ON THE RISK SITUATION OF FINANCIAL CONGLOMERATES: DOES DIVERSIFICATION MATTER?

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Abstract

In general, conglomeration leads to a diversification of risks (the diversification benefit) and to a decrease in shareholder value (the conglomerate discount). Diversification benefits in financial conglomerates are typically derived without explicitly accounting for reduced shareholder value. However, a comprehensive analysis requires competitive conditions within the conglomerate, i.e., shareholders and debtholders should receive risk-adequate returns on their investment. In this paper, we extend the literature by comparing the diversification effect in conglomerates with and without accounting for the altered shareholder value. We derive results for a holding company, a parent-subsidiary structure, and an integrated model. In addition, we consider different types of capital and risk transfer instruments in the parent-subsidiary model, including intra-group retrocession and guarantees. We conclude that under competitive conditions, diversification does not matter to the extent frequently emphasized in the literature. The analysis aims to contribute to the ongoing discussion on group solvency regulation and enterprise risk management.

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1. INTRODUCTION

In an environment of increasingly frequent consolidation activity, the advantages and risks of corporate diversification are of great interest to regulatory authorities and financial group management.[1] In general, conglomeration leads to a diversification of risks (the diversification benefit) but, at the same time, to a decrease in shareholder value (the conglomerate discount). These two effects have not been analyzed simultaneously in the literature to date. Diversification benefits are typically calculated without accounting for the reduction in shareholder value, even though a comprehensive analysis requires a competitive situation in financial conglomerates (i.e., shareholders and debtholders receive risk-adequate returns on their investments). In this paper, we extend earlier contributions and compare diversification benefits and insolvency risks in groups with and without accounting for the reduced shareholder value. To attain a more profound understanding of the effects of diversification, we derive results for a holding company, a parent-subsidiary structure, and an integrated model. In addition, we consider different types of capital and risk transfer instruments (CRTIs)—which are legally enforceable agreements between two entities of the group—in the parent-subsidiary model, including intra-group retrocession and guarantees.

The extent of diversification effects and conglomerate discount depends on the specific organizational form and is contingent upon capital and risk transfer instruments. Different legal

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[1] In this paper, we use the terms "financial group" and "financial conglomerate" interchangeably. A definition of financial conglomerates is given in Diereck (2004, p. 10): "In the most general sense, a financial conglomerate is a group of entities whose primary business is financial and whose regulated entities engage to a significant extent in at least two of the activities of banking, insurance and securities. According to this definition, bancassurance groups would qualify as financial conglomerate, but so would groups combining insurance and securities or banking and securities."

structures of conglomerates, relevant risks, and benefits are discussed in Diereck (2004). The holding company model is representative of the stand-alone case, as the entities fail independently and, therefore, no portfolio effects arise if no transfer of assets takes place. Integrated financial conglomerates have a single, consolidated balance sheet and must satisfy a single solvency capital requirement. Therefore, they benefit fully from diversification effects, but also face risk concentration (see Allen and Jagtiani, 2000; Mälkönen, 2004; Gatzert et al., 2008). In a parent-subsidiary structure, single entities can generally default without causing others to do the same. However, the subsidiary's market value is an asset for the parent. In this setting, two concepts can be distinguished with respect to the diversification of risks. First, group-level diversification arises if risks of different legal entities in a group are not fully correlated. Second, down-streaming of diversification occurs if CRTIs are in place.

The diversification benefit is typically measured based on the conglomerate's economic capital relative to the sum of stand-alone economic capital. In the context of regulation, Keller (2007) and Luder (2007) discuss the group-level Swiss Solvency Test and how CRTIs are accounted for when measuring the solvency capital requirements of insurance groups in a parent-subsidiary structure. In a similar setting, Filipovic and Kupper (2007a, 2007b) derive optimal CRTIs that minimize the difference between available and required capital in an insurance group for convex risk measures, and thus focus on the group perspective. Freixas et al. (2007) compare the risk-taking incentives of stand-alone firms, holding company conglomerates, and integrated conglomerates, and show that diversification within integrated models can increase risk-taking incentives and thus lower social welfare relative to the stand-alone case. Loranth and Morrison (2007) examine the effect of the liability structure of a multinational bank, showing that diversification is unattractive with fixed bank capital requirements. Kahn and Winton (2004) derive an optimal subsidiary structure for financial institutions given moral hazard between group and subsidiary management. Devos et al. (2008) empirically estimate average synergy gains of mergers to 10.03% of the combined equity, which is decomposed into operating and financial synergies. The authors find that mergers mainly generate value by improving resource allocation rather than by reduced tax payments or increasing market power.

In respect to the conglomerate discount, Berger and Ofek (1995) empirically show for the U.S. market that there was a reduction in firm value of between 13% and 15% between 1986 and 1991, which they attribute, in part, to overestimation and cross-subsidization. For financial firms, Laeven and Levine (2005) also observe a conglomerate discount and stress agency problems as a possible cause. In agency theory, conglomerate discount on firm value has been explained by asymmetric information distribution, which implies that managers do not necessarily behave in the best interests of their equityholders, but instead act to increase their personal wealth (see Amihud and Lev, 1981; Jensen, 1986; Jensen and Murphy, 1990). Based on financial theory, Ammann and Verhofen (2006) explain and quantify the conglomerate discount using Merton's structural model and attribute the discount to the equityholders' limited liability.

Thus, the cited literature either quantifies the conglomerate discount or measures diversification benefits with respect to solvency capital but does not combine the two concepts. Furthermore, for the most part, parent-subsidiary models and the effect of CRTIs are not considered. When comparing diversification effects and insolvency risk within different conglomerate structures, the corresponding fair capital structure differs. In particular, we expect stakeholders to adjust their capital structure in order to achieve risk-adequate returns whenever the group structure changes. This is an important aspect that has not received any attention in the literature to date, even though it has major implications for group management decisions and solvency regulation. Our aim is to fill this gap and provide a better understanding of a financial conglomerate's risk situation by conducting an analysis that looks at conglomerate discount and diversification effects simultaneously.

To achieve this aim, we first provide a model framework for the different financial group structures and then proceed as follows: For two entities, we first keep the capital structure fixed and study diversification and insolvency risk, thereby comparing results for different organizational forms (parent-subsidiary model, holding company, and integrated conglomerate). Furthermore, we account for CRTIs and include a guarantee from parent to subsidiary and quota share retrocession, i.e., the parent pays a share of the subsidiary's liabilities. Second, we adjust the equity capital for each type of conglomerate and then conduct the same analysis. This ensures a competitive situation for each type of conglomerate, i.e., the value of the equityholders' payoff equals their initial contribution. Thus, we account for the conglomerate discount, which varies depending on the type of financial conglomerate, and tends toward zero with increasing dependence between the two firms. We further illustrate our theoretically derived results using numerical examples based on Monte Carlo simulation. The conglomerate discount is quantified employing an option-based approach; diversification benefit is calculated using the tail value at risk.

In this analysis, we consider the perspective of the group—i.e., diversification benefit and joint default probabilities—as well as the viewpoint of the individual institutions—i.e., solvency capital and individual shortfall risk—to provide a detailed picture of the altered group situation. We conclude that for the considered conglomerate structures, diversification regarding risk reduction does not matter to the extent frequently emphasized in the literature when diversification effects are studied under competitive conditions. Our analysis aims to contribute to the ongoing discussion on group solvency regulation (Swiss Solvency Test, Solvency II) and enterprise risk management.

The remainder of the paper is organized as follows. Section 2 introduces the model of the stand-alone institutions and the corresponding fair valuation, solvency capital, and shortfall-risk calculations. Different corporate structures of financial conglomerates and capital and risk transfer instruments are discussed in Section 3. Section 4 analyzes the measurement of diversification benefits and conglomerate discount in the considered group structures. To illustrate our theoretical results, a simulation analysis on diversification benefits with and without accounting for the conglomerate discount is conducted in Section 5. Section 6 summarizes the results.

2. MODELING STAND-ALONE INSTITUTIONS

We consider a firm with a market value of liabilities L_t and a market value of assets A_t with $t = 0$, 1. In this one-period setting, debtholders and equityholders make initial payments of D_0 and E_0, respectively. The sum of the initial contributions $A_0 = D_0 + E_0$ is invested in the capital market. At time $t = 1$, debtholders receive the value of the liabilities, and equityholders receive the remainder of the market value of the assets. If the company is not able to cover the liabilities, the total value of the assets is distributed to the debtholders and the equityholders receive nothing. The debtholders' payoff D_1 is thus expressed by

$$D_1 = L_1 - \max\left(L_1 - A_1, 0\right),$$

where the second term represents the payoff of the default put option (*DPO*) (see Doherty and Garven (1986)). The payoff to the equityholders E_1 is accordingly given by the remainder,

$$E_1 = A_1 - D_1 = \max\left(A_1 - L_1, 0\right).$$

To model the development of assets and liabilities, we use a geometric Brownian motion. Under the real-world measure $\mathbb{P}$, the stochastic processes are described by

$$dA(t) = \mu_A A(t)\,dt + \sigma_A A(t)\,dW_A^{\mathbb{P}}(t),$$

$$dL(t) = \mu_L L(t)\,dt + \sigma_L L(t)\,dW_L^{\mathbb{P}}(t),$$

with μ and σ denoting the drift and volatility (assumed to be constant over time) of the stochastic processes. $W_A^{\mathbb{P}}$ and $W_L^{\mathbb{P}}$ are standard $\mathbb{P}$-Brownian motions with a correlation of coefficient ρ, i.e., $dW_A dW_L = \rho(A,L)\,dt$. Given values for A_0 and L_0, the solutions of the stochastic differential equations above are given by (see, e.g., Björk, 2004)

$$A(t) = A_0 \cdot \exp\left(\left(\mu_A - \sigma_A^2/2\right)t + \sigma_A W_A^{\mathbb{P}}(t)\right),$$

$$L(t) = L_0 \cdot \exp\left(\left(\mu_L - \sigma_L^2/2\right)t + \sigma_L W_L^{\mathbb{P}}(t)\right).$$

Changing the real-world measure $\mathbb{P}$ to the equivalent risk-neutral martingale measure $\mathbb{Q}$ leads to the constant riskless rate of return r as the drift of the processes.

Risk-neutral valuation

Valuation of the claims is conducted using risk-neutral valuation (also referred to as "fair valuation"). From the debtholders' perspective, a fair price for their claims (subject to default risk) satisfies the following condition (see, e.g., Doherty and Garven, 1986):

$$D_0 = E^{\mathbb{Q}}\left(\exp(-r)\cdot L_1\right) - E^{\mathbb{Q}}\left(\exp(-r)\cdot \max\left(L_1 - A_1, 0\right)\right) = L_0 - \Pi_0^{DPO}. \tag{1}$$

Hence, the initial payment by the debtholders' must equal the nominal value of liabilities less the value of the *DPO* at $t = 0$. Given a fixed safety level measured with the *DPO*-value Π_0^{DPO} and the value for the nominal liabilities L_0, the contribution of the debtholders D_0 is fixed. Due to no arbitrage, Equation (1) also implies

$$E_0 = E^{\mathbb{Q}}\left(\exp(-r)\cdot E_1\right) = E^{\mathbb{Q}}\left(\exp(-r)\cdot \max\left(A_1 - L_1, 0\right)\right).$$

Thus, the payment by the equityholders equals the value of their payoff at time $t = 1$.

Solvency capital

Based on a given capital structure (E_0, D_0), available and necessary economic capital can be derived. In banking and insurance regulation (see, e.g., Basel II, Solvency II, Swiss Solvency Test), the firm's available economic capital is often named risk-bearing or risk-based capital (*RBC*) which is defined as the market value of assets less the market value of liabilities at time *t* (see, e.g., Keller, 2007):

$$RBC_t = A_t - L_t.$$

The solvency (or target) capital (SC) required is the amount of capital needed at $t = 0$ to meet future obligations over a fixed time horizon for a required confidence level α. In general, regulators require that the firm's solvency capital will not exceed the risk-bearing capital in $t = 0$:

$$RBC_0 \geq SC .$$

The amount of necessary economic capital depends on the risk measure chosen. In the following, we use the tail value at risk (*TVa*R) for a given confidence level *α*, which is more restrictive than the value at risk.[2] Hence, *SC* can be derived by

$$SC = TVaR_\alpha = -E^{\mathbb{P}}\left(\exp(-r)\cdot RBC_1 \middle| \exp(-r)\cdot RBC_1 \leq VaR_\alpha\right) + RBC_0 \qquad (2)$$

where VaR_α is the value at risk for a confidence level α given by the quantile of the distribution $F^{-1}(\alpha) = \inf\{x : F(x) \geq \alpha\}$.[3] Thus, in order to satisfy the regulatory requirement $RBC_0 \geq SC$, one can check whether

$$E^{\mathbb{P}}\left(\exp(-r)\cdot RBC_1 \middle| \exp(-r)\cdot RBC_1 \leq VaR_\alpha\right) \geq 0 .$$

2 The *TVaR* is implemented in insurance regulation in Switzerland, while the value at risk is the required risk measure in the European banking regulation (Basel II) and also planned for Solvency II. For a discussion of value at risk and tail value at risk, see, e.g., Chen and Lin (2006, p. 381 ff).

3 Equation (2) is equivalent to

$$SC = TVaR_\alpha = -E^{\mathbb{P}}\left(\exp(-r)\, RBC_1 - RBC_0 \middle| \exp(-r)\, RBC_1 - RBC_0 \leq VaR_\alpha\right),$$

which corresponds to the change in *RBC* within one year, where RBC_1 is discounted with the riskless interest rate *r*.

The amount of solvency capital further depends on the input parameters and the underlying stochastic model.

Shortfall risk

In addition to the capital requirements, a legal entity's shortfall probabilities are calculated by

$$SP = \mathbb{P}\left(RBC_1 < 0\right) = \mathbb{P}\left(A_1 < L_1\right).$$

Shortfall is thus defined by the event that the available economic capital falls below zero, i.e., the firm is insolvent.

3. Corporate Structures of Financial Conglomerates

The previous section set out fair valuation and solvency capital calculations for stand-alone firms. These calculations can be substantially different for financial conglomerates where the type of conglomerate structure plays an important role in risk and capital requirements. A detailed discussion covering conglomeration and regulatory issues involved in the supervision of financial conglomerates in the European Union is given in Diereck (2004). In the following, we present three different types of conglomerates that differ with respect to ownership, including the holding company model, the parent-subsidiary model, and the integrated model. The financial conglomerate we consider consists of two legal entities, (P) and (S).

Holding company

In the holding company model, an umbrella corporation owns the two entities. Operationally, the firms are separate and also must be separately capitalized as they have no access to each others' cash flows. In an umbrella corporation certain tasks, such as risk management, capital raising and allocation, or IT are typically centralized (Diereck, 2004). Thus, in essence, the holding company model is similar to the case of two stand-alone firms since the holding company does not benefit from portfolio effects. In the following numerical analysis, we compare the uncorrelated case to the case where there exists a highly positive correlation coefficient regarding the cash-flows of the two legal entities, which may be due to a high degree of centralization in the group.

Parent-subsidiary model

In the parent-subsidiary model, the parent owns the subsidiary but the two companies remain legally and operationally separate. As in the holding company model, the firms are separately capitalized, and the parent company is not obliged to cover the subsidiary's liabilities in the absence of legally binding capital and risk transfer instruments (CRTIs). On the other hand, the parent has direct access to the subsidiary's profits. Thus, the market value of the subsidiary is an asset to the parent. In the analysis, we assume that the subsidiary will continue in business after $t = 1$. Thus, the firm must meet at least certain minimum capital requirements (MCR^S), and the available capital at $t = 1$ must be $\min\left(A_1^S - L_1^S, MCR^S\right)$. Therefore, the subsidiary's market value ($A_1^S - L_1^S$) will not be fully extracted and the transferable value to the parent is given by

$$\max\left(A_1^S - L_1^S - MCR^S, 0\right).$$

It is assumed that the parent can sell the subsidiary for this value. The limitation of the market value to *MCR* can be considered as regulatory costs (see, e.g., Filipovic and Kupper, 2007b).

In the parent-subsidiary model, we further integrate capital and risk transfer instruments (CRTIs). CRTIs are legally enforceable contractual capital and risk transfer instruments (e.g., FOPI, 2006, p. 4), such as dividends, reinsurance agreements, intra-group retrocession, securitization of future cash flows, guarantees, and other contingent capital solutions. However, a parent can offer guarantees only when its financial situation is appropriate to ensure the guarantees. These instruments serve to reduce the subsidiary's solvency capital requirements. When the financial situation is good, capital transfers may also include transfers that are not legally binding. In a situation of financial distress, only legal, contractual agreements can be enforced. The economic (available, risk-bearing) capital of a parent company is thus also affected by the liabilities of the subsidiary when CRTIs are in place.

In this analysis, we consider two types of CRTIs: a guarantee from parent to subsidiary and a quota share retrocession. Under the guarantee, the parent company covers the shortfall $DPO^S = \max\left(L_1^S - A_1^S, 0\right)$ of the subsidiary in $t = 1$, but only to the extent that its own available capital at time $t = 1$ is at least above the minimum capital necessary for it to continue its own business, i.e., $\min\left(A_1^P - L_1^P, MCR^P\right)$. Therefore, the transfer T to the subsidiary is limited to $\max\left(A_1^P - L_1^P - MCR^P, 0\right)$. Hence, if the parent offers the subsidiary a guarantee, liability T^G with

$$T^G = \min\left(DPO^S, \max\left(A_1^P - L_1^P - MCR^P, 0\right)\right)$$

is down-streamed as equity to the subsidiary. The other CRTI under consideration is quota share retrocession, where the parent promises to pay a share β of the subsidiary's liabilities:[4]

$$T^R = \min\left(\beta \cdot L_1^S, \max\left(A_1^P - L_1^P - MCR^P, 0\right)\right).$$

[4] This instrument has also been considered by Filipovic and Kupper (2007b) in the context of insurance groups.

Integrated model

An integrated conglomerate has one consolidated balance sheet and capital is in principle fully fungible between the different entities. In this model, the conglomerate benefits from diversification, since losses from failing projects can be offset by returns from successful projects. This situation can lead to increased risk-taking behavior by the entities, i.e., moral hazard due to a "too-big-to-fail" attitude (see, e.g., Diereck, 2004). In the European Union, e.g., insurance companies and banks are prohibited from forming this type of conglomerate.

4. DIVERSIFICATION BENEFIT AND CONGLOMERATE DISCOUNT

On a stand-alone basis, both legal entities in the financial conglomerate, (P) and (S), can be treated as described in Section 2. However, if the two firms form a financial conglomerate, these calculations will generally be different due to the ownership relations as shown in the previous section. Thus, following the general discussion, the three types of group structure will be individually analyzed and described with respect to diversification effects and conglomerate discount.

4.1 Diversification benefits in financial conglomerates

We measure diversification effects in a financial group in two ways. First, we compare the shortfall risk of firms on the group level. From the group's perspective, the joint default probabilities of exactly one (P_1) or both entities (P_2) are given by

$$P_1 = \mathbb{P}\left(RBC_1^S < 0,\, RBC_1^P > 0\right) + \mathbb{P}\left(RBC_1^S > 0,\, RBC_1^P < 0\right),$$

$$P_2 = \mathbb{P}\left(RBC_1^S < 0, RBC_1^P < 0\right).$$

Second, the diversification effect in a financial conglomerate is also typically measured based on solvency capital requirements (see, e.g., Filipovic and Kupper, 2007a). The relative diversification benefit is given by the sum of capital requirements when taking into account the conglomerate structure, divided by the sum of stand-alone (solo) capital requirements:

$$d^{group} = 1 - \frac{SC^{P,group} + SC^{S,group}}{SC^{P,solo} + SC^{S,solo}} .$$

The less solvency capital the group is required to hold, the higher is the coefficient d, and thus the higher is the degree of diversification for the conglomerate. Since the holding company model corresponds to the stand-alone case, no diversification benefits can occur as we do not include a transfer of assets between different legal entities in the model. In general, asset transfers may likely take place for reputational reasons, for instance. However, in our analysis, we only consider legally binding capital and risk transfers between legal entities to calculate diversification benefit and conglomerate discount. In the presence of further asset transfers, these effects will be enhanced.

In a parent-subsidiary structure, two types of diversification can be distinguished: First, group-level diversification arises if the cash-flows of legal entities in the conglomerate are not fully correlated. In particular, non-perfectly correlated assets and liabilities of parent and subsidiary are beneficial for the parent company in terms of risk reduction, while the subsidiary neither profits nor suffers disadvantages from the ownership relation. Second, downstreaming of diversification occurs when legally binding transfer of losses contracts are in place, which are beneficial for the subsidiary. If no CRTIs are implemented, no contagion effects can occur, and only group-level diversification can arise. In what follows, we compare these two cases.

In a fair situation, the subsidiary's debtholders pay a fair premium for the guarantee, which is transferred to the parent company. The guarantee leads to an increase in available economic capital at t =1 for the subsidiary, and to a decrease in same for the parent. It is assumed that the subsidiary's available economic capital at t = 0 remains unchanged (and hence equals the solo case), and so the solvency capital requirements remain the same. At time t = 1, the available capital is lowered by the parent's participation and increased by the CRTI transfer (denoted by T) from the parent to the subsidiary. Thus, one obtains

$$RBC_0^S = A_0^S - L_0^S, \; RBC_1^S = \min\left(A_1^S - L_1^S, MCR^S\right) + T \, .$$

Analogously, the risk-bearing capital of the parent company at t = 0 and t = 1 is given by

$$RBC_0^P = A_0^P - L_0^P, \; RBC_1^P = A_1^P - L_1^P + \max\left(A_1^S - L_1^S - MCR^S, 0\right) - T \, .$$

The formulas for the risk-bearing capital show that the CRTI payment will only take place if the parent's financial situation allows for it, i.e., after all own debt is paid off. This means that the parent's shortfall risk will not be negatively affected and remains unchanged. Thus, the parent's debtholders will not be worse off if CRTIs are in place. On the other hand, the subsidiary's debtholders will benefit from CRTIs due to a reduction in shortfall risk and reduced solvency capital requirements. In addition, double gearing of capital is avoided since the value of the subsidiary is split into two parts:

$$A_1^S - L_1^S = \max\left(A_1^S - L_1^S - MCR^S, 0\right) + \min\left(A_1^S - L_1^S, MCR^S\right).$$

In the integrated model, risk-bearing capital is determined by the difference between the sum of assets and the sum of liabilities of the group's entities,

$$RBC_0^{\text{int}} = A_0^P + A_0^S - L_0^S - L_0^P,$$

$$RBC_1^{\text{int}} = A_1^P + A_1^S - L_1^S - L_1^P,$$

where full fungibility of capital is assumed. Joint shortfall is not defined in the sense described before, but coincides with the individual shortfall probabilities:

$$SP = P_2 = \mathbb{P}\left(RBC_1^{int} < 0\right).$$

In this setting, diversification benefits originate as assets and liabilities are not fully correlated. Table 1 summarizes the risk-bearing capital at time 1 for the different conglomerate structures that will be used in the following numerical examples.

Table 1: Risk-bearing capital at $t = 0$ and $t = 1$ for different conglomerate structures

	$t = 0$		$t = 1$	
	RBC_0^P	RBC_0^S	RBC_1^P	RBC_1^S
Holding	$= A_0^P - L_0^P$	$= A_0^S - L_0^S$	$= A_1^P - L_1^P$	$= A_1^S - L_1^S$
Parent-subsidiary	$= A_0^P - L_0^P$	$= A_0^S - L_0^S$	$= A_1^P - L_1^P$ $+ \max\left(A_1^S - L_1^S - MCR^S, 0\right)$	$= \min\left(A_1^S - L_1^S, MCR^S\right)$
Parent-subsidiary with guarantee	$= A_0^P - L_0^P$	$= A_0^S - L_0^S$	$= A_1^P - L_1^P$ $+ \max\left(A_1^S - L_1^S - MCR^S, 0\right)$ $-T^G$	$= \min\left(A_1^S - L_1^S, MCR^S\right)$ $+T^G$
Parent-subsidiary with retrocession	$= A_0^P - L_0^P$	$= A_0^S - L_0^S$	$= A_1^P - L_1^P$ $+ \max\left(A_1^S - L_1^S - MCR^S, 0\right)$ $-T^R$	$= \min\left(A_1^S - L_1^S, MCR^S\right)$ $+T^R$
Integrated conglo-merate	$= A_0^P + A_0^S$ $-L_0^S - L_0^P$	—	$= A_1^P + A_1^S - L_1^S - L_1^P$	—

4.2 Measuring the conglomerate discount

The conglomerate discount is identified by determining the fair capital structure after group building using risk-neutral valuation and by comparing this value to the stand-alone case. In particular, a diversification of risks will imply a reduction in shareholder value ("conglomerate discount"). Hence, by deriving the fair capital structure in a financial group, we are able to explicitly quantify the conglomerate discount. For the case of a holding company model, conglomerate discount does not occur as there is no diversification of risks due to no asset transfers.

In the parent-subsidiary model one needs to distinguish between fair valuation (leading to a fair capital structure that accounts for the conglomerate discount) and solvency assessment (actual shortfall risk, solvency capital). In the fair valuation process, we assume that the subsidiary separately pays a fair price for any CRTIs and thus they are not part of the fair initial equity that ensures the preset safety level without the CRTI. Furthermore, the ownership relation (the parent can sell the subsidiary for its market value) does not influence the situation for the subsidiary's debtholders. Hence, the debtholders require the same amount of equity capital in the company as would be the case without CRTI structure. Therefore, the subsidiary's initial situation in the CRTI model is identical to the stand-alone case and no conglomerate discount is present in the case of downstreaming diversification.

This is different for the parent company, as its debtholders profit from the possibility of selling the subsidiary at its market value due to the reduction in the *DPO* payoff to

$$DPO_1^P = \max\left(L_1^P - A_1^P - \max\left(A_1^S - L_1^S - MCR^S, 0\right), 0\right), \tag{3}$$

and thus the debtholders' payoff at $t = 1$ is

$$D_1^P = L_1^P - DPO_1^P.$$

Given the same safety level *DPO* and same nominal value of liabilities (such that parent's debtholders pay the same amount with and without participation), initial equity capital can in general be reduced. This reveals the existence of a conglomerate discount for the parent, which originates from the ownership relation. To find the new fair initial equity E_0^P, Equation (1) can be solved for E_0^P, which also satisfies the following equation:

$$E_0^P = \Pi_0^S = E^{\mathbb{Q}}\left(\exp(-r) \cdot E_1^P\right) = E^{\mathbb{Q}}\left(e^{-r} \cdot \max\left(A_1^P - L_1^P + \max\left(A_1^S - L_1^S - MCR^S, 0\right), 0\right)\right).$$

Hence, the conglomerate discount effect generally implies a reduction in the value of the equityholders' payoff through the participation in the subsidiary.

The conglomerate discount is also distinct in the case of an integrated conglomerate. To keep the different conglomerate structures comparable, we let the debtholders of the conglomerate pay the same initial amount as in the stand-alone case. One fair equity-premium combination is then derived by adjusting the equity capital of the subsidiary E_0^S only, leaving everything else as in the stand-alone case:

$$D_0^P + D_0^S = L_0^P + L_0^S - E^{\mathbb{Q}}\left(\exp(-r) \cdot \max\left(L_1^P + L_1^P - A_1^P - A_1^S, 0\right)\right).$$

Since the debtholders pay the same amount and have the same claims cost distribution in $t = 1$ (and the same nominal value of liabilities $L_0^{P,S}$), to ensure a fair situation, the *DPO* value in the integrated conglomerate must equal the sum of stand-alone *DPO* values:

$$\Pi_0^{DPO,\text{int}} = E^{\mathbb{Q}}\left(e^{-r}\max\left(L_1^P + L_1^S - A_1^P - A_1^S, 0\right)\right) = \Pi_0^{DPO,S} + \Pi_0^{DPO,P}.$$

Furthermore, the fact that

$$\max\left(L_1^P + L_1^S - A_1^P - A_1^S, 0\right) \le \max\left(L_1^P - A_1^P, 0\right) + \max\left(L_1^S - A_1^S, 0\right)$$

implies that, in general, less equity capital is necessary to meet the safety level $\Pi_0^{DPO,\text{int}}$.[5] Therefore, the fair capital structure will as well imply a reduction in shareholder value. Since shareholders require risk-adequate returns on their investment, equity capital will be reduced in a financial group (without considering other effects). This conglomerate discount will be higher with decreasing correlation coefficient between the companies' cash flows.

As a consequence, the conglomerate discount has a substantial effect on the diversification benefits, since the reduction in equity capital ceteris paribus implies a reduced diversification effect regarding shortfall probability and solvency capital. This is evident in the calculation of the solvency capital in Equation (2), where a reduction in equity capital leads to an increase in solvency capital requirements. Similar results hold for the calculation of shortfall risk. For firms that face a choice on whether to merge or which type of ownership relation to take, it is vital to account for the conglomerate discount upfront before estimating future diversification benefits.

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[5] Ammann and Verhofen (2006) take a similar approach in the integrated case and attribute the conglomerate discount to the limited liability of equityholders. They conduct an analysis of the conglomerate discount under different distributional assumptions and different numbers of business lines in the case of an integrated conglomerate.

5. NUMERICAL ANALYSIS

In this section, we illustrate the general derived results from the previous sections on diversification benefits and conglomerate discount using numerical examples. Thus, the holding company is compared to the parent-subsidiary model without CRTIs and the integrated model. In addition, we conduct a deeper analysis of the impact of introducing CRTIs into the parent-subsidiary model, i.e., guarantees and retrocession. The holding company model essentially corresponds to the stand-alone case of the two firms.

Input parameters

As input parameters we set the confidence level for the *TVaR* to α = 1% (as required, e.g., by the Swiss Solvency Test). We consider two firms, (P) and (S), that have the same safety level, are the same size, and have the same asset and liability structure. The *DPO* value of both firms is fixed at $\Pi_0^{DPO} = 0.1$ and the nominal value of liabilities is given by $L_0^S = L_0^P = 100$. Therefore, according to the fairness condition in Equation (1), the debtholders' contribution for both firms is given by

$$D_0 = L_0 - \Pi_0^{DPO} = 100 - 0.1 = 99.9\,.$$

Drift and standard deviation of the assets and liabilities of (P) and (S) are set to $\mu_A = 0.09$, $\sigma_A = 0.10$ (for the assets) and $\mu_L = 0.01, \sigma_L = 0.10$ (for the liabilities). The coefficient of correlation between assets and liabilities of subsidiary and parent company are $\rho\left(A^P, L^P\right) = \rho\left(A^S, L^S\right) = 0.2$ and $\rho\left(A^P, L^S\right) = \rho\left(A^S, L^P\right) = 0$. The correlation between the assets of (P) and (S), as well as the correlation between their liabilities, are fixed at the same value $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$ for sensitivity analyses. In the analysis, we compare results for $\rho = 0$ and $\rho = 0.7$. The riskless rate of return is given by $r = 3.5\%$, and the share of the subsidiary's liabilities ceded to the parent company in the quota share retrocession is $\beta = 5\%$. The analysis is conducted using Monte-Carlo simulation with 1,000,000 simulation runs on the basis of the same set of random numbers (see Glasserman, 2004).[6]

In a first step, diversification and joint shortfall risk are measured without accounting for the conglomerate discount, i.e., given a fixed capital structure. In a second step, we do account for the conglomerate discount by calibrating the initial equity capital so that both equityholders and debtholders receive a net present value of zero (fair condition for both stakeholders). Based on the adjusted values, diversification benefits are compared for the different conglomerate structures. First, we take the individual-firm perspective and assess the solvency situation for each entity (P) and (S). Second, the group-management perspective is taken by calculating the diversification benefit for the whole group, as well as joint shortfall probabilities of the entities.

5.1 Measuring diversification benefits without accounting for the conglomerate discount

For the given initial payment of the debtholders ($D_0 = 99.9$) of firms (P) and (S) and with the same input parameters, the fair initial equity E_0 is 30.1 for both entities.

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[6] Some of the calculations have also been conducted by using closed-form solutions. Formulas for options on two stochastic underlyings can be derived similarly to exchange options, as presented in Margrabe (1978) and Fischer (1978).

Individual-company perspective

Based on the given capital structure ($D_0 = 99.9$, $E_0 = 30.1$), solvency capital and shortfall probabilities are derived for the individual firms that are included in the different conglomerate structures. Results are displayed in Table 2. Since equity capital is fixed in all cases, the situation is only fair in the solo case and thus in the holding case (see Equation (1)), and not for the other conglomerate structures. The left (right) columns in Table 2 show outcomes for $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right) = 0\,(0.7)$.

Table 2: The individual-firm perspective for a fixed capital structure, $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$

Panel A: Solvency capital	$\rho = 0$		$\rho = 0.7$	
	Parent (P)	*Subsidiary (S)*	*Parent (P)*	*Subsidiary (S)*
Holding	29.5	29.5	29.5	29.5
Parent-subsidiary	14.9	29.5	29.0	29.5
Parent-subsidiary with guarantee	15.1	28.0	29.0	29.4
Parent-subsidiary with retrocession	17.0	24.1	29.0	28.9
Integrated conglomerate	36.3		56.5	

Panel B: Shortfall probability SP	$\rho = 0$		$\rho = 0.7$	
	Parent (P)	*Subsidiary (S)*	*Parent (P)*	*Subsidiary (S)*
Holding	0.34%	0.34%	0.34%	0.34%
Parent-subsidiary	0.02%	0.34%	0.32%	0.34%
Parent-subsidiary with guarantee	0.02%	0.02%	0.32%	0.32%
Parent-subsidiary with retrocession	0.02%	0.10%	0.32%	0.32%
Integrated conglomerate	0.01%		0.25%	

We first focus on the case where $\rho = 0$ (left column in Table 2), i.e., the cash flows of both companies are uncorrelated. In the holding company case, the solvency capital requirements (Panel A) are the same for both firms (P) and (S) due to the same input parameters. In the parent-subsidiary group, the parent's capital requirements are substantially reduced to 14.9 compared to the holding company case of 29.5, while the subsidiary's *SC* remains stable. This illustrates the group diversification effect, which arises because assets and liabilities of parent and subsidiary are not fully correlated. The introduction of a guarantee or quota share retrocession leads to a slight increase in the parent's *SC* to 15.1 and 17.0, respectively, and to a decrease in the subsidiary's *SC* to 28.0 and 24.1 (from 29.5). Here, the subsidiary benefits from down-streaming diversification. In the integrated model, only one result is shown as the two firms are fully merged into a single entity. Thus, the solvency capital can be shown only for the conglomerate as a whole.

The Panel B of Table 2 shows the shortfall probability *SP* for the two firms. It can be observed that in a parent-subsidiary model without CRTIs, the parent's shortfall probability is reduced to near zero. The subsidiary's *SP*, on the other hand, is unaffected by the ownership relation since surplus transfers to the parent occur only in states of solvency. The implementation of guarantees or retrocession, however, leads to a considerable reduction in the subsidiary's shortfall probability from 0.34% to 0.02% and 0.10%. The extent of the reduction depends on the type of risk transfer. In this case, the parent's shortfall probability does not change, since it only makes the CRTI payment when it is financially able to do so. Thus, the parent's debtholders are not in a worse position when CRTIs are in place, whereas the subsidiary's debtholders benefit. The integrated model has a shortfall probability close to zero.

An increase in the correlation coefficient to $\rho = 0.7$ (right column in Table 2) greatly reduces diversification effects compared to the case without correlation. Hence, a low correlation between the cash flows of the entities is crucial in order to benefit from conglomeration in terms of increased solvency.

Group perspective

In a second step, we take the group-management perspective and derive relative diversification benefit and joint default probabilities (see Table 3).

Table 3: The group perspective for fixed capital structure in Table 2, $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$

	Relative diversification benefit		*Joint default probability (exactly one entity)* P_1		*Joint default probability (exactly two entities)* P_2	
	$\rho = 0$	$\rho = 0.7$	$\rho = 0$	$\rho = 0.7$	$\rho = 0$	$\rho = 0.7$
Holding	0%	0%	0.68%	0.38%	0.00%	0.15%
Parent-subsidiary	24.58%	0.80%	0.36%	0.36%	0.00%	0.15%
Parent-subsidiary with guarantee	26.68%	0.90%	0.04%	0.34%	0.00%	0.15%
Parent-subsidiary with retrocession	30.07%	1.64%	0.12%	0.34%	0.00%	0.15%
Integrated conglomerate	38.32%	4.23%			0.01%	0.25%

The relative diversification benefit in the left column of Table 3 illustrates that in our example, the level of group diversification increases with increasing capital linkage between the entities in the conglomerate. Parent-subsidiary models can raise the diversification benefit by implementing CRTIs. The integrated model exhibits the highest diversification benefit with 38.32%. This result, however, depends on the choice of input parameters. Further analyses revealed that, e.g., a change in the volatility of the subsidiary's liabilities to $\sigma_L^S = 0.2$ and an overall decrease in the safety level to $\Pi^{DPO} = 0.3$ can lead to a higher diversification coefficient for the parent-subsidiary model (without CRTIs) than for the integrated model.

In any case, the relative diversification level is substantially reduced for highly correlated assets and liabilities of the two entities ($\rho = 0.7$). Furthermore, for zero correlation, the probability that both entities default at the same time (P_2) is near zero for all conglomerate structures. At the same time, the probability that exactly one of the two firms defaults is lowest for the parent-subsidiary model with guarantee ($P_1 = 0.04\%$). The picture changes tremendously for a correlation coefficient of 0.7. Here, the joint shortfall probabilities are very similar for all models, except the integrated one. In that model, one needs to consider that $SP = P_2 = \mathbb{P}\left(RBC_1^{Int} < 0\right)$, i.e., the joint shortfall probability corresponds to the individual one, and hence P_1 is not defined.

5.2 Measuring diversification benefits by accounting for the conglomerate discount

Despite the fact that the analysis in the previous subsection allowed a high degree of comparability because of the fixed capital structure and fixed input parameters, the given capital structure is in general no longer fair (in the sense of Equation (1)) when a financial conglomerate is formed due to the conglomerate discount. In particular, the value of the equityholders' payoff is less than their initial contribution. To obtain a fair situation for all conglomerate structures, we calibrate the fair initial payment of the equityholders so that it is equal to the value of their payoff, leaving everything else constant. The fair equity capital values are summarized in Table 4 for $\rho = 0$ (left column) and $\rho = 0.7$ (right column).

Table 4: Measuring the conglomerate discount: fair capital structure for different types of financial conglomerates (fair equity capital), $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$

	$\rho = 0$		$\rho = 0.7$	
	Parent (P)	*Subsidiary (S)*	*Parent (P)*	*Subsidiary (S)*
Holding	30.1	30.1	30.1	30.1
Parent-subsidiary	19.5	30.1	30.1	30.1
Parent-subsidiary with guarantee	19.5	30.1	30.1	30.1
Parent-subsidiary with retrocession	19.5	30.1	30.1	30.1
Integrated conglomerate	30.1	8.0	30.1	27.5

As described in the model section of this paper, for $\rho = 0$ the value of the equityholders' payoff in the parent-subsidiary model is reduced one third to 19.5 by the diversification effect due to participation in the subsidiary. Implementation of guarantee and retrocession does not influence the fair capital structure as they are settled separately. In particular, accounting for the conglomerate discount by using the fair equity capital in Table 4 ensures the fixed safety level $\Pi_0^{DPO} = 0.1$ for a given payment of $D_0 = 99.9$ by the firms' debtholders. Capital and risk transfer instruments further increase the safety level. In the case of the integrated conglomerate model, the amount of equity capital from (S) can be substantially reduced compared to that required in the parent-subsidiary model. For a correlation coefficient of $\rho = 0.7$, the conglomerate discount on equity capital almost vanishes as diversification effects tend toward zero. In the case of the integrated model, however, there is a small reduction in equity capital.

Individual-company perspective

Based on the fair equity capital values for the different conglomerate structures in Table 4, we next calculate the corresponding solvency capital requirements and shortfall probability for the individual companies in Table 5, thus explicitly considering the conglomerate discount. The results are then compared to the results of the previous subsection where the conglomerate discount was not taken into consideration, i.e., the capital structure remained unchanged (Tables 2 and 3).

Table 5: Individual-firm perspective for fair capital structure in Table 4 (accounting for the conglomerate discount), $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$

Panel A: Solvency capital	$\rho = 0$		$\rho = 0.7$	
	Parent (P)	*Subsidiary (S)*	*Parent (P)*	*Subsidiary (S)*
Holding	29.5	29.5	29.5	29.5
Parent-subsidiary	24.6	29.5	29.1	29.5
Parent-subsidiary with guarantee	24.6	28.2	29.1	29.4
Parent-subsidiary with retrocession	23.5	25.0	29.1	28.9
Integrated conglomerate	34.8		56.2	

Panel B: Shortfall probability SP	$\rho = 0$		$\rho = 0.7$	
	Parent (P)	*Subsidiary (S)*	*Parent (P)*	*Subsidiary (S)*
Holding	0.34%	0.34%	0.34%	0.34%
Parent-subsidiary	0.16%	0.34%	0.32%	0.34%
Parent-subsidiary with guarantee	0.16%	0.07%	0.32%	0.32%
Parent-subsidiary with retrocession	0.16%	0.13%	0.32%	0.32%
Integrated conglomerate	0.01%		0.25%	

Since the fair equity capital is nearly unchanged for $\rho = 0.7$ compared to the solo case, the results based on fair capital structure do not differ much from the results based on the fixed capital structure in Table 2. We thus focus on $\rho = 0$ (left columns in Tables 2 and 5) and find that the group diversification effects for the parent company are substantially reduced when accounting for the conglomerate discount. The reduction in solvency capital, for instance, is much less distinct in the parent-subsidiary model (with and without guarantees or retrocession): The solvency capital in Table 5 decreases from 29.5 to 24.6 instead of being reduced from 29.5 to 14.9 as is the case when the capital structure is not adjusted accordingly (see Table 2). Similarly, the shortfall probabilities *SP* are much higher in the parent-subsidiary models—especially for the parent company (0.16% instead of 0.02%). In contrast, the integrated model continues to have a very low shortfall risk, similar to the case of fixed capital structure.

Group perspective

From the group-management perspective (Table 6), the differences between fair and fixed capital structure are best visible when considering the relative diversification benefit in Tables 3 and 6. In the parent-subsidiary construct, the benefit is reduced from 24.58% to 8.10%; when including a quota share retrocession, benefit decreases from 30.07% to 17.56%. This is caused by two effects: (1) the available capital of both companies is reduced because of the adjustment of equity capital, and (2) the much higher solvency capital requirements intensify the effect. The probability that exactly one of the two entities in the parent-subsidiary model defaults increases as well, as indicated by the results for the individual shortfall risk.

Table 6: Group perspective for fair capital structure in Table 4 (accounting for the conglomerate discount), $\rho = \rho\left(A^P, A^S\right) = \rho\left(L^P, L^S\right)$

	Relative diversification benefit		*Joint default probability (exactly one entity)* P_1		*Joint default probability (exactly two entities)* P_2	
	$\rho = 0$	$\rho = 0.7$	$\rho = 0$	$\rho = 0.7$	$\rho = 0$	$\rho = 0.7$
Holding	0%	0%	0%	0%	0.00%	0.15%
Parent-subsidiary	8.10%	0.67%	0.68%	0.38%	0.01%	0.16%
Parent-subsidiary with guarantee	10.21%	0.77%	0.48%	0.36%	0.01%	0.16%
Parent-subsidiary with retrocession	17.56%	1.51%	0.21%	0.34%	0.01%	0.16%
Integrated conglomerate	40.85%	4.70%	0.27%	0.34%	0.01%	0.25%

In contrast to the lower diversification benefit in the parent-subsidiary model, the integrated model shows a 2.5 percentage points higher benefit for $\rho = 0$ given the fair capital structure, even though the available capital is reduced by adjusting E_0^S.

6. SUMMARY

This paper aims to contribute to the literature by providing a new perspective on the risk situation of financial conglomerates. This is done by analyzing diversification effects in a competitive setting, i.e., by accounting for the conglomerate discount in a holding company, a parent-subsidiary group, and an integrated model. In addition, we consider capital and risk transfer instruments in the parent-subsidiary group. For both group and individual company management, our model allows studying the impact of diversification on the risk and return situation of financial conglomerates and increases transparency in enterprise risk management processes. The results further contribute to the current discussion on group solvency capital requirements in the insurance and banking industry.

In a first step, we show that the choice of a conglomerate structure has a substantial influence on solvency capital requirements. In general, the group solvency capital requirements decrease substantially with the level of integration. However, this effect is alleviated when the entities' cash flows are highly correlated. Capital and risk transfer instruments lead to an increase in solvency capital requirements for the parent and to a decrease in those applicable to the subsidiary. From a regulatory perspective, it is thus important to consider the specific characteristics of the conglomerate when calculating capital requirements, including the degree of participation of each entity as well as capital and risk transfers between the entities.

In a second step, a meaningful comparison of diversification and insolvency risk requires an adjustment of the initial equity and debt capital, in other words, a competitive situation. Aside from the solvency situation, the returns to a conglomerate's stakeholders also depend on the type of conglomerate. In particular, diversification reduces shareholder value, which requires a decrease in the initial equity capital (conglomerate discount).

We further study shortfall probabilities for the conglomerate and its legal entities. In the parent-subsidiary model, the parent's shortfall probabilities are considerably reduced compared to the solo case, whereas the subsidiary's shortfall risk remains unchanged. Capital and risk transfer instruments from parent to subsidiary do not affect the parent's insolvency risk, but reduce the subsidiary's shortfall risk. Thus, policyholders of both companies profit from this ownership structure in terms of reduced insolvency risk. However, diversification benefits are much lower when the conglomerate discount effect is taken into consideration and, hence, the stakeholders receive risk-adequate returns for their initial contributions. In this respect, our results relativize previous contributions on diversification benefits in financial conglomerates.

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