contracts will be purchased and the insurer therefore collects less profit loadings. In total, the insurer will hold sufficient capital to ensure a low default ratio if insurance demand reacts strongly to default risk and weakly to price and frictional costs are low.

3.3 Numerical example

Throughout the article, we use a numerical example to illustrate our results. We assume that the insurer's assets and liabilities evolve according to the stochastic processes under the risk-neutral measure $\mathbb{Q}$:

$$\begin{aligned} \mathrm{d}A_t &= rA_t\mathrm{d}t + \sigma_A A_t \mathrm{d}W^{\mathbb{Q}}_{A,t}, \\ \mathrm{d}L_t &= rL_t\mathrm{d}t + \sigma_L L_t \mathrm{d}W^{\mathbb{Q}}_{L,t}, \\ \mathrm{d}W^{\mathbb{Q}}_A \mathrm{d}W^{\mathbb{Q}}_L &= \rho \mathrm{d}t, \end{aligned}$$

with σ_A and σ_L the volatilities of the asset and liability processes, and $W^{\mathbb{Q}}_A, W^{\mathbb{Q}}_L$ geometric Brownian motions under $\mathbb{Q}$, correlated by ρ. To make a realistic assumption about the insurance demand curve, we use the two-parametric demand function experimentally observed by Zimmer et al. (2011). In this experiment, participants were asked about

[16] Cf. Cummins and Danzon (1997); Phillips et al. (1998).
[17] Cf. Schlütter (2011, p. 12).

their willingness to pay for insurance contracts having different levels of default risk. The best fit for the data obtained from the experiment is a demand function of the type

$$y(p, dr) = n \cdot exp\left(-f_p \cdot p - f_d \cdot dr\right), \tag{5}$$

Furthermore, we set the risk parameters to $\mu = 200, \sigma_A = 5\%, \sigma_L = 20\%, \rho_{AL} = 0\%$, which is consistent with the market-based calibrated model of Yow and Sherris (2008). Corresponding to Zanjani (2002, p. 298), we assume for the frictional cost parameter $\tau = 5\%$. For convenience, we assume $r = 0\%$. The price sensitivity parameter $f_p = 7.2\%$ corresponds to the results by Yow and Sherris (2008, p. 318).[18] As shown by Equation 4, the optimal default ratio is determined by the ratio $\frac{y_{dr}}{y_p}$. In the experiment by Zimmer et al. (2011, p. 16), where participants had perfect information about insurer safety levels, this ratio was estimated to be about $\frac{y_{dr}}{y_p} = \frac{f_d}{f_p} \approx 920$, which implies $f_d = 7.2\% \cdot 920 = 66.24$. Since this parameter is crucial for our analysis, but is infeasible to estimate empirically, we consider a second scenario with $\frac{y_{dr}}{y_p} = 460$, reflecting a market in which there is less information available about insurer default risk. Table 1 contains the results. According

Table 1: Optimal strategies in the stand-alone case.

Default sensitivity	Low	High
y_{dr}/y_p	460	920
dr^*	0.47%	0.16%
$\mu \cdot (1 - dr)$	199.07	199.67
$\tau \cdot K^*/y$	3.46	4.71
SHV^*/y	14.62	14.62
p^*	217.15	219.00
y^*	13.90	12.73
SHV^*	203.15	186.11

to Equation 4, the default ratio is lower if default sensitivity of demand is high (see line 1 in Table 1). The three insurance premium components are illustrated in lines 2 to 4 of the table. The lower default ratio in the right column implies a higher value of payoffs to policyholders ($\mu \cdot (1 - dr)$) and more frictional costs of equity endowment per insurance contract ($\tau \cdot K^*/y$). Therefore, the premium increases in the default sensitivity of demand (line 5). As shown in line 6, insurance demand is lower if consumers are more sensitive to

[18] Under the optimal strategy, the price elasticity of demand equals $\epsilon = -y_p/\frac{y}{p} = 15.6$, which is similar to the results in Yow and Sherris (2008, p. 318).

insurer default risk, and since shareholders' profits per contract are independent of y_{dr}, SHV is also lower for $y_{dr}/y_p = 920$.

4 Insurance group

We next investigate the optimal risk management strategy of an insurance group. For convenience, we consider a group consisting of a holding company and two direct 100% subsidiaries, a and b. The subsidiaries are insurers with distinct groups of policyholders. The insurance premium at subsidiary $i \in \{a, b\}$ is denoted by $p^{(i)}$ and the default ratio by $dr^{(i)}$. As the policyholders are contracting with the subsidiary (and not the group), insurance demand depends on the subsidiary's safety level, and is modelled by $y^{(i)}(dr^{(i)}, p^{(i)})$. In the following, we initially define intra-group capital transfers and analyse their influence on the subsidiary default risk. We then investigate how the group optimises its capital allocation and insurance pricing policy.

4.1 Intra-group risk transfer

Based on Filipović and Kupper (2008), we model intra-group risk diversification by capital-and-risk transfers that may take place at time 1. Furthermore, we assume that the group can fully exploit risk diversification between the subsidiaries:[19] if subsidiary a does not have sufficient assets at time 1 ($A_1^a < L_1^a$), available assets from subsidiary b will be transferred to a. Formally, the capital transfer from b to a can be denoted by

$$Z_1^{b \to a} = \min\{\max\{L_1^a - A_1^a; 0\}; \max\{A_1^b - L_1^b; 0\}\}.$$

In turn, the capital transfer from a to b is given by

$$Z_1^{a \to b} = \min\{\max\{L_1^b - A_1^b; 0\}; \max\{A_1^a - L_1^a; 0\}\}.$$

By construction, these capital transfers can preserve policyholder claims against the struggling subsidiary, but they cannot jeopardise the payment of claims by the supporting

[19]Cf. Gatzert and Schmeiser (2011).

subsidiary. To explain how the capital transfers affect the subsidiaries' default ratios, we temporarily assume that $y^{(a)}$, $y^{(b)}$, $p^{(a)}$, $p^{(b)}$, $K^{(a)}$ and $K^{(b)}$ are fixed. Including the intra-group capital transfers, the default ratio of subsidiary a is given by

$$\begin{aligned}
dr^{a,group} &= \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^a + Z_1^{a\to b} - A_1^a - Z_1^{b\to a}, 0\}\right]/L_0^a \\
&= \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^a - A_1^a - Z_1^{b\to a}, 0\}\right]/L_0^a \\
&= \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^a - A_1^a, Z_1^{b\to a}\}\right]/L_0^a - Z_0^{b\to a}/L_0^a \\
&\leq \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^a - A_1^a, 0\}\right]/L_0^a - Z_0^{b\to a}/L_0^a \\
&= dr^{a,stand-alone} - Z_0^{b\to a}/L_0^a, \qquad (6)
\end{aligned}$$

with $Z_0^{b\to a} = \exp(-r)\mathbb{E}_{\mathbb{Q}}\left[Z_1^{b\to a}\right] \geq 0$. The last equation illustrates the diversification effect in this context. If, in the future, a becomes insolvent, and b has available assets, the capital transfer $Z^{b\to a}$ has a positive time 0 value and intra-group capital transfers reduce the default ratio of subsidiary a. Vice versa, the same applies for the default ratio of subsidiary b. Hence, if capital transfers can take place in either direction at time 1, they lead to lower default ratios for both subsidiaries.

4.2 Adjustment of the risk management strategy

How does the group adjust its pricing and capital structure in the presence of the diversification effect outlined by Equation 6? To answer this question, we now formulate the group's optimisation problem. Similar to Equation 1, we can present the group's SHV as

$$SHV^{group} = \sum_{i\in\{a,b\}} \left\{ y^{(i)}\left(dr^{(i)}, p^{(i)}\right) \cdot \left[p^{(i)} - \mu^{(i)}\left(1 - dr^{(i)}\right)\right] - \tau K^{(i)} \right\}, \qquad (7)$$

where we denote the term in the curly brackets as the SHV of subsidiary i (SHV_i). The group's optimisation problem is as follows:

$$(P_2)\begin{cases}\sum_{i\in\{a,b\}} y^{(i)}\left(dr^{(i)},p^{(i)}\right)\cdot\left[p^{(i)}-\mu^{(i)}\left(1-dr^{(i)}\right)\right]-\tau K^{(i)}\to \max\limits_{K^{(a)},K^{(b)},p^{(a)},p^{(b)}}\\ dr^{(a)}=\exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^{(a)}-A_1^{(a)}-Z_1^{b\to a},0\}\right]/L_0^{(a)}\\ dr^{(b)}=\exp(-r)\mathbb{E}_{\mathbb{Q}}\left[\max\{L_1^{(b)}-A_1^{(b)}-Z_1^{a\to b},0\}\right]/L_0^{(b)}\\ A_0^{(i)}=(1-\tau)K^{(i)}+y^{(i)}\left(dr^{(i)},p^{(i)}\right)p^{(i)}, i=a,b\\ L_0^{(i)}=y^{(i)}\left(dr^{(i)},p^{(i)}\right)\cdot\mu^{(i)}, i=a,b\end{cases}$$

As the subsidies are legal entities, each with its own balance sheet, the group needs to decide how to allocate its capital at time 0. In the formulation of (P_2), this is done by choosing separate equity levels $K^{(a)}$ and $K^{(b)}$ at time 0. Compared to capital allocation within an insurance company,[20] which involves the problem of arbitrary choice of an allocation principle,[21] capital allocation at the group level has "physical" consequences for the subsidies' balance sheets and is uniquely defined under the given objective function. An essential difference between this case and that of the stand-alone insurer is that the capital transfers $Z_1^{a\to b}$ and $Z_1^{b\to a}$ act as risk management instruments additional to raising capital.

An important aspect of this framework is that the capital transfers are contractually fixed at time 0, which could be achieved, e.g., via intra-group reinsurance contracts, guarantees, or profit and loss transfer agreements. Information intermediaries take the capital transfers into account when informing consumers about insurer default risk. Therefore, the capital transfers will influence insurance demand. Furthermore, a change in the premium or equity level at subsidiary (a) will also affect the safety level, and thus insurance demand, at subsidiary (b). This in turn influences the premium volume at subsidiary (b) and also the capital transfer that flows from (b) to (a). These circular relationships do not abolish the definition of problem (P_2), but they do not permit solving the problem analytically, as could be done for the stand-alone insurer. We therefore derive solutions to the problem (P_2) by numerical optimisation.

[20]Cf. Myers and Read (2001); Ibragimov et al. (2010).
[21]Cf. Gründl and Schmeiser (2007).

4.3 Numerical example

The subsequent numerical examples are based on the examples in Section 3.3. Except for the default sensitivity y_{dr}, the parameters for the subsidiaries are identical to those of the stand-alone insurer in Section 3.3. For y_{dr}, we consider three scenarios, which are presented in Table 2. Random variables are modelled by a Monte-Carlo simulation with 5,000,000 runs.

Table 2: Scenarios for composition of the insurance group.

Scenario	Default sensitivity of demand (y_{dr}/y_p)		Subsidiary
	Subsidiary a	Subsidiary b	parameterisation
I	Low (460)	Low (460)	symmetric
II	High (920)	High (920)	symmetric
III	Low (460)	High (920)	asymmetric

Table 3 contains the optimal strategies in Scenario I. As the subsidiaries are symmetrically parameterised, we find that the group allocates its capital evenly to the subsidiaries and chooses identical safety levels and prices for both subsidiaries. Due to intra-group risk diversification, the optimal default ratio decreases from 0.47% in the stand-alone case to 0.30% in the group case. Furthermore, the group has to hold less equity per insurance contract, and thus saves on frictional costs. While the profit loading on the premium is not affected by the group building and remains at 14.62, the group transmits its saved frictional costs to policyholders via a lower insurance premium. Together with the higher safety level, this induces a higher sales volume and implies that SHV increases from 406.30 (both stand-alone insurers in sum) to 461.14 for the group.

Table 4 provides the corresponding results for Scenario II. Again, the group achieves higher safety levels for its subsidiaries than the stand-alone insurers. Interestingly, intra-group risk diversification has stronger effects on the required equity than in Scenario I, as frictional costs of equity per insurance contract decrease by 1.77 in Scenario II (Scenario I: -1.31). Due to the higher safety levels in Scenario II, it is more probable that a subsidiary can be bailed out with the group's remaining capital, and therefore intra-group diversification is more effective. This implies that group building has stronger effects on the premium reduction, the increase in sales volume, and also the increase in SHV in Scenario II.

Table 5 presents the results for Scenario III with asymmetric parameterisations for the subsidiaries. It is notable that the group optimally allocates all its equity to subsidiary b, where insurance demand is more default sensitive (see line $\tau \cdot K^*/y$). Subsidiary a does not hold any equity at all and its safety level is only ensured by means of the time-1-capital transfers from the other subsidiary. Nevertheless, both subsidiaries achieve higher safety levels than the stand-alone insurers. The higher frictional costs of equity at subsidiary b do not fully increase the insurance premium at this subsidiary, but are compensated by a reduction of the profit loading (see line SHV/y). In turn, the group increases the profit loading at subsidiary a and thereby finances the frictional costs of equity at the other subsidiary, which enables future capital transfers from subsidiary b to a. Therefore, both the group's subsidiaries can attract more customers than in the stand-alone case and group building increases the SHV by $60.55 + 4.64 = 65.19$.

Table 3: Optimal strategies in the group case (Scenario I). Values are identical for subsidiaires a and b.

	stand-alone	group	Δ
dr^*	0.47%	0.30%	(−0.17%)
$\mu \cdot (1 - dr)$	199.07	199.41	(+0.34)
$\tau \cdot K^*/y$	3.46	2.15	(−1.31)
SHV^*/y	14.62	14.62	(±0.00)
p^*	217.15	216.18	(−0.97)
y^{*1}	27.79	31.53	(+3.74)
SHV^{*1}	406.30	461.14	(+54.84)

[1] Lines y^* and SHV^* contain the values for both insurance firms (group case: both subsidiaries) in sum.

Table 4: Optimal strategies in the group case (Scenario II). Values are identical for subsidiaires a and b.

	stand-alone	group	Δ
dr^*	0.16%	0.10%	(−0.06%)
$\mu \cdot (1 - dr)$	199.67	199.80	(+0.12)
$\tau \cdot K^*/y$	4.71	2.95	(−1.77)
SHV^*/y	14.62	14.62	(±0.00)
p^*	219.00	217.36	(−1.64)
y^{*1}	25.46	29.85	(+4.39)
SHV^{*1}	372.22	436.54	(+65.32)

[1] Lines y^* and SHV^* contain the values for both insurance firms (group case: both subsidiaries) in sum.

Table 5: Optimal strategies in the group case (Scenario III).

	Subsidiary a ($y_{dr}/y_p = 460$)			Subsidiary b ($y_{dr}/y_p = 920$)		
	stand-alone	group	Δ	stand-alone	group	Δ
dr^*	0.47%	0.35%	(−0.11%)	0.16%	0.07%	(−0.10%)
$\mu \cdot (1 - dr)$	199.07	199.29	(+0.22)	199.67	199.87	(+0.20)
$\tau \cdot K^*/y$	3.46	0.00	(−3.46)	4.71	5.06	(+0.35)
SHV^*/y	14.62	16.03	(+1.41)	14.62	12.93	(−1.69)
p^*	217.15	215.32	(−1.83)	219.00	217.86	(−1.15)
y^*	13.90	16.45	(+2.56)	12.73	14.75	(+2.02)
SHV^*	203.15	263.70	(+60.55)	186.11	190.75	(+4.64)

5 Welfare analysis

The previous analyses have shown that intra-group risk diversification can be beneficial for shareholders as well as for policyholders. Compared to the stand-alone case, the group's value-maximizing strategy implies a higher safety level and lower prices. This combination attracts more customers and thus increases shareholder value. However, empirical research indicates that mergers of financial firms frequently destroy shareholder value, often termed the "conglomerate discount".[22] In theory, it is agency conflict between shareholders and managers that explains the conglomerate discount.[23] Since groups are more complex and opaque than smaller entities, shareholders could have reduced capacity for avoiding inefficient overinvestments or cross-subsidisation. We incorporate this aspect by letting the carrying charge τ differ between the stand-alone case $\tau^{st.a}$ and the group case τ^{gr}. All other parameters are taken from above (Scenario I). In addition to the results in Tables 3 and 4, we measure policyholder value by the consumer surplus, which is defined by $CS(dr,p) = \int_p^\infty y(dr,\bar{p})d\bar{p} \overset{\text{Eq.5}}{=} \frac{y(dr,p)}{f_p}$.[24]

Table 6 presents the optimal strategies when τ changes after group building from 5% to 8%, 9%, or 10%. The results show that both the optimal default ratio and the insurance premium increase with a higher carrying charge τ^{gr}, and hence the number of concluded contracts decreases. In all three cases, $\tau^{gr} = 8\%$, 9%, or 10%, the default ratio is even higher than in the stand-alone case. For $\tau^{gr} = 10\%$, the insurance premium is also higher

[22]Cf. Berger and Ofek (1995); Laeven and Levine (2007); Schmid and Walter (2009).
[23]Cf. Aron (1988); Stulz (1990); Rotemberg and Saloner (1994).
[24]Cf. Stoyanova et al. (2011).

than in the stand-alone case. Group building is beneficial for shareholders if $\tau^{gr} \leq 9\%$, and destroys SHV for $\tau^{gr} \geq 10\%$. Policyholders are better off with the group if $\tau^{gr} \leq 8\%$, and worse off if $\tau^{gr} \geq 9\%$.

From a regulatory perspective, the case of $\tau^{gr} = 9\%$ is the most relevant one, because in this case shareholders would favor group building, even though it destroys consumer surplus. The reasoning behind this result is that the insurer reacts to the higher carrying charge τ by demanding a higher profit loading on the premium ($\frac{SHV}{y}$), which helps economise on costly equity. Together with $\frac{SHV}{CS} = f_p \cdot \frac{SHV}{y}$,[25] this implies that the increase of τ^{gr} destroys more consumer surplus than shareholder value.

Table 6: Optimal strategies in the group case with change in the carrying charge τ (Scenario I).

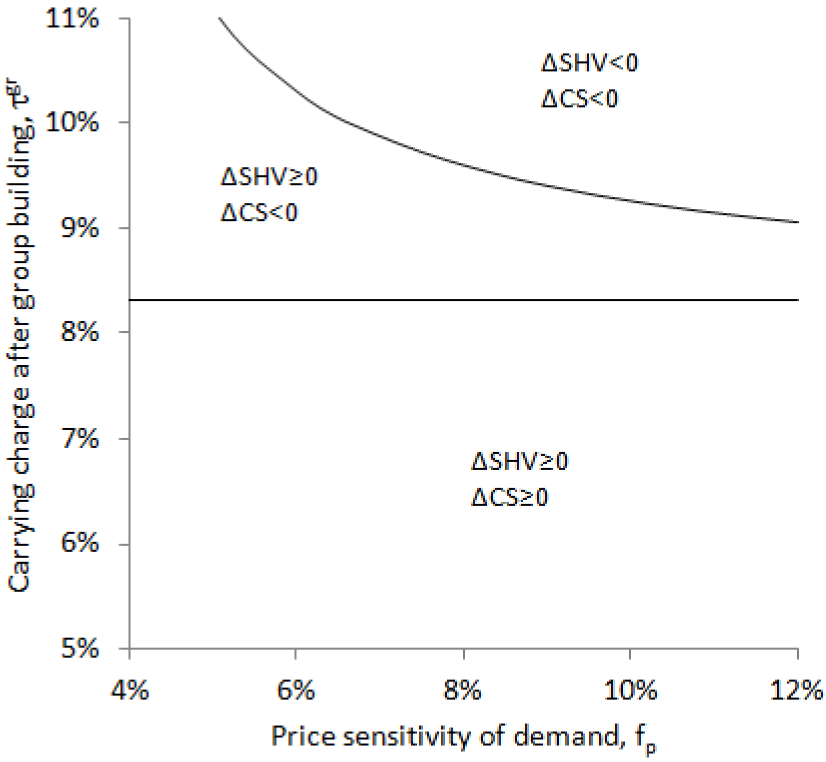
Organisation	stand-alone[1] $\tau^{st.a} = 5\%$	group $\tau^{gr} = 5\%$	group $\tau^{gr} = 8\%$	group $\tau^{gr} = 9\%$	group $\tau^{gr} = 10\%$
dr^*	0.47%	0.30%	0.48%	0.54%	0.61%
$\mu \cdot (1 - dr)$	199.07	199.41	199.04	198.91	198.79
$\tau \cdot K^*/y$	3.46	2.15	2.80	2.96	3.10
SHV^*/y	14.62	14.62	15.09	15.27	15.44
p^*	217.15	216.18	216.93	217.14	217.33
y^*	27.79	31.53	28.09	27.09	26.19
SHV^*	406.30	461.14	424.17	413.95	404.54
		(+54.84)	(+17.87)	(+7.65)	(−1.76)
CS^*	192.99	218.95	195.08	188.15	181.86
		(+51.91)	(+4.17)	(−9.68)	(−22.27)

[1] The lines SHV^* and CS^* present the values of both stand-alone insurers in sum.

In the following, we generalise the results from Table 6 by considering different sets of parameters. Figure 1 depicts the combinations of the group's carrying charge τ^{gr} and the price sensitivity of demand f_p in which group building is beneficial or detrimental for shareholders or policyholders, respectively. According to Scenario I, we fix the ratio $\frac{y_{dr}}{y_p} = 460$. The figure shows that the interval of τ^{gr}, in which shareholders benefit from group building, but policyholders do not, becomes larger the smaller the price sensitivity of demand. If demand reacts weakly to price, the insurer finds it easier to substitute for costly equity by charging higher premiums and thus avoiding the frictional costs of equity. In turn, if the price sensitivity of demand becomes high, insurers cannot demand

[25]This results from $SHV = y \cdot \frac{SHV}{y}$ and $CS = y \cdot \frac{1}{f_p}$.

Figure 1: Areas in which group building is beneficial/detrimental for shareholders or policyholders (Scenario I).



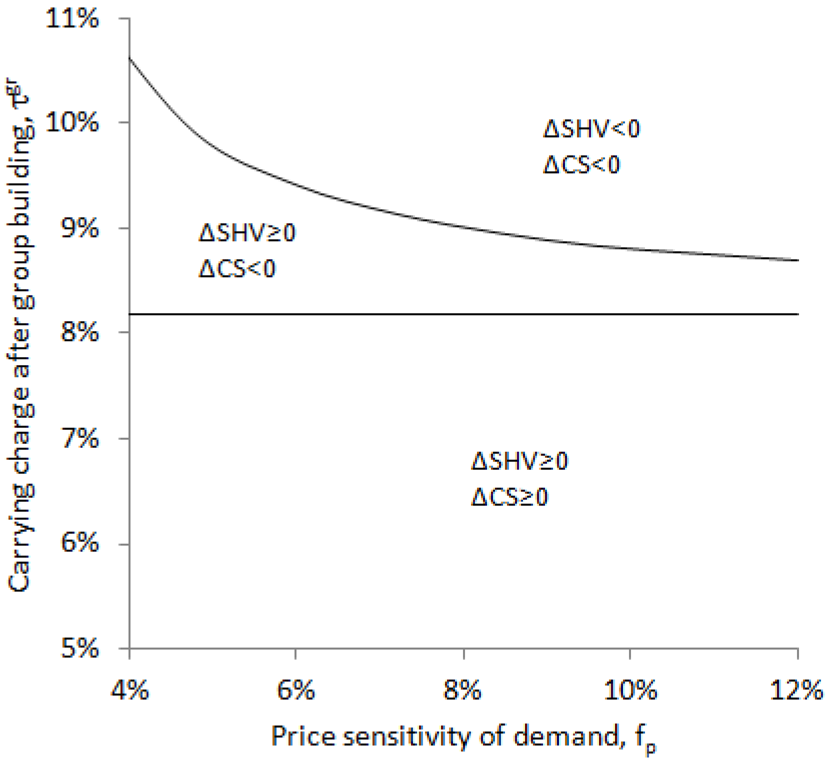
an essential profit margin on the premium and have less latitude in replacing equity with premiums. Figure 2 transfers the results to Scenario II. We see that the "problematic" area in which only shareholders benefit from group building is smaller than in Figure 1. Due to the higher default sensitivity of demand, the group cannot adjust the subsidiaries' default ratios as much as in Scenario I.[26]

6 Discussion

With regard to shareholders' benefits from insurance group building, both the theoretical and the empirical literature provide heterogeneous results. On the one hand, risk diversification between the group's entities can reduce the sum of the group's required capital.[27] Assuming that holding capital is costly, this would imply that group building benefits

[26] Adjustment of the default ratio in scenario I is documented in line dr^* of Table 6.
[27] Cf. Filipović and Kupper (2008).

Figure 2: Areas in which group building is beneficial/detrimental for shareholders or policyholders (Scenario II).



shareholders.[28] On the other hand, there are several theoretical arguments that group building is disadvantageous for shareholders. The disadvantages result from a reduction in the group's cash flow volatility which reduces the value of shareholder claims,[29] and from additional agency costs due to the higher complexity of groups.[30]

This article combines the two lines of reasoning by balancing the diversification benefits against the higher dead-weight costs of holding equity capital. We are able to identify scenarios in which group building is beneficial or detrimental to both shareholders and policyholders, and in which shareholders are better off while policyholders suffer from group building. The results are driven by different carrying charges for holding equity, and price and default sensitivities of the insurance demand.

Our results are important for insurance supervision. Up to now, there is little literature on measuring welfare effects from group building on policyholders.[31] Based on the ex-

[28] Cf. Smith and Stulz (1985); Froot (2007).
[29] Cf. Mansi and Reeb (2002).
[30] Cf. Aron (1988); Stulz (1990); Rotemberg and Saloner (1994).
[31] Cf. Freixas et al. (2007); Gatzert and Schmeiser (2011).

isting literature, it is not clear whether policyholders could lose value by consolidation, whether shareholders could provoke such situations based on their own incentives, and thus, whether supervisory authorities should be concerned about group building activities from a consumer protection perspective. By identifying situations in which shareholders will approve group building, even though it has negative consequences for policyholders, this paper might help insurance supervisors to better foresee the consequences of insurance group building.

To compare the optimal risk management strategies of stand-alone insurers and groups, the paper uses a simplified model set-up which could be extended in several directions. An important issue for future research would be to incorporate a higher number of subsidiaries. By doing so, the question arises how intra-group capital transfers at time 1 should be arranged, and the approach by Filipović and Kupper (2008) could be useful in finding a solution. Since capital transfers help the group to attract a larger number of customers and save frictional costs of equity, we expect that it would be optimal for the group to arrange transfers which use all available assets to bail out struggling subsidiaries. The definition of an optimal net of capital transfers could therefore be simplified to finding an optimal ranking order in which subsidiaries are supported if more than one should get into financial distress. Besides, large groups face a more complex problem of allocating their equity at time 0 to the subsidiaries. Insurance risk managers' lack of ability (or willingness) to attain an optimal intra-group capital allocation is another explanation for increasing agency costs in large insurance groups.

In a multi-period context, it is not clear whether the group will actually use all its existing assets for bail-outs, or will prefer to continue the business with the financially sound subsidiaries. Here, contagion and reputation risk should be taken into account when optimizing the capital transfer arrangements. In an empirical analysis, Zanjani (2009) finds that non-core affiliates of insurance groups have a lower insolvency risk than those affiliates with strong ties to the group flagship. The finding suggests that reputation and regulatory pressure provide groups with strong incentives to bail out subsidiaries, even if no explicit commitment exists. Severe threats to affiliate solvency can occur if the group as a whole gets into financial trouble.

Finally, our paper stresses that more research should be undertaken to identify the shape and the parameter size of the price-default-demand function. We have shown that shareholders' incentives for insurance group building as well as the likelihood that shareholders will advocate a merger which is destructive to consumer welfare strongly depend on the sensitivities of insurance demand. To forecast the welfare of insurance groups, it is therefore necessary to have knowledge of the shape and parameterisation of insurance demand functions in different insurance branches.

7 Conclusion

This paper analyses insurance groups' optimal equity capital levels and insurance premiums and compares them to those optimal for stand-alone insurers. We first demonstrate the stand-alone insurers' optimal solutions based on an analytical formula. We then generalise the model with regard to a simplified insurance group. We show that the group engages in intra-group risk diversification by adjusting its safety levels and insurance prices. As long as group building does not affect the carrying charge for holding equity, it is beneficial for consumers as well as for shareholders.

However, if the group's diversity and complexity increases the dead-weight cost of equity capital, insurer default risk and premiums both could be higher for the group than for the stand-alone insurer. We show that an increase in dead-weight costs has even more severe consequences for consumer surplus than for shareholder value. Hence, situations can occur in which shareholders would support group building even though doing so will be detrimental for consumers. This stresses the importance of insurance group supervision acting on behalf of consumer protection.

The paper can also be seen as a contribution to the literature on capital allocation in insurance companies. In previous articles, certain capital allocation methods are investigated to what extent they meet certain axiomatic requirements.[32] In our approach, we endogenise capital allocation by determining the optimal equity capital at the sub-

[32]Cf. Denault (2001); Myers and Read (2001).

sidiary level by shareholder-value-maximisation and thus finding an economic foundation for group-wide capital allocation.

The paper also provides a basis for further empirical work. If it is possible to attribute certain parameter settings, such as price and default sensitivities, to certain insurance lines of business, we would have a theoretical basis for hypothesizing on possible benefits and drawbacks of insurance group building. To this end, the numerical analyses in this paper provide first insights on the interdependence between insurance demand functions, frictional costs of capital and group building welfare effects.

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