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Risk Measurement, Risk Management and Capital Adequacy in Financial Conglomerates

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Risk Measurement, Risk Management and Capital Adequacy in Financial Conglomerates[1]

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Abstract: Is there something special, with respect to risk and capital, about a financial conglomerate that combines banking, insurance and potentially other financial and non-financial activities? To what degree is the risk of the whole less than the sum of its parts? This paper seeks to address these questions by evaluating the risk profile of a typical banking-insurance conglomerate, highlighting the key analytical issues relating to risk aggregation, and raising policy considerations. Risk aggregation is the main analytical hurdle to arriving at a composite risk picture. We propose a 'building block' approach that aggregates risk at three successive levels in an organization, (corresponding to the levels at which risk is typically managed). Empirically, diversification effects are greatest within a single risk factor (Level I), decrease at the business line level (Level II), and are smallest across business lines (Level III). Our estimates suggest that the *incremental* diversification benefits achievable at Level III are modest, around 5-10% reduction in capital requirements, depending on business mix.

Keywords: Economic capital, financial regulation, risk aggregation

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1. Introduction

Is there something special, with respect to risk and capital, about a financial conglomerate that combines banking, insurance and potentially other financial and non-financial activities? To what degree is the risk of the whole less than the sum of its parts? This paper seeks to address these questions by evaluating the risk profile of a typical banking-insurance conglomerate and highlighting some of the key analytical issues relating to risk aggregation. We provide a framework of analysis which builds up this risk profile and allows for coherent dissection of a financial conglomerate's diverse set of risks. We then use the analytical results to frame a policy debate for regulating the solvency of a multi-line financial conglomerate.

Increasing industry consolidation, financial deregulation, and globalization are fuelling rapid growth in the scope of large, multi-line financial conglomerates. The Joint Forum (Joint Forum, 2001a, p.5) defines a financial conglomerate as "any group of companies under common control whose exclusive or predominant activities consists of providing significant services in at least two different financial sectors (banking, securities, insurance)." In fact, it is fair to say that virtually all of the large, multinational financial institutions operating around the world today are, to some degree, financial conglomerates by either the strict "3 of 3" or weaker "2 of 3" definitions.

The merits and sins of specialization vs. conglomeration, small vs. big, have been debated at length, and most of that debate has been conducted using data and experience from the U.S. banking industry.[4] There is some evidence suggesting that economies of scale exist in banking (Berger, Hancock and Humphrey (1993), and Hughes and Mester (1998)). However, to achieve those gains from strict cost efficiency has proven to be difficult (Berger (1998), and Pilloff and Santomero (1998)). Are bigger banks less risky? Demsetz and Strahan (1997) show that while large U.S. bank holding companies are better diversified than small ones, this diversification does not translate into lower risk. Effectively they 'spend' their diversification benefits through larger C&I portfolios.

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[4] For a review of the literature, see Berger, Demsetz and Strahan (1999).

Economies of scope have also been used to explain the existence (or creation) of financial conglomerates. These economies of scope can take different forms: lower joint production costs (Berger, Hunter and Timme (1993)), consumers desiring (and being willing to pay for) one-stop-shopping (Herring and Santomero (1990)), and more efficient internal capital markets (Gertner, Scharfstein and Stein (1994)). Putting these together firms might achieve economies of scale and scope to lower monitoring costs (Mester, Nakamura and Renault (2002)), or perhaps by using very large customer databases to cross sell retail financial products and services (reference). Using the U.S. insurance industry as their laboratory, Berger, Cummins, Weiss and Zi (2000), try to explain the coexistence of, in their terminology, the "conglomeration hypothesis" -- diversified insurers -- with the "strategic focus hypothesis" – pure life or P&C insurers. They do so using a concept of "profit scope economies, which measures the relative efficiency of joint vs. specialized production, taking both costs and revenues into account." (pp. 325-326). They find that "the conglomeration hypothesis tends to apply more to insurers that are large, emphasize personal lines of business, [and] use vertically integrated distribution systems [. . .] while the strategic focus hypothesis tends to apply more to insurers that are small, emphasize commercial lines, [and] use non-integrated distribution systems" (p. 358).[5]

But are conglomerates more or less risky?[6] A stylized story promises reduction in earnings volatility as the business activities generating those earnings become more diverse. Stiroh (2002) debunks this story for the case of banking by showing that the U.S. banking industry did not achieve any obvious diversification benefits, in the form of stable profits or revenue, through an ongoing shift away from traditional interest income during the last twenty years.[7] Flannery (2000), Santomero and Eckles (2000), and Wilmarth (2001) all argue that correlation will likely go up once business and product silos are placed under one roof. Moreover, risk may actually increase because monitoring goes down, either

[5] Berger, Demsetz and Strahan (1999) report that consolidation appears to have increased profit efficiency in banking.

[6] The idea of risk mitigation as a merger motivation is not new. There is a rich literature on co-insurance following the seminal paper by Lewellen (1971), which discusses the impact of mergers on debtholders (and, indirectly, shareholders).

through the bank monitoring its counterparties (Winton (1999)) or the bank being monitored by others such as rating agencies (Wilmarth (2001)). Cummings and Hirtle (2001) argue that the risk of the whole may be greater than the sum of its parts, largely due to spillover effects from reputational risk.[8] Moreover they point out that the practicalities of achieving integrated risk management are daunting and "appear to have discouraged firms from adopting consolidated risk management" (p. 1). Once those systems are in place, however, firms should expect to reap economies of scale in risk management (Flannery (2000)).

We will examine the risk reduction, in terms of economic capital, that might be experienced by possible conglomerate profiles. Others have also considered different inter-sector marriages. Lown et al. (2000), using pro-forma analysis of potential combinations of banks with either of securities firms, life or P&C insurers, find that the merger of bank with a life insurer resulted in the best risk-return benefit, largely because of enhanced revenue opportunities (economies of scope) and anticipated risk reduction, rather than anticipated cost savings or manufacturing scale (economies of scale). Estrella (2001), using a different approach based on options pricing and the arbitrage pricing theory (APT), finds potential diversification gains from virtually all combinations of banking and insurance (both life and P&C) arising from revenue gains and the already well diversified nature of an insurance portfolio. While these results are in harmony with ours, and we will use some of Estrella's correlation estimates as a robustness check on our analysis later (Section 3.7), we are less bullish about the degree of diversification that is actually realizable.

Finally, systemic risk concerns have been raised by several authors, either because the conglomerates are larger and might be considered too-big-to-fail --TBTF – (Santomero and Eckles (2000), de Nicolo and Kwast (2001), and Wilmarth (2001)), or that even if they are not "too big" they may become too-complex-to-fail – TCTF – (Herring (2002)). Moreover, one might be concerned that bank supervisors, in order to help prevent failure of a non-bank affiliate, might be tempted to extend the

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[7] In his literature review, Stiroh points to eighteen studies collected in Saunders and Walter (1994) that examine

safety net beyond just the bank. This would inhibit market discipline by reducing the incentive to monitor the financial institution and increase the risk of contagion across the pieces of the holding company (Flannery (2000), and Santomero and Eckles (2000)).

Against this backdrop, we turn to a question that has not been examined previously in the literature: What does the risk structure of financial conglomerate imply for capital adequacy, particularly at the holding company level? In fact, where are the major sources of risk, and of equal importance, where are the diversification benefits within a financial conglomerate? We will not speculate on possible revenue synergies or management span-of-control issues, but rather focus on the size and composition of the risk pie (e.g. how big is market risk in banking vs. insurance) and what that implies for different financial conglomerates (e.g. large universal bank merging with a small P&C insurer) from the perspective of capital adequacy.

We make several arguments in this paper. Despite the increasing importance of financial conglomerates, the regulatory structure in most jurisdictions is still largely based around single business lines, on the notion that financial institutions, or their business lines, can be classified as banks or insurance companies or securities firms.[9] This is particularly true of the regulatory approach to capital adequacy, which historically has treated different regulated businesses as independent 'silos' in setting capital requirements.

Analytically, the special problem of capital management in a conglomerate stems from the need to aggregate risks across diverse business lines, such as banking and insurance. Our suggested approach for constructing a composite risk picture is to follow a 'building block' approach that aggregates risk at three successive levels in an organization (corresponding to the levels at which risk is typically managed):

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whether non-bank activities broadly are risk reducing; nine conclude yes, six no, and three have mixed results.

[8] See also Footnote 24.

[9] For the purposes of this paper, securities and asset management activities for third parties are deemed part of the bank or insurance group. These activities are, therefore, not explicitly and separately dealt with in this paper.

Level I: The first level aggregates the standalone risks within a single risk factor (e.g. credit risk in a commercial loan portfolio)

Level II: The second level aggregates risk across different risk factors within a single business line (e.g. combining the asset, liability, and operating risks in P&C or life insurance)

Level III: The third level aggregates risk across different business lines (e.g., banking and insurance).

Our analysis adopts this building block approach because it isolates the incremental effects of cross-business diversification that are unique to a conglomerate.

Empirically, diversification effects are greatest within a single risk factor (Level I), decrease at the business line level (Level II), and are smallest across business lines (Level III). Our estimates suggest that the *incremental* diversification benefits achievable at Level III by combining a bank with an insurance company are on the order of a 5-10% reduction in capital requirements, depending on business mix.

In such a building block approach, the result of adding risks at the holding company level can be no more accurate than the standalone capital measures for individual risk factors (Level I) and business lines (Level II). The existing regulatory capital measures at these levels are inherently limited, and in particular, fail to reflect important diversification effects at Levels I and II.

In our view, a well-constructed economic risk and capital management framework offers the best chance of overcoming the limitations of the silo approach to capital regulation. Specifically, such a framework can have the potential to address – in a flexible way that is sensitive to business mix – both the standalone distributions and correlation structures of different risk factors, leading to a composite 'aggregate' risk picture of the organization. Finally, by defining economic capital as a 'common currency' for risk, the framework has the potential to overcome inconsistent measurement of risks based on where a transaction is booked.

We suggest that supervisors respond to industry developments in risk measurement and management by supplementing existing supervision of regulated subsidiaries with oversight at the

holding company level of a conglomerate's internal risk and capital management framework. This oversight should seek both to validate – and to leverage – internal capital models, harnessing their power to frame the right questions for each institution. Ultimately, rather than focusing just on the numbers, supervision of the holding company should focus on the effectiveness of the capital decision making process.[10]

The structure of the paper is as follows. In Section 2 we discuss the limitations of a 'silo'-based approach to regulation and describe how these limitations give rise to the questions posed by the Project Sponsors. Section 3 describes an analytical framework for assessing the risk profile of a typical banking-insurance conglomerate and examines the scale and scope of aggregation effects. Section 4 highlights industry practices for measuring and managing risk and capital in a financial conglomerate. Section 5 concludes with a brief policy discussion.

2. Current 'Silo'-Based Approach to Regulation

Despite the increasing significance of financial conglomerates, the regulatory structure in most jurisdictions is still largely based around single business lines, on the notion that financial institutions, or their business lines, can be classified as banks or insurance companies or securities firms (see, for instance, Herring (2002)). This is particularly true in the regulatory approach to capital adequacy.[11] The current Basel Committee (BIS I) rules for the banking industry, for example, limit capital requirements to the credit and trading activities of licensed banks. Life insurance capital regulation similarly focuses on reserve requirements for authorized underwriting activities. Capital requirements for securities firms, meanwhile, vary by jurisdiction. In countries with a universal banking heritage, such as the Netherlands and Germany, the requirements for securities firms fall under bank capital guidelines. In other countries, such as the U.S., the requirements for securities firms fall under different

[10] Estrella (1995) was one of the first to highlight the importance of this issue.

rules set by a separate authority (Haberman (1987), Dimson and Marsh (1995), Ball and Stoll (1998), Kupiec, Nickerson and Golding (2001), Herring and Schuermann (2002)). The UK and Japan, through their respective Financial Services Authorities (FSA), have placed regulation of all three sectors under one roof.[12]

2.1. Limitations of this 'Silo' Approach

The approaches to capital regulation for banks, insurance companies, and securities firms have evolved from very different starting points, under different statutory regimes, accounting conventions, time horizons, intervention triggers, and policy objectives. This 'silo' approach to capital adequacy raises a number of issues:

First, the silo approach is inconsistent: it may lead to different treatment of similar risk types depending on where the risk is booked. As an example, consider a credit exposure to an 'A' rated counterparty(See Table 1). If the exposure were booked in a bank as a loan, it would, under current (BIS I) capital rules, require Tier I capital of 4% of outstandings.[13] If it were booked as a credit insurance transaction in a P&C insurance company, the same economic exposure would, under EU regulation, require capital of only 0.16% of outstandings – or twenty-five times less capital than a bank loan.[14] By comparison, if the credit exposure were held as a bond in a life insurance company investment portfolio, it would, under EU regulation, require an (implicit) asset risk charge of 3% of outstandings.[15] Inconsistent treatment creates the potential for regulatory arbitrage: It may encourage institutions to book business in those subsidiaries or shell companies that face the lightest regulation, irrespective of their ability to manage or sustain the level of risk.

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[11] See Joint Forum (2001b), Section III.
[12] Gramm-Leach-Bliley, with the Financial Holding Company (FHC), makes this now possible in the U.S. as well. An interesting recent proposal from the UK's FSA is in the form of CP136 which seeks to draft a framework for capital adequacy standards for each financial sector (FSA (2002)).
[13] BCBS (1988).
[14] Article 16a of Directive 73/239/EC, as inserted by Directive 2002/13/EC (EU Non-life insurance Solvency Directive).
[15] en Directive 2002/12/EC (EU Life assurance Solvency Directive).

Banking Regulation (BIS I)	EU Credit Insurance Regulations	EU Life Insurance Regulations
• Treat as commercial loan • Tier 1 capital = 4% of outstandings	• Treat as credit insurance paying credit insurance premium of 1% per annum • Solvency capital = 16% of premiums ⇒ 0.16% of outstandings	• Treat as an investment • Implicit asset risk charge = 3% of outstandings

Table 1: Example – 'A' Credit Risk

Second, the silo approach ignores aggregation because it fails to take account of risk concentrations or diversification across different operating subsidiaries. It is possible that an acceptable level of credit risk to a given counterparty in a firm's banking book may become a possibly unintended concentration if added to exposures to the same counterparty in the firm's trading book or insurance investment portfolios.[16] For example, if a bank has extended a credit facility to the same business to which the insurance company has issued a catastrophic (CAT) risk insurance policy, the concentration of risks will be lost in the silo approach. More fundamentally, many of the major risk factors within an operating subsidiary will tend to be mitigated by offsetting and diversifying exposures in other businesses.

Third, the silo approach is incomplete because it ignores the capital requirements of unlicensed subsidiaries, including a top holding company. Unlicensed subsidiaries that are engaged in commercial activities impose incremental risk, even if limited to non-financial factors (such as business and operational risk), which suggests a need for additional capital. At the same time, it is at the holding company level that the benefits of diversification across business lines are ultimately realized. These diversification benefits, however, need to be evaluated in the context of a holding company's funding

[16] In the EU, banking and trading book exposures within one firm (and group) are together subject to the large exposure rule.

practices and capital structure, taking into account such factors as the potential for double leverage. We summarize the problems of inconsistency, aggregation, and incompleteness in Table 2.

Inconsistent Treatment	Aggregation	Incompleteness
• Capital requirements dependent on where risk is booked • Boundaries breaking down due to product innovation • Increased demand/potential for regulatory arbitrage	• Concentration of risks across legal boundaries • Diversification across risk classes within a legal entity • Diversification of risks across business activities and operating companies	• Capital requirements of unlicensed operating companies • Capital requirements/funding structure of holding company • 'Strategic' investments in non-financial companies

Table 2: Limitations of the Silo Approach

The limitations of the current silo approach will continue to be exacerbated by industry consolidation and product innovation, which will further blur the boundaries between traditional business lines and risk classifications. If the regulatory structure fails to keep pace with these developments, the whole purpose of rule-based capital requirements may prove to be self-defeating. There is a danger that institutions will increasingly view risk and capital reporting as a game to be arbitraged, rather than as an opportunity to communicate their financial strength to the outside world.

While there are no simple answers to these challenges, the development of integrated risk and capital frameworks for evaluating capital adequacy in a conglomerate context is progressing. These developments are being driven by a number of factors, including:[17]

- The introduction of risk measurement methodologies and analytical tools for risk and capital management as well as performance measurement
- The evolution of enterprise risk management as a key corporate center function
- The blurring of product boundaries through financial innovation, and the potential for regulatory capital arbitrage

- The increased reliance by rating agencies on enterprise-wide capital models for evaluating the ratings of financial conglomerates
- The pressure from some regulators for a consolidated view of risk and capital at the holding company level

As we conclude in Section 5, advances in internal risk and capital management practices offer the potential for innovative and more powerful regulatory approaches.

2.2. Recent Regulatory Debate

The debate in the regulatory arena around these issues has intensified in the last three to four years. Notably, the New Basel Accord, sometimes called BIS (or Basel) II, proposes to "include, on a fully consolidated basis, holding companies that are parents of banking groups to ensure that it captures risks within the whole banking group" (Basel Committee on Banking Supervision (2001), p.1). This includes especially securities and even insurance subsidiaries.[18] More recently, in September 2002, the EU Council of Ministers approved an EU directive on the supervision of financial conglomerates.[19] This directive had four main objectives: 1) to ensure that the conglomerate be adequately capitalized, with particular attention focused on preventing 'multiple gearing;' 2) to introduce methods for calculating a financial conglomerate's overall solvency position; 3) to deal with issues of intra-group transactions, group-level risk exposure and internal risk management and control processes; and 4) to adopt a provision for lead supervisor by the member states for each financial conglomerate.

The Joint Forum (2001b) at the BIS has also tackled the issue of risk measurement and management in a financial conglomerate head-on.[20] This Joint Forum grew out of a "Tripartite Group" formed in 1993. The purpose of the Group was to identify and provide solutions for problems that financial conglomerates pose for supervisors. It was the first time three sets of supervisors worked

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[17] See also Kaufman (2000).
[18] Section C.9 (p.2) in BCBS (2001), "A bank that owns an insurance subsidiary bears full entrepreneurial risks of the subsidiary and should recognise on a group-wide basis the risks included in the whole group."

together. In 1995, the Group submitted the Tripartite Report (Joint Forum (1995)), which, while not officially endorsed by the Basel Commission, the International Organization of Securities Commissions (IOSCO), and the International Association of Insurance Supervisors (IAIS), served as the launching point for the Joint Forum consisting of these three regulatory bodies. Fundamentally, the Tripartite Group agreed that supervision of financial conglomerates cannot be effective if individual components of a group are supervised on a purely solo basis. The solo supervision of individual subsidiaries continues to be of primary importance, but it needs to be complemented by an assessment from a group-wide perspective. The paper laid out simple policy alternatives and proposed some accounting and managerial guidelines but did not provide any answers to the questions of diversification or concentration.

The 1999 Joint Forum Report, under the aegis of the Basel Committee on Banking Supervision (Basel Committee), IOSCO and IAIS, was meant to take forward the work completed by the 1995 report described above. The report is a set of five papers around capital adequacy, supervisory principles and information sharing and co-ordination (Joint Forum (2001a)). While the first paper on Capital Adequacy made significant progress on the 1995 effort, it focused less on diversification and concentration effects and more on issues such as double (or multiple) leverage, regulatory arbitrage (across distinct bodies), and provided a very simple, banking focused approach to risk aggregation.[21]

The most recent report (Joint Forum (2001b)) explicitly compares approaches to risk management and capital regulation across the three sectors of banking, securities and insurance. It not only gives the comparative regulatory view but also summarizes many of the different approaches employed by financial firms across the three sectors, including, of course, practices by financial conglomerates.

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[19] EU Directive on Supervision of Financial Conglomerates, Commission to the European Communities, SEC(2002) 995 Final.

[20] This report in turn builds on their earlier work (Joint Forum (1995) and (2001a)).

3. Risk Profile of a Financial Conglomerate: Measurement and Management

The special problem of capital management in a conglomerate stems from the need to aggregate risks across a diverse set of businesses.[22] This section seeks to size the magnitude of aggregation effects by examining the risk profile of a banking-insurance conglomerate. In effect, it asks just how big a problem risk aggregation actually is: are aggregation effects so severe that a typical conglomerate is over-capitalized to the point of inefficiency (in particular to shareholders), or under-capitalized to the point where it causes undue risk of insolvency to debtholders and policyholders?

3.1. Capital Management of a Financial Conglomerate

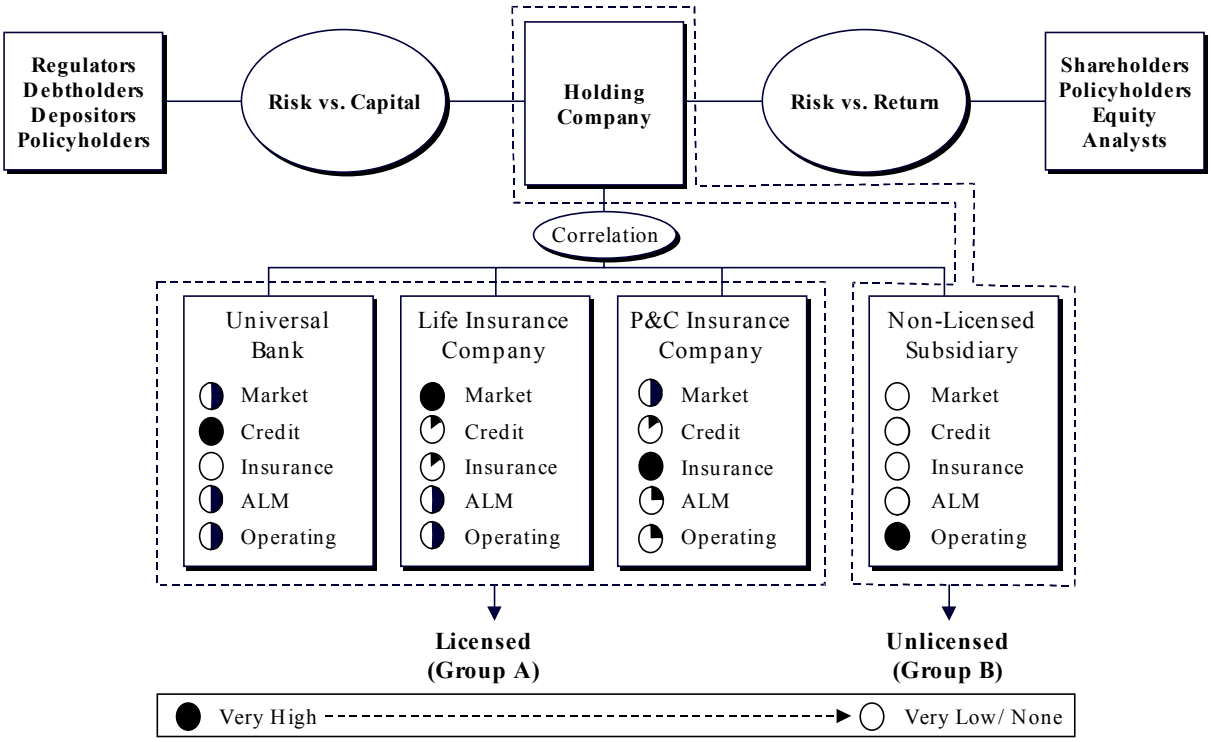

Figure 1: Illustrative Financial Conglomerate Risk Profile

A financial conglomerate is, by definition, a combination of diverse businesses operating under a common ownership structure. As shown in Figure 1, the organization can be broken down into major

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[21] The 2002 EU directive on the supervision of financial conglomerates adopted the 1999 Joint Forum recommendations.

business lines, each of which has a distinct risk profile. For example, the universal banking activities – consisting of retail, corporate, and investment banking -- are dominated by credit risk. Life insurance activities are dominated by market (investment) risk, and P&C activities by insurance (CAT) risk. In addition, non-licensed subsidiaries may be part of the conglomerate structure. While the common ownership structure is typically in the form of a holding company, it need not be. The analysis and results in this section are independent of the specific legal structure of the conglomerate.

The capital management problem for a conglomerate is to determine – both within and across businesses – how much capital is required to support the level of risk taking. The problem is of concern to different constituencies. On the one hand, debtholders, policyholders, regulators and rating agencies are primarily concerned with the *solvency* of the institution. For them, the key issue is whether the institution holds sufficient capital to absorb risk – or the potential for loss – under all but the most extreme loss scenarios. Put another way, they are seeking capital to backstop the organization's risk taking at a high degree of confidence.[23]

On the other hand, shareholders, participating policyholders, and investment analysts are primarily concerned with the *profitability* of the institution. For them, the key issue is whether the institution is earning a sufficient return (at or above hurdle rate) on the capital invested to support risk taking. While capital is the common denominator that links the debtholders and shareholders, their interests pull in different directions. Lower capital for a given degree of risk taking will make an institution less solvent, but more profitable, and vice versa.

A conglomerate poses special challenges for capital management: internally, for managers charged with balancing the risk, capital, and return equation, and externally, for regulators concerned with the safety and soundness of the institution. The first challenge is to determine the standalone risk of an activity within a business line – such as the credit risk in a commercial loan portfolio or the

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[22] Given the myriad ways in which a financial conglomerate can be structured, the only valid method for aggregating risks is one that is based on underlying risk fundamentals and is independent of legal structure. For a more extensive discussion, see Section 3.8.

[23] See also Berger, Herring Szegö (1995) on the role of capital in financial institutions.

catastrophe risk in a P&C insurer's homeowners portfolio. A number of techniques have been developed within banks and insurance companies to assess risk at this level.

The next challenge is to combine the different risk factors within a business line or licensed subsidiary. Because risks are less than perfectly correlated, they cannot be strictly added together. The licensed subsidiaries include banks, insurance companies, and securities firms that are subject to specific capital requirements. The potential for diversification suggests that the whole will be less than the sum of the parts.

A further challenge for a conglomerate results from the presence of unlicensed subsidiaries. They generally fall into two categories: financial subsidiaries that engage in financial businesses such as financing, insurance, and brokering outside of a licensed banking group, insurance company or securities firm; and commercial subsidiaries that are principally engaged in non-financial activities. In both cases, unlicensed subsidiaries impose an incremental need for capital, at a minimum to cover the incremental operating risks (including both business and event risk) inherent in the business. For a non-licensed financial subsidiary – such as a consumer finance or leasing company – the need for capital will be similar to that for other regulated activities. For an unlicensed commercial subsidiary, the incremental capital will be analogous to that held by a non-financial firm, and will be needed to cover operating risks, including business and event risk.

At the same time, the top holding company within a conglomerate structure may also be an unlicensed entity. Because of the scope of activity, the holding company raises unique issues of aggregation.

3.2. Economic Capital as a Common Currency for Risk

In order to assess capital requirements in a diverse conglomerate, there needs to be a 'common currency' for risk that can equate risk taking in one activity or business line with another. Economic capital is often used as that common currency for risk measurement, irrespective of where the risk is incurred. Under the economic capital approach, the risks of a conglomerate – or of the individual

businesses within it – can be classified into primary components of asset risk, liability risk, and operating risk. As shown in Figure 2, these risks can be further decomposed. Asset risk is typically broken down into credit risk and market/ALM (asset/liability mis-match or management) risk. Insurance liability risks can be separated into P&C catastrophe risk; P&C experience-based risks; and life risks. Operating risks can be split into business risk and event risks.[24]

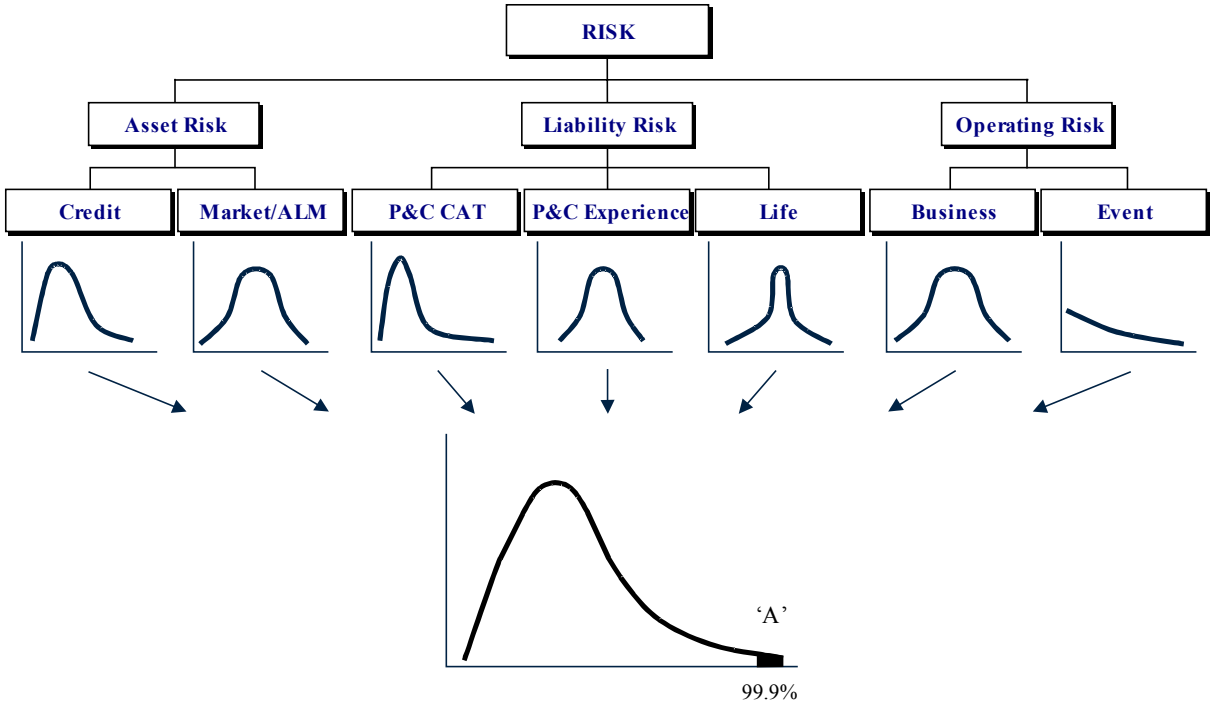

Figure 2: Distributions of Risk Types

[24] This framework does not explicitly address what is sometimes referred to as "reputation risk." Reputation risk has two separate connotations: the first is the spillover risk to one business resulting from the insolvency of an affiliated entity. This effect is not incorporated in an economic capital framework because it is not a result of risk-taking per se. Rather, it is a result of the failure to hold sufficient capital to prevent the insolvency of the affiliate, and of the legal or market conventions that transfer some or all of the resulting loss to the surviving business. This "risk" can be mitigated by setting high solvency standards for all entities within a conglomerate. Equally, if risks are correctly aggregated, then the total amount of economic capital at the top of the organization will determine the amount of financial resources (capital) necessary to support all of the organization's risk taking at the desired confidence level, inclusive of any spillover effects.

Another meaning of "reputation risk" refers to franchise risk associated with a major fiasco – such as the damage to a financial institution that could result from a large internal fraud or involvement in illegal money laundering. In principle, any direct losses stemming from such occurrences should be captured as an "event" risk within an economic capital framework. The more diffuse harm to franchise value is not something which capital resources are effective at alleviating. See also Santomero and Eckles (2000), Flannery (2000), Wilmarth (2001) and Kuritzkes (2002).

Although each of these risks has distinct statistical properties – as reflected in the stylized risk distributions shown for them – economic capital sets a common standard for measuring the degree of risk taking. The standard is defined in terms of a confidence interval in the cumulative loss distribution, assessed over a common time horizon.[25] By setting capital for different risks at the same confidence interval, the economic capital requirements for different risk factors and types of activities can be directly compared. Only by having such a common standard can one meaningfully assess the risk for a complex conglomerate with a diversity of business activities across the financial spectrum.

A typical approach is to tie the degree of capital protection to the target debt rating of the institution. One convention is to adopt a one-year time horizon.[26] In the figure above, the economic capital requirement is set to protect against losses over one year at the 99.9% level – roughly equivalent to the default risk of an 'A' rated corporate bond. Put another way, a business that holds capital to protect against one-year losses at the 99.9% confidence interval would have a default risk consistent with a 'A' debt rating. Setting capital for the individual risks within a conglomerate at this confidence interval assures that each of them, on a standalone basis, is protected to a level consistent with the target rating.

Economic capital models are typically built up from the specific analytical approaches for individual risk factors. Table 3 lists common modeling approaches for the main risk types. While the specific tools for risk factors such as credit, CAT, P&C experience and market risks differ, the common denominator in an economic capital framework is the attempt to describe the risk distribution in probabilistic terms, and set capital at a common confidence interval.

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[25] The different risks have traditionally been measured at often rather different time horizons. We address this issue in more detail in Section 3.10.

[26] The one-year horizon is indeed typical for banking. In insurance, longer time horizons are considered. More detail on this topic is provided in Section 3.10.

Risk Type	Description	Measurement/Modeling Approaches
Market/ALM	The risk of adverse movements in market factors, such as asset prices, foreign exchange rates, interest rates, etc.	VaR, Scenario Analysis
Credit	The risk of loss resulting from failure of obligors to honor their payments	Expected Loss, Unexpected Loss
Life	The risk of loss due to unforeseen increase in life claims	Surplus Testing
Catastrophe	The risk of loss due to catastrophe, such as hurricanes or earthquakes	Simulation, Exceedence Probability Curves
Non-Catastrophe P&C	The risk of loss due to unforeseen increase in non-catastrophe claims, such as car accidents, fires, etc	Frequency Severity Modeling, Payout Pattern Analysis Using Loss Triangles
Business	The risk of loss due to adverse conditions in revenue/exposure, such as decreased demand, competitive pressure, etc.	Historical Earnings Volatility, Analogues
Event	The risk of loss due to fraud, natural disaster, litigation, etc	Extreme Value Theory

Table 3: Risk Types and Modeling Approaches

3.3. Risk Aggregation: The Building Block Approach

Just as risks can be decomposed into individual factors, they can also be re-aggregated. The distribution drawn at the bottom of Figure 2 shows conceptually how the various risk distributions of a financial conglomerate can be combined to yield a single, cumulative loss distribution – and economic capital requirement -- for the institution.

In practice, aggregating the various risk distributions in a complex financial organization is a challenging task and somewhat arbitrary. Ultimately, the total amount of economic risk at the top of an organization is independent of how risks are aggregated within it.[27] One proposed method for constructing a composite risk picture is to follow a 'building block' approach that aggregates risk at successive levels in an organization. There are three key levels, corresponding to the levels at which risks are typically managed:

Level I: The first level aggregates the standalone risks within a single risk factor in an individual business line. Examples include aggregating the credit risk in a commercial loan portfolio; the equity risks in a life insurance investment portfolio; and the catastrophe risks in a P&C underwriting business.

Level II: The second level aggregates risk across different risk factors within a single business line. Examples include aggregating the credit, market/ALM, and operating risks in a bank; or combining the asset, liability, and operating risks in P&C or life insurance.

Level III: The third level aggregates risk across different business lines, such as banking and insurance subsidiaries. This leads to the composite picture – or cumulative loss distribution – at the top (holding company) level.

Our analysis adopts the building block approach because it allows the risk profiles of each of the businesses within a conglomerate to be considered separately, *before introducing the cross-business aggregation effects that are unique to a conglomerate*. Put another way, Level I and Level II aggregation effects are already present within regulated banks and insurance companies. The unique problems of a conglomerate are associated with Level III.

Differences in corporate structure, business line definitions, legal requirements, or risk management philosophy may lead some organizations to follow other hierarchies in aggregating risks than the three-level building block approach. Although this should ultimately produce the same amount

[27] See also our more extensive discussion in Section 3.8.

of overall risk at the top of the organization, alternative approaches to risk aggregation will yield different results at lower levels. This is discussed in Section 3.8.

3.4. Estimating Aggregation Effects: General Principles

The starting point for risk aggregation is to begin with standalone estimates of the economic capital required for individual risk factors. While the general concept of economic capital is explained above, the specific techniques for calculating risk at this level are beyond the scope of this paper.

Given estimates of standalone economic capital, one can aggregate risks – to a first-order approximation -- based on the relative amounts of economic capital, and then consider correlations between risk factors. As discussed in Appendix A, the diversification benefits that accrue from aggregation are driven by three main factors:

A1. The number of risk positions (*N*)

A2. The concentration of those risk positions, or their relative weights in a portfolio

A3. The correlation between the positions

In general, the diversification benefit increases with the number of positions, decreases with greater concentration, and decreases with greater correlation. These properties are depicted in Figure 3 which shows the diversification benefits for a portfolio of equally weighted assets or liabilities for two different levels of correlation.

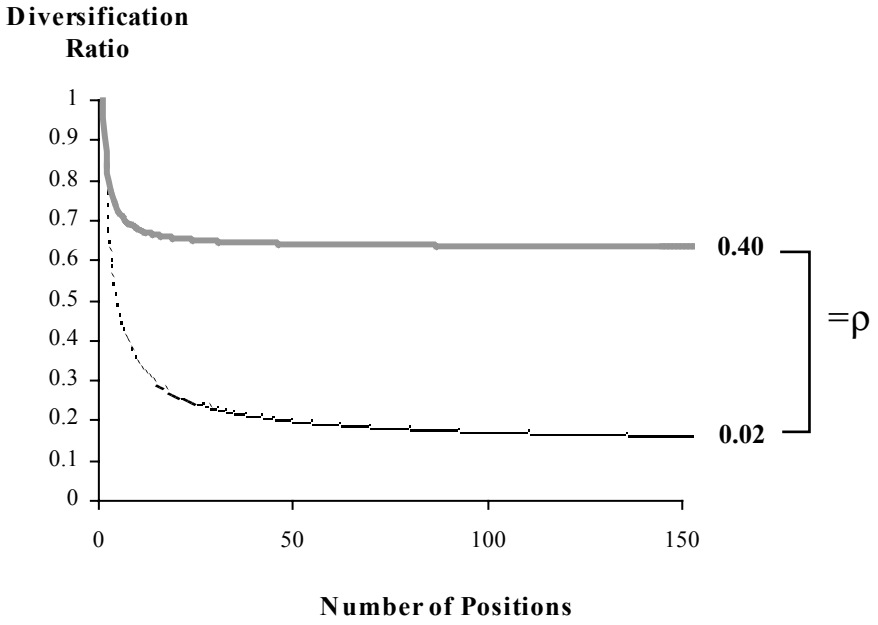


Figure 3: Diversification within a Risk Factor

As the number of positions[28] increases for a given level of correlation, the diversification ratio decreases – i.e., there is an increase in the diversification benefit. For a given number of positions, as the correlation decreases the diversification benefit increases. For a correlation level typically experienced in market risk – around 40% – the full diversification benefit amounts to about one-third; this is achieved fairly rapidly, after about 30 positions. For the much lower correlations typical of a credit portfolio – around 2% – the diversification benefit is significantly greater – around 75%. However, it takes longer to get there; this limit is achieved after around 100 positions.[29]

Though the figure deals with equally weighted positions, as concentration increases the diversification benefit decreases. This is most easily seen at the extreme. The diversification benefit obtained by one risk factor that is nine times the size of another will be very small, even if the two risks

[28] The term 'positions' is used to highlight the fact that this holds universally for assets, liabilities, number of risk factors, etc.

[29] It is important to note that some credit portfolios with considerably more than 100 loans do not converge on the systematic risk limit, because the loans are not equally weighted. Often, a few individual loans can each account for as much as 2-3% of the portfolio, which limits diversification because of concentration effects.

are completely uncorrelated (independent). At zero correlation, the largest diversification benefit possible cannot exceed 10%.[30]

There is a related point that can be illustrated in Figure 3. The Capital Asset Pricing Model (CAPM) breaks total risk into specific (or idiosyncratic) and systematic risk. While the two curves represented in the graph show the systematic risk associated with average correlations of 40% and 2%, respectively, it is possible to conceive of different systematic risk curves for a given risk factor, reflecting different average levels of correlation. For example, a systematic risk curve for a domestic equities portfolio will have a higher level of average correlation – and lower diversification benefit – than a systematic risk curve for a globally diversified equities portfolio. Similarly, the systematic risk curve for a regionally concentrated credit portfolio will have a higher level of average correlation than a systematic risk curve for a globally diversified credit portfolio. Thus, the diversification benefit obtainable within a given risk factor will vary with the scope of activity.

With these principles in mind, the general characteristics of the three levels of aggregation can be stated as follows:

- Level I has many risk factors (individual assets or liabilities) that are neither strongly concentrated nor highly correlated. As a result, there should be a high diversification benefit at Level I. The achievable diversification benefit will be driven by the scope of activity.
- Level II has fewer risk factors, and they are likely to be more concentrated and more correlated. Consequently, there should be a lower diversification benefit at Level II than at Level I.
- At Level III, there are only a few risk factors; some are likely to be much more highly concentrated than others, and correlations will tend to be high. Level III should therefore

[30] This result follows from Equations 1 and 2 in the Appendix: if $EC_1 = 9$ and $EC_2 = 1$, and $\rho = 0$, then $EC_T = \sqrt{9^2 + 1^2} > 9$ and the diversification benefit $DB < 10\%$.

yield the smallest diversification effects of the three levels. These relationships are examined empirically in the following sections.

These relationships are examined empirically in the following sections.

3.5. Level I Diversification

Level I diversification benefits reflect the degree of diversification achievable for a single risk factor within a given business line. At this level, the number of positions in a portfolio is quite large – typically well over 1,000 policies or loans in an insurance or loan portfolio, and over a hundred positions in an investment portfolio. As a result, diversification benefits will converge fairly rapidly to the systematic risk limit. Recall that for an equity portfolio, a one-third reduction is achievable due to diversification of idiosyncratic risk alone, while for credit risk the lower correlations allow for a four-fifths reduction.

Beyond the number of positions, differences in the scope of activity can have a dramatic impact on the level of systematic risk, and hence the achievable diversification benefits. As an example, Figure 4 shows the increasing benefit from diversifying the credit risk of an equally weighted commercial loan portfolio internationally across geographies, essentially diversifying the portfolio with respect to the most fundamental of systematic risks, the (national) business cycle.[31] We present results using correlation based on GDP changes from 1991 to 2000.[32]

[31] A discussion of the methodology is presented in the Appendix.
[32] Global is represented here by the EU, Japan, Australia, Indonesia, Brazil and South Africa. Source: IMF: International Financial Statistics.

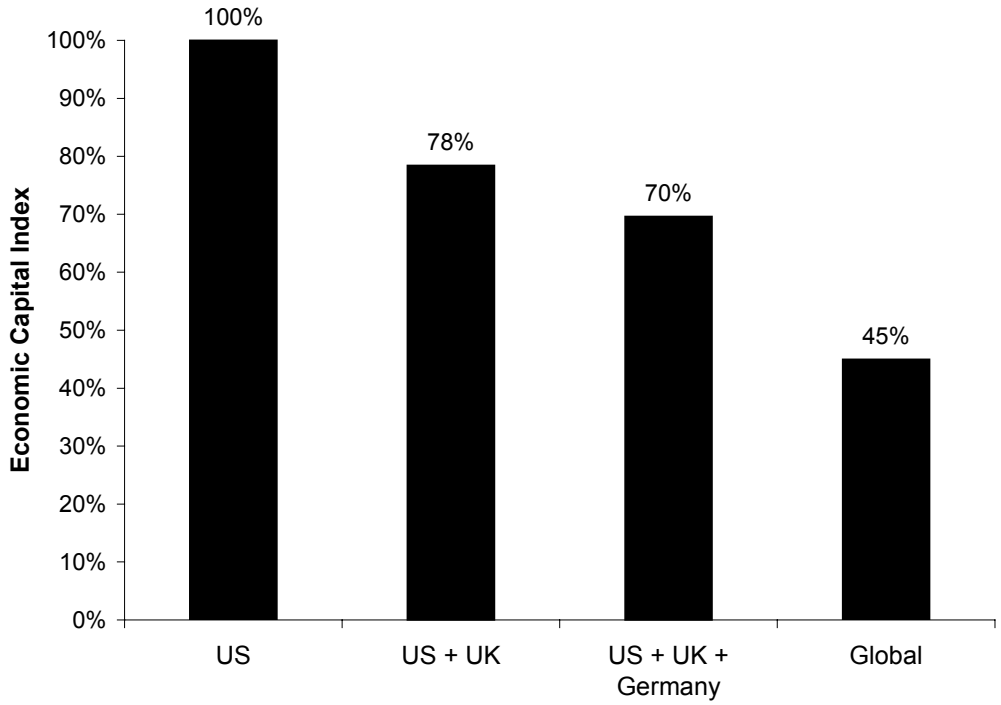


Figure 4: Impact of Level I Diversification

In this example, the economic capital requirement for a U.S. only portfolio is indexed to 1.0 If that portfolio were combined with an equivalent sized portfolio of U.K. commercial loans of similar ratings, the capital requirement (as a percentage of exposure) would be reduced by about one-fifth. Adding a German portfolio of equal size would increase the diversification benefit to 30%, while a fully diversified global credit portfolio would require slightly less than half as much capital, per unit of exposure, as the regionally concentrated U.S. portfolio. Not surprisingly, diversification is a major rationale for financial institutions to internationalize portfolios. For a given amount of expected loss, the same notional exposure leads to less loss volatility and lower capital requirements. Note that this result is not unique to credit risk, rather it can be generalized beyond just banking to insurance as well as non-financial activities.

The same principles apply to equity portfolios – where international diversification is the only means of lowering the systematic risk in any one market. And equally, in P&C insurance, diversifying CAT risk across product lines and geographies produces a similar effect. Since CAT risk for hurricanes

and earthquakes is uncorrelated, a U.S. insurer exposed to Florida hurricanes can lower systematic CAT risk by underwriting Tokyo earthquake policies. This explains one of the key benefits of internationalization for insurance companies, particularly P&C and reinsurance. As in the credit example, single risk factor diversification benefits can be on the order of 50% or more.

Significantly, existing capital requirements typically ignore differences in Level I diversification by assuming some 'average' level of correlation and hence systematic risk. As an example, current (BIS I) rules for bank credit risk set a 4% Tier I capital requirement for all commercial lending – irrespective of the degree of diversification in the portfolio. This would continue to be true under the internal ratings based capital reforms proposed in BIS II.[33]

3.6. Level II Diversification

Level II diversification depends on the correlation of risks within a business line. The magnitude of Level II effects will differ systematically for banks, life insurers, and P&C insurers.

For banks, the dominant risk, as reflected in BIS capital rules, is credit risk (Joint Forum (2001b)). This is corroborated by two benchmarking studies conducted in 2000. One was conducted by Oliver, Wyman & Company, which surveyed the internal economic capital allocations of ten large international banks in Europe and North America (Kuritzkes (2002)). Capital Market Risk Advisors conducted its own survey of 38 banks, six of which were classified as "large, global" (CMRA (2001)). The results presented in Figure 5 are quite similar. The standalone economic capital requirements for the banks – as determined by their internal models – was broken down into three major risk factors: credit risk, market/ALM risk, and operating and other risks. On average, credit risk accounted for about half of the total economic capital requirement, market/ALM risk accounted for one fifth and operating and other risks accounted for one quarter to one third of the total economic capital.

[33] The same applies to insurance, both under EU and NAIC guidelines.

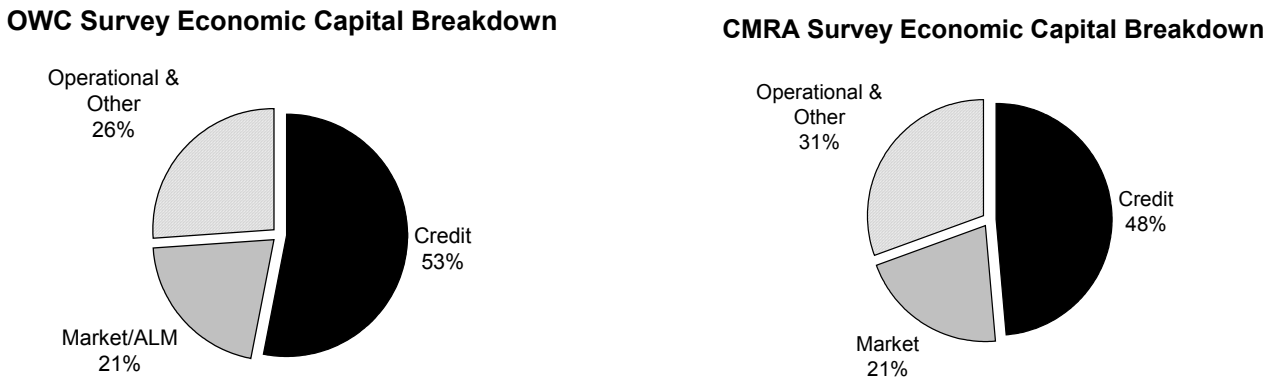


Figure 5: Economic Risk Capital Breakdowns

Given the relative weights of the standalone economic capital for the risk factors, the Level II diversification benefits can be estimated from the risk factor correlations. In practice, there are a number of approaches for calculating correlations and diversification benefits. We discuss some in the appendix and focus on the results here. Taking the OWC economic capital breakdown as an example, we compute the diversification benefits under three different correlation assumptions, presented in Table 4. The first set is taken from Dimakos and Aas (2002) who estimate correlations for a Norwegian bank which also owns a life insurance subsidiary. The second set comes from Ward and Lee (2002) who present risk aggregation results for a diversified insurer with the risk types broken out. Ward and Lee (2002) have separate correlations for market and ALM risk.[34] As we aggregate those risks here, we took the higher of the two correlations. Finally we present results based on the correlations used in Kuritzkes, Schuermann and Weiner (KSW) (2001),[35] which are based on interview findings and reflect the values used by Dutch and other financial conglomerates in their internal capital models.

[34] We group market and ALM risk together as the interest rate risk associated with ALM is typically the dominant risk factor in market risk.
[35] and as cited in Joint Forum (2001b), p. 25.

	Credit	Market/ALM	Operational & Other
Credit	100%	30% 30% 80%	20% 44% 40%
Market/ALM	30% 30% 80%	100%	20% 13% 40%
Operational & Other	20% 44% 40%	20% 13% 40%	100%

Table 4: Inter-Risk Correlations

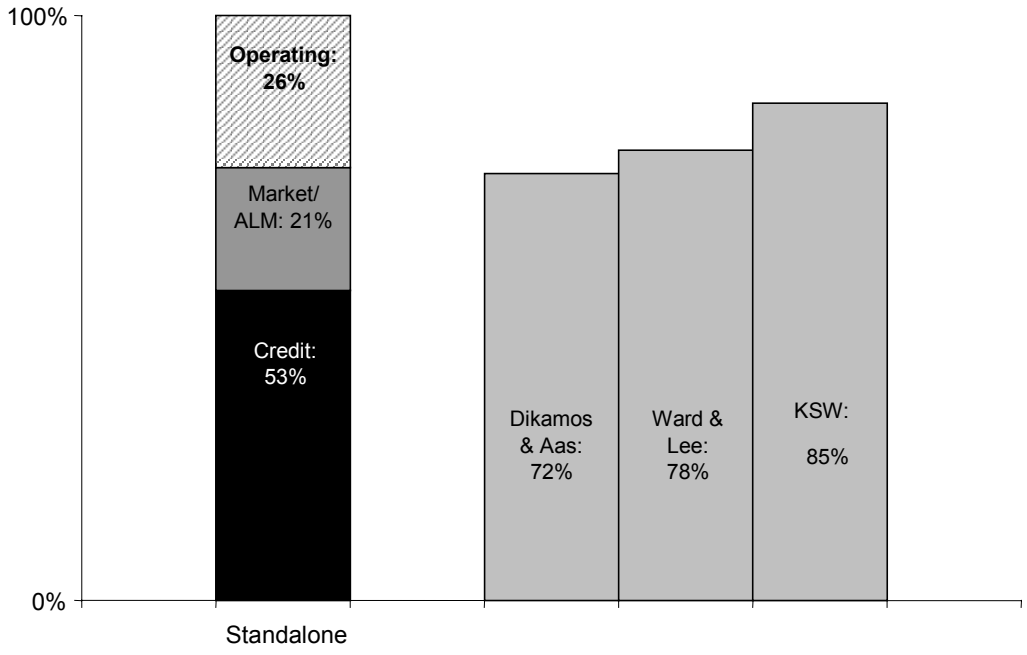


Figure 6: Diversification at Level II (Bank)

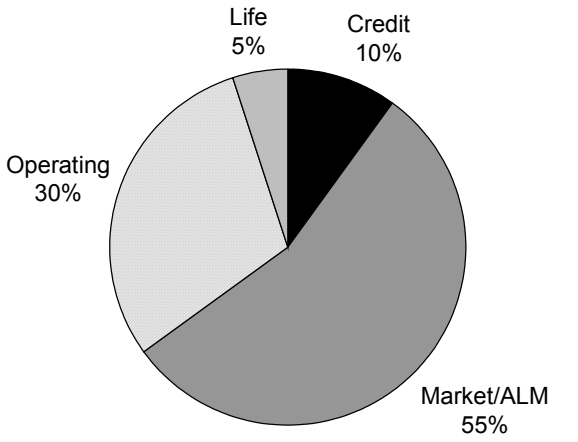
Combining the economic capital weights with the correlations, the Level II diversification benefits for a 'typical' bank can be estimated to be on the order of 15% to 28% (Figure 6). So far, this

supports the proposition that as the level increases, the magnitude of the diversification benefit decreases. The explanation is straightforward: at the bank level, there are only three risk factors; they are concentrated (credit risk alone accounts for over half of total capital); and have relatively high correlations (for the more conservative KSW case, 40% or greater).[36] This provides a possible justification for why existing bank capital regulations ignore Level II benefits: both the present and proposed BIS guidelines treat credit and market risks on a standalone basis, and simply add together the combined requirement without any deduction for cross-risk factor diversification. Many banks do the same in their internal economic capital frameworks. This underscores the importance of Level I diversification relative to Level II for the banks.

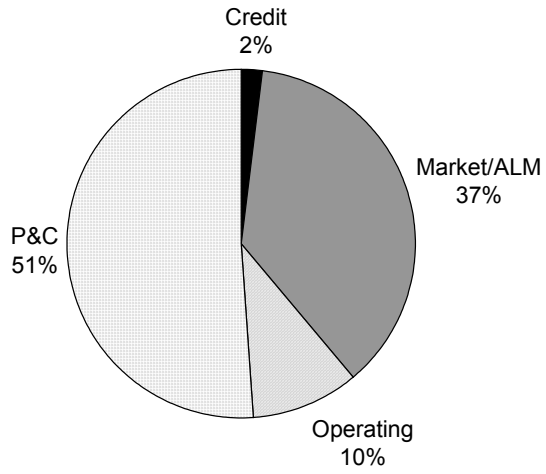
The same analysis can be repeated for insurance companies. Below in Figure 7 we show three risk profiles: a life insurer (from Stevens, den Dekker, Shamieh and Tadros (2001)), a P&C insurer (from Nakada et al., 1999) and a diversified insurer (from Ward and Lee, 2002). Note that the risk profile of the insurers differs significantly from that of a bank and also from each other. Credit risk, for example, accounts for only about 5% and 10% of the total economic capital of a typical P&C and life insurer respectively, although the Ward and Lee (2002) estimate is closer to 20% for the diversified insurer, compared to 50% for a bank. At the same time, market/ALM risk accounts for 50% of the capital requirement of a life insurer, 44% of the diversified insurer, 37% of the P&C insurer while only 21% of the total risk of a bank.[37]

[36] They may, in fact, not be all that conservative. It is well known that in times of stress, correlations often increase (see Embrechts, Klüppelberg and Mikosch (1997), Diebold and Santomero (1999), Jorion (2000), Anderson, Bollerslev, Diebold and Labys (2001), and Carey (2002)).

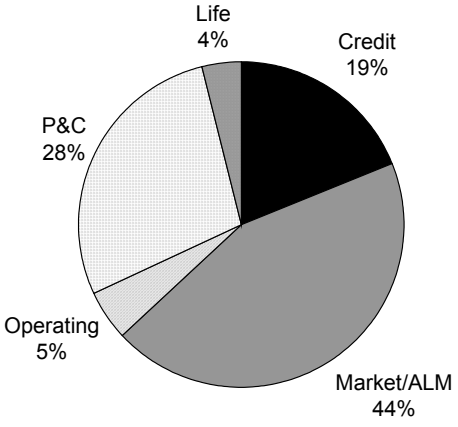
[37] While grouping ALM and Market Risk is generically useful, life insurance has potentially distinctive ALM features stemming from the unique obligations to its policy holders. Specifically, the policyholders (i.e. liabilities to the insurer) often bear some of the market risk from the asset side of the balance sheet.



Life Insurer



P&C Insurer



Diversified Insurer

Figure 7: Insurance Risk Profiles

Studies reporting inter-risk correlations for insurers are harder to come by than for banks. We are aware of only one, Ward and Lee (2002), who do so for a diversified insurer. Thus we present diversification benefit results for a life, P&C and diversified insurer using their correlations as well as the correlations used in KSW. With only one exception (the correlation between operating and life risk), our correlations are higher (often much higher) than those of Ward and Lee (2002).[38]

Figure 8 below presents Level II diversification benefits for a life and P&C insurer using two different correlation assumptions.[39] The lower correlations of Ward and Lee (2002) result in larger diversification benefits than do our more conservative estimates. This benefit is 46% for a P&C and 38% for a life insurer, while the higher correlation version results in 27% and 19% respectively.

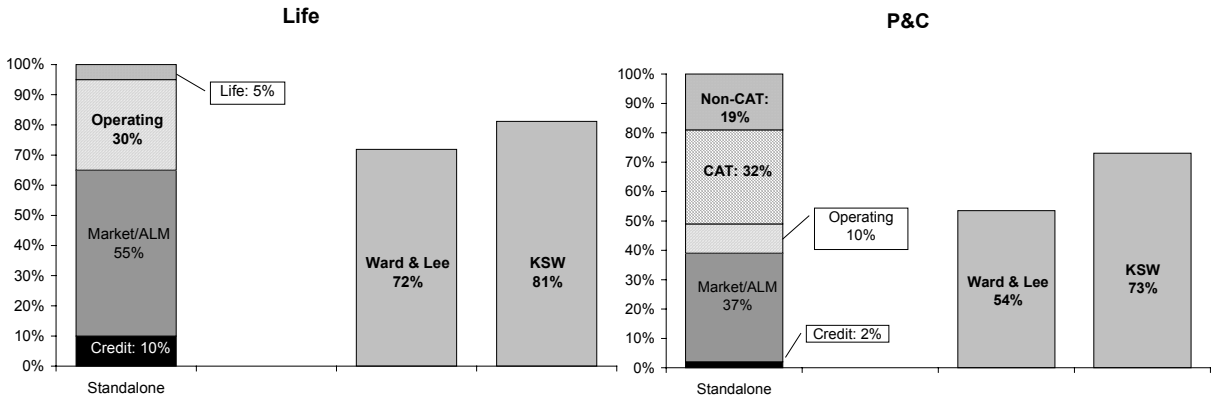


Figure 8: Diversification at Level II (Insurance)

In both cases, the larger diversification benefit for the P&C insurer result from P&C risk being relatively uncorrelated with other risk types. This lower level of correlation overcomes the high concentration that P&C risk represents in the risk profile of a P&C insurer.

Despite the larger diversification benefits at Level II for the insurers relative to a bank, the main hypothesis holds, namely, in moving from Level I to Level II, the diversification benefit decreases.

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[38] See Appendix for details.
[39] The results for the diversified insurer are very similar to those of the P&C insurer.

While the incremental diversification benefits encountered at Level II are less than at Level I, they can nevertheless be economically important and often are not accounted for by regulatory capital rules.[40]

For example, the bank capital regulation (under both BIS I and BIS II) simply adds together the standalone requirements for credit, market, and prospectively, operational risk without any offset for diversification. Similarly, existing European insurance capital requirements assume some "average" level of correlation within one licensed insurance entity. If several such entities form part of an insurance group, as is typically the case, any diversification effects (e.g., geographic diversification) are ignored.[41]

Considering an example from insurance, in the U.S. the P&C risk based capital (RBC) formula for underwriting risk capital has two components: reserve risk and premium risk (Feldblum (1996)). The reserve risk charge is calculated by multiplying net premiums written with a set of RBC factors. The factors are different for each line, thereby introducing some diversification benefit. This is called the Loss Concentration Factor (LCF), which is linearly related to the ratio of the volume of the reserves for the largest line to the total reserves. Suppose that for two companies A and B, the largest line comprises one-fourth of total reserves – but the two lines are different. Then each line will have a different standalone risk and different correlations with the rest of their respective business lines. Nevertheless the capital requirements will be the same.[42]

3.7. Level III Diversification

Having addressed the diversification benefits at Level II, the incremental diversification benefits at Level III can be estimated by combining banking and insurance activities in varying proportions. As discussed earlier, the three key factors in quantifying diversification benefits are the number of assets or liabilities, the concentration of risk factors, and the cross-risk factor correlations. Note, however, that in

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[40] Existing European insurance capital requirements assume some 'average' level of correlation within one licensed entity. In case several of such entities form part of an insurance group, any additional diversification effects (e.g., geographic diversification) are ignored, however (see also Section 3.8).

[41] See our discussion in Section 3.8.

combining an insurance company with a bank, there are only two business lines, and they share many of the same risk factors (e.g. exposure to a common business cycle). In addition, one of the subsidiaries may well be larger than the other one. These factors will tend to limit the possible diversification benefits.

To aid in understanding the potential diversification benefits at Level III, we consider five different conglomerate profiles reflecting possible different mixes of a universal bank (bank plus securities firm), life and P&C insurers, plus in one scenario, the addition of a small non-financial, commercial subsidiary. The proportions represent the unit's level of standalone economic capital. These risk profiles are meant to capture a wide range of possible structures, from banking-dominated conglomerates to insurance-dominated conglomerates. For each profile, the diversification benefits were calculated by breaking down the bank, life, and P&C businesses into their Level II risk factors. The Level II risks were then re-aggregated based on the cross-risk factor correlations.

		Sub Units			
		Universal Bank	**P&C**	**Life**	**Non-financial**
Profile 1	"Bank / P&C-lite"	70%	30%	0%	0%
Profile 2	"Bank / Life-lite"	70%	0%	30%	0%
Profile 3	"Bank / P&C"	50%	50%	0%	0%
Profile 4	"Life / Bank-lite"	25%	0%	75%	0%
Profile 5	"Mixed"	35%	30%	30%	5%

Table 5: Conglomerate Profiles

[42] The LCF formula is LCF=0.7+0.3*ratio. This adjustment reduces the capital required for reserve risk. Obviously, LCF is a rough approximation for the true diversification benefit.

We then estimate diversification benefits for these profiles given the standalone levels of economic capital by risk type and their correlations as described in Section 3.6.[43] We do so using several different sets of inter-risk correlations taken from different studies, including the correlations used in our original study. These correlations are presented in the Appendix as well as a brief synopsis of each study. Below in Figure 9 we present the results, including an average across all four correlation specifications.

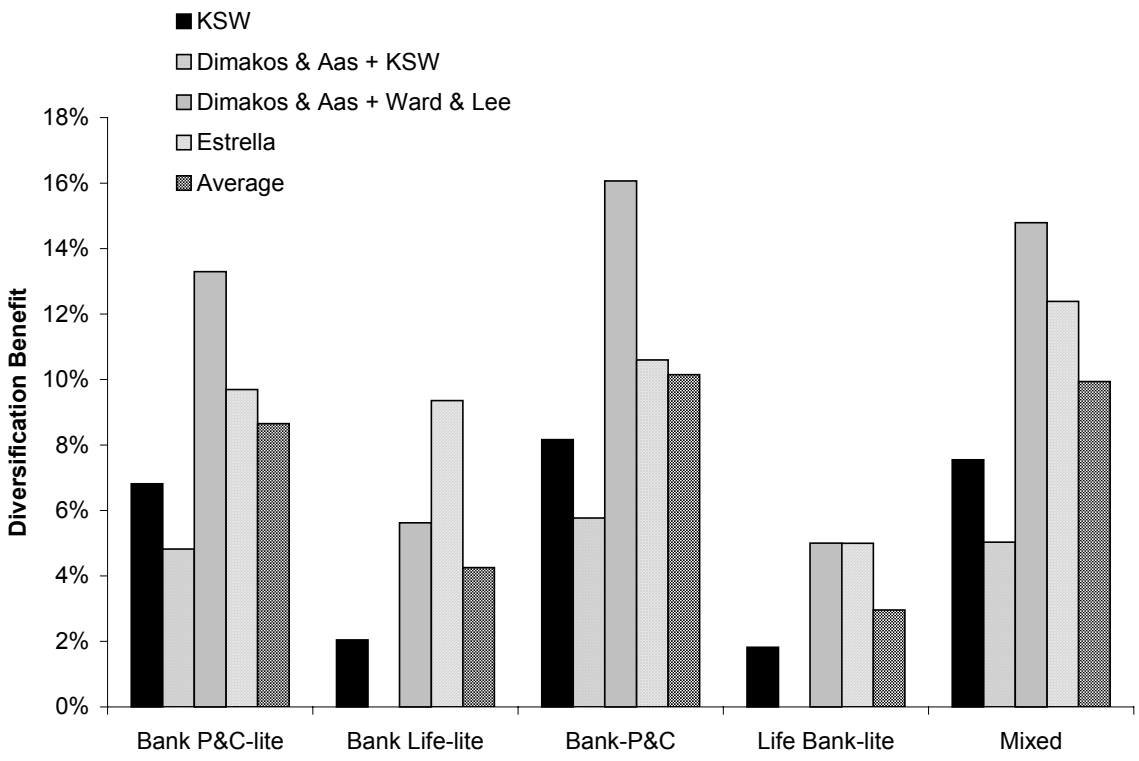

Figure 9: Conglomerate Diversification Benefits

Several observations come to light. First, the overall results confirm our initial hypothesis: the benefits at Level III are smaller than at Level I and Level II. For three of the four correlation specifications, the benefits only range from 0% to 12%.[44] For the specification which combines correlation estimates from Dimakos and Aas (2002) for banking and from Ward and Lee (2002) for insurance, the implied diversification is larger: 5% to 16%. Indeed, under any of the correlation

[43] For details, see Appendix A4.

assumptions from this broad range, diversification benefits are modest. Expected benefits likely fall in the 5% to 10% range.[45]

Second, across the range of estimates, the largest diversification benefits stem from combining a bank with a P&C insurer. This follows because credit risk (the dominant risk in banking) is uncorrelated with catastrophe risk (the dominant risk in P&C).

Third, relative size matters. The biggest bang for the diversification buck comes from combining risks of equal size. Moving from an equally weighted Bank-P&C group, for example, to a 70% bank – 30% P&C combination reduces the diversification effects by about five percentage points on average.

3.8. The Fallacy of Composition

As noted above, the diversification effects estimated through the building block approach reflect an *economic* view of risk aggregation, in which risks are first aggregated within a single risk factor; then within a business line; and then across business lines at the level of the conglomerate. This approach to risk aggregation isolates the *incremental* effect of diversification across business lines. It also corresponds to the way risk and capital is managed at the group level in leading banking-insurance groups.

Ultimately, the total amount of economic risk at the top of an organization is independent of how risks are aggregated within it. However, to the extent that risks are added differently at each of the three levels above, then the magnitude of the diversification effects at those levels will also differ. This is best illustrated with an insurance example in Figure 10. Insurance companies tend to be broken down

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[44] If a bar is missing, the diversification benefits are near zero. The results differ somewhat from KSW due to slight differences in standalone risk specification.

[45] There is an effect that may tend to reduce capital requirements at Level III beyond the potential for diversification. Certain risks could actually be offsetting in different subsidiaries, e.g., if one subsidiary is "long" the risk and the other subsidiary is "short" the risk. This could lead to a net reduction in the particular risk factor. Although theoretically possible, the only major risk for which an offset is likely to occur is interest rate risk between banks and insurance companies. The magnitude of this effect will depend on a number of factors, including the size of the bank asset/liability mismatch gap and the insurance investment portfolio mix. For other major risk factors, banks and insurance subsidiaries are each likely to be long the risk.

by geography and product line into a number of operating subsidiaries, each of which is separately capitalized under local law (Chart A). In many cases, the operating subsidiaries carry their own ratings in terms of default and policyholder protection. Historically, this has made centralized risk and capital management less of a pressing issue for insurance companies than for banks. However, the trend currently is increasingly towards centralization, especially for large, globally active insurers and more particularly for financial conglomerates, which require this centralized view of risk and capital (Joint Forum (2001b), and Wang (2002)).

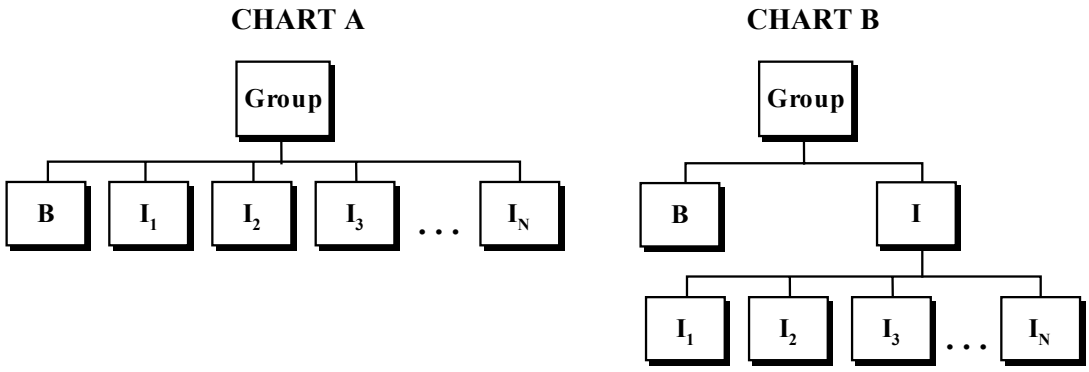

Figure 10: Fallacy of Composition

The figure above describes two possible structures for a conglomerate. They differ in the way the insurance subsidiaries are aggregated at Level II. If the insurance subsidiaries are *not* aggregated into one business line at Level II (Chart A), then the *perceived* aggregation benefits from Level II to III could be greater than the 0-12% range reported above, simply because there are a greater number of small businesses at Level II.[46] But this is an artifact of organizational structure; the amount of risk and the cross-business line diversification effects do not differ by moving to Chart B, where the insurance subsidiaries are first aggregated into one insurance line. To be sure, there is nothing to prevent management from also splitting up the banking line into many individual subsidiaries at Level II.[47] Obviously this would not change the amount of risk or cross-business diversification effects either.

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[46] It is not uncommon for large insurers to have well over 50 separate subsidiaries.
[47] An extreme case would be if each bank branch were a distinct subsidiary and separately capitalized.

In practice, the diversification potential for insurance subsidiaries located in different geographies and hence capitalized (and regulated) separately is often not exhausted prior to Level III aggregation. But the problem here is that the standalone insurance capital requirements fail to take account of the level of diversification already present within the insurance "silo." It is not a feature of cross-business line diversification associated with a conglomerate.

The "fallacy of composition " – or the sensitivity of perceived diversification benefits to how risk units are added within an organization – drives home a central point: Given the myriad ways in which a financial conglomerate can be structured, the only valid method for aggregating risks is one that is based on underlying risk fundamentals, such as the economic capital approach, and is independent of legal structure.[48]

3.9. Compounding Risk and Model Mis-Specification

The diversification effects estimated above also underscore a basic tenet of portfolio theory: the risk of the whole cannot be greater than the sum of the parts.[49] *Provided standalone risks are correctly measured,* this means that the economic capital for a conglomerate cannot exceed the total standalone economic capital of the individual business units.[50] Concern that combining businesses within a single entity can somehow increase, rather than reduce, total capital is really a concern about mis-specification of risks at lower levels. For example, in the case of Long Term Capital Management, there was a compounding exposure to credit spread risk, as positions in different trading books were aggregated (Jorion (2000), Lowenstein (2000)).[51] But the fundamental problem was that the underlying risk estimates for individual positions were mis-specified since they failed to account of the potential for extreme credit spread movement. Ultimately, no method of risk aggregation can overcome mis-

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[48] Legal requirements will, however, imply restrictions on the use of capital and assets within a conglomerate.
[49] Cumming and Hirtle (2001) argue that the spillover effects resulting from reputational risks may result in this inequality not necessarily holding.
[50] Some have argued that the whole may actually be riskier than the sum of the parts (Santomero and Eckles (2000), and Wilmart (2001)), due to reputation and spillover effects.
[51] See also Jarrow and Turnbull (2000), for sound arguments why it is very difficult to cleanly separate market and credit risk.

specification of underlying risks. The best antidote to mis-specification is to stress the model parameters and supplement traditional analysis with scenario testing across a wide range of market movements.[52]

Indeed the industry is placing greater importance on stress testing and scenario analysis to explore the edges of the risk space for the very reason that the models are almost always estimated with data dominated by "normal" times (BCGFS (2001)). Yet risk managers care disproportionately about the "non-normal" times, i.e., the tails and not the middle of the distributions. This is the risk manager's dilemma: she understands the unimportant part of the loss (or value change) distribution quite well but not the part which really matters to her, namely the tails. With the current state of the art this can only be characterized through stress testing and scenario analysis.[53]

3.10. Time Horizon

Another challenge of evaluating risk within a conglomerate is specifying a uniform time horizon (Joint Forum (2001b), Wilmarth (2001)). At one end of the spectrum, market risk is typically measured on a daily basis and scaled up to ten days for capital requirements under Basel. Credit risk is typically calibrated to a one year horizon, as is operational risk. In banks, the convention for modeling risks and assessing capital is to adopt a one-year horizon. The logic to a one-year horizon is that it typically ties to reported business line P&Ls, corresponds to the internal capital allocation and budgeting cycle, and is a period in which an institution can access the markets for additional capital. It is also the horizon used in the New Basel Accord (BCBS (2001)). Alternatively, insurance companies are often capitalized for longer decision horizons (Webb and Lilly (1994)). This is particularly true for life insurers, where the obligation to policyholders is unique and often extends to 30+ years.

In our approach, in order for economic capital to serve as a 'common currency' for risk, a common time horizon needs to be specified. We adopt a one-year perspective rather than a longer-term

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[52] See, for instance, Berkowitz (2000).
[53] See, for instance, the collection of papers in Embrechts (2000).

view – which is the dominant practice within banking-insurance groups (Joint Forum (2001b), and CMRA (2001)).

4. Industry Practices

While the previous section provided a foundation for evaluating the risk profile and aggregation effects of a financial conglomerate, this section highlights industry practices for risk modeling and capital management within conglomerates. These trends are important for defining the "world of the possible" for policy reform.

Perhaps the most important trend, as noted by the Joint Forum (2001b), is that internationally active financial institutions are adopting economic capital as the fundamental measure of risk. This is true of major banking-insurance groups, which have either implemented, or are in the process of implementing, economic capital frameworks across both banking and insurance business lines. Our earlier study (KSW) confirmed that all of the major banking-insurance groups in the Netherlands are adopting economic capital as the cornerstone of an integrated risk and capital management framework. The economic capital framework allows for consistent measurement of risk factors across both banking and insurance lines. It also addresses risk aggregation at successive levels in an organization, through internal models that are sensitive to differences in risk profile and business mix.

Yet risk modeling and measurement is only relevant to the extent that it drives management decision making. The corollary is that the structure of risk modeling and measurement needs to reflect both management processes and organization structure.(see inter alia Crouhy, Galai and Mark (2001) and Hendricks and Hirtle (1997)).

Financial conglomerates are building up group risk and capital management functions to oversee capital planning and decision making at the holding company level (Joint Forum (2001b)). This trend overcomes significant differences in the evolution of capital management for banks and insurance companies. Banks historically expanded through branching. Branching, in turn, depends on a single

balance sheet with centralized capital resources. When a bank entered a new market it typically did so on the strength of the capital resources at the head office. This created a natural need for centralized risk and capital management in banking organizations.

Insurance companies, by contrast, typically expanded either by starting up or acquiring new subsidiaries – whether in adjacent product lines, or in new geographic markets. Each of the subsidiaries, in turn, was subject to separate, standalone capital or reserving requirements, independent of the parent. As a result, insurance companies tended to be locally capitalized – in many cases, with operating subsidiaries rated separately in terms of debt and policyholder protection. Historically, this made centralized risk and capital management less of a pressing issue for insurance companies than for banks.

Notwithstanding these differences, internationally active financial conglomerates – including banking-insurance groups – are putting in place centralized risk and capital management units. The dominant approach is to adopt a 'hub and spoke' organizational model that corresponds to the three levels of risk modeling and measurement identified previously.

At Levels I and II are the spokes, which are responsible for risk management within business lines. Examples of activities at the spoke include the credit function within a bank, or the actuarial function within an insurance subsidiary or group, each of which serves as the front-line managers for most transaction decision making. Level II risk management – across risk factors within a business line – also typically takes place in the spokes, often in a finance unit that is responsible for funding and business reporting for the subsidiary.

At Level III is the hub, which provides centralized oversight of risk and capital at the Group level. While the hub is dependent on risk reporting from Levels I and II, in many cases it is also responsible for overseeing the methodology development of an integrated economic capital framework that is then implemented within the spokes (Joint Forum (2001b)). The specific roles of the hub vary, but tend to include assuming responsibility for Group-level risk reporting; participating in decisions about Group capital structure, funding practices, and target debt rating; liaising with regulators and

rating agencies; advising on major risk transfer transactions, such as CLOs (collateralized loan obligations) and securitizations; and, in some institutions, actively managing the balance sheet.

The 'hub and spoke' system is both a reflection of – and a reinforcement of – the importance of economic capital modeling. Risk measures, as manifested by internal economic capital models, increasingly drive management decisions, not just for loss prevention but for business optimization through efficient capital management. The group capital structure considers disparities in the different kinds of capital: Accounting capital vs. economic capital vs. regulatory capital vs. rating agency capital. As there is no single view on the relevant measure of capital, the group's task is to balance the requirements of different constituencies (regulators, shareholders, debtholders, rating agencies) with efficient yet prudent capital management.[54]

The net effect is increasingly proactive management of risk, capital and value in conglomerate companies, both within business lines and at the group level. It strongly suggests a need for regulation to keep pace with internal developments and market structure.

5. Policy Discussion

So how should one interpret our analytical results? A naive interpretation would be that since Level III diversification effects are small, silo regulation is adequate and capital at the holding company level should simply be the sum of the parts. This would suggest that the de-consolidation approach taken in the New Basel Capital Accord (BIS II) is essentially correct – that insurance company capital should be subtracted, dollar for dollar, from holding company capital for a predominantly banking group. This is the equivalent of saying that holding company capital must equal banking capital plus insurance company capital.

A more nuanced interpretation of our results, however, would be that the naive interpretation is only correct if diversification effects are already fully captured at Levels I and II. But we know that is

[54] See also Berger, Herring Szegö (1995).

not the case with existing regulatory measures: Rules-based capital measures at both levels are based on a "lowest common denominator" approach that assumes an average level of correlation within a single risk factor and ignore cross-risk factor diversification at the business line level. As an example, consider the proposed credit risk capital rules under BIS II. The Level I capital requirements for credit risk under the internal ratings-based approaches assume just a single correlation factor for all commercial and industrial loan portfolios. Similarly, for the bank, the Level II requirements for credit, market, and operational risk will simply be added together, with no offset for cross-risk factor diversification. A key point is that capital regulation at Level III can be no more accurate than the standalone measures on which it is based.

Given the inherent limitations of existing regulatory measures at Levels I and II, a better approach to capital regulation for conglomerates would be to adopt a more supervision-intensive approach such as that contemplated by BIS II's second pillar. Such an approach would require conglomerates to put in place their own economic capital models for assessing risk and capital at successive levels. These customized models are the only real hope of being able to capture the complexity of diversification at all levels within a conglomerate.

In advocating new policy, we are not starting with a clean slate. The reality is that the regulation of financial conglomerates is rooted firmly in the silo approach described above. Any new policy proposal focused on addressing some of the unique problems of a multi-line financial conglomerate will have to reflect the very different starting points and traditions of banking, insurance, and securities capital regulation. In short, the silo approach is here to stay, at least for the foreseeable future.

Estrella (2000) provides a thoughtful discussion of the difficulties and trade-offs encountered in design of regulation for financial institutions. They include the different goals and objective functions of the different constituencies (see top of Figure 1, for instance); the desire for simplicity (emphasis on

rules) and flexibility (emphasis on supervision); at the same time we want to allow for market forces to provide a powerful monitoring and correction mechanism.[55]

The framework of the New Basel Accord is partly motivated to strike a balance among these apparently competing forces. We think the main issues surrounding risk measurement and management in a financial conglomerate can fit within that framework of the New Basel Accord, perhaps with renewed emphasis on legal firewalls as a possible structural response to contagion of risks across distinct entities. This proposal is summarized in Table 6 as a '3+1' pillars:

I: Rules	II: Supervision	III: Market Mechanisms	IV: Legal Firewalls
• Specific minimum capital requirements • Lowest common denominator • Imposed by regulator • Non-discretionary, non-judgmental	• Review of internal capital approach • Institution-specific • Internally driven • Flexible	• Market evaluation of capital adequacy • Aggregate judgment of multiple views • Externally driven • Limited to publicly disclosed information	• Legal mechanism for separating risks • Jurisdiction & institution specific • Recognized under law • Both statutory and contractual

Table 6: Proposed '3+1' Pillar Framework

The '3+1' pillars would combine rules-based, supervisory-based and market-based approaches to capital regulation with legal mechanisms. Importantly, the pillars are designed to be mutually reinforcing; no one pillar by itself is sufficient.

The first pillar would incorporate specific, rules-based minimum capital requirements for a conglomerate at the holding company level. Given the findings on the magnitude of Level III aggregation effects, a simple rule-based approach to capital adequacy would be to add up the individual capital requirements for regulated subsidiaries at the parent holding company level, without any offset

[55] Estrella (2000) and Santos (2001) stress that risk and capital are hard to determine in the presence of safety net such as deposit insurance, and that the two design problems (capital adequacy, deposit insurance) should be addressed simultaneously (Santos (2001)).

for diversification. While this would tend to overcapitalize the conglomerate to some extent, the degree of overcapitalization attributable to cross-business line diversification is likely to be small – on the order of 5-10%.[56] The incremental capital might be justified as compensating for the increased complexity of a multi-line financial conglomerate, for measurement and modeling error at Levels I and II, or alternatively, as imposing a somewhat higher solvency standard for a conglomerate.

The second pillar, however, should be the main load-bearing column of the regulatory framework. In the words of Estrella (1998, p. 192), this pillar would allow regulators to reap "the benefits of informed supervision. Mechanical formulas may play a role in regulation, but they are in general incapable of providing a solution to the question of how much capital a bank should have. At the margin, scarce public resources are better employed to enhance supervision than to develop new formulas whose payoff may be largely illusory." Especially for a large, complex conglomerate, the supervisory review is likely to be far more important than the rule-based approach. It would enable the supervisor to evaluate the adequacy of an institution's internal risk management and capital decision processes along a number of dimensions. Importantly, this pillar should be a flexible approach that allows for differences across institutions. Such differentiation is necessary to accommodate variations in business mix, risk profile, legal structure, and level of sophistication.

The third pillar would leverage market judgements on capital adequacy. In the end, the market's judgement of capital for the holding company (and potentially individual subsidiaries) will be decisive, through its influence on pricing and access to funding. While it is attractive from a theoretical standpoint to place great weight on the market's consensus, in practical terms there are too many limitations in current accounting conventions and disclosure standards for this pillar to be sufficient on its own. Similar to the sentiment expressed by the Basel Committee in BIS II, our recommendation is

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[56] A 5-10% difference in capital is likely within the tolerance range for capital planning, and is unlikely to prompt specific management action. This is especially true since regulatory capital for major financial conglomerates is a floor – and often non-binding. The capital ratios for banks in G10 countries, for example, currently average 11.2%, or 40% above the 8% (Tier I plus Tier II) regulatory requirements. The recent Joint Forum survey (2001b, p. 53) found that banks typically operate with capital levels between 1.3 and 1.8 times required capital, securities

that regulators encourage improved accounting rules and better disclosure of the risk and financial structure of a conglomerate, to enable the market to do its job better.[57]

The fourth pillar – legal firewalls – is a possible structural response to contagion of risks. Legal firewalls might be appropriate for a 'mixed conglomerate' that combines both financial and unlicensed commercial subsidiaries. In practice, there is a very broad range of non-financial subsidiaries that are owned by or affiliated with financial conglomerates. Given the difficulty of evaluating the capital requirements for such a broad array of businesses, an alternative might be to segregate the risks of these activities from the financial activities in a conglomerate. They could be erected by requiring that non-financial subsidiaries be separately capitalized, and by preventing inter-company funding of the subsidiary and cross-company guarantees. Such barriers might not fully mitigate against reputation risk, but they should go a long way toward limiting financial contagion.

The specifics around legal firewalls – what exactly are they? how will they be enforced? – are very important and complex, but well beyond the scope of this paper. We simply want to propose for discussion a possible solution to an obviously complex problem, namely that of assessing capital for unlicensed commercial (i.e. non-financial) subsidiaries.

Our proposed '3+1' framework will inevitably require more detailing – and debate – both within the regulatory community and among other constituencies. We look forward to the exchange.

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firms from 1.2 to 1.3 times the warning level (defined below as 5 percent of aggregate debit items) and insurance companies more than 5 times required capital.

[57] To be sure, financial institutions are particularly opaque, making assessments by delegated monitors such as rating agencies and equity analysts more difficult. Indeed Morgan (2002) measures this opacity by showing that bond raters disagree more about banks and insurance companies than about any other kind of firm.

Appendix

A4. Economic Capital Calculation

One of the fundamental technical hurdles in risk measurement for a financial conglomerate, indeed for any financial firm, is the aggregation of a diverse set of risks. Just how diverse these risks can be is illustrated by Figure 2. Typically the risk manager has some knowledge of the marginal distribution of each risk type (as is indeed illustrated in Figure 2) is interested in the joint distribution, i.e. the distribution of all risks together. Aggregating these risks is technically quite challenging; a full treatment is beyond the scope of this paper. Below we give some detail of our rather simplified approach as well as provide some pointers to more sophisticated alternatives.

A4.1. A Simplified Gaussian Approach

Our aggregations to overall economic capital are done using a highly simplified approach to illustrate some of the main issues. We assume that all risks are jointly normally distributed. This allows very straight forward calculation of the risks. Specifically, given the standalone levels of economic capital by risk type and their correlations as described in Section 3.6, we may compute aggregate economic capital in the following way (1):

$$EC_T = \sqrt{\begin{pmatrix} EC_1 \\ EC_2 \\ \vdots \\ EC_N \end{pmatrix}' \begin{pmatrix} 1 & \rho_{12} & \cdots & \rho_{1N} \\ \rho_{21} & 1 & \cdots & \rho_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{N1} & \rho_{N2} & \cdots & 1 \end{pmatrix} \begin{pmatrix} EC_1 \\ EC_2 \\ \vdots \\ EC_N \end{pmatrix}} \tag{1}$$

EC_T is the aggregate economic capital taking diversification effects into account. At a given level of aggregation, the diversification benefit is simply one minus the ratio of aggregate economic capital to the sum of the standalone economic capital.

$$DB = 1 - \frac{EC_T}{\sum_{i=1}^{N} EC_i} \tag{2}$$

For each of the diversification computations, we considered *N* different portfolios whose stand-alone risks add up to one. Considering the Level I aggregation through geographic diversification example (Figure 4), we consider four different portfolios whose stand-alone risks add up to one. That is, on a non-diversified basis, each geographic piece has a given amount of risk, and the sum of those risks is the non-diversified risk. We normalize to one, so that in the US.-only case, the US portfolio has one unit of risk, in the US-UK portfolio, each has 0.5 units of risk, etc. We then allow for the correlation across these risks to yield a diversified measure of risk relative to the non-diversified unit portfolio. For Level III we follow the same logic (Figure 9) by allowing each conglomerate profile to consist of a unit amount of non-diversified risk across the possible business units within the profile. We then allow for correlations across the various business activities within these business units to diversify some of the risk away. The result is the decrease in risk relative to the standalone risk in each individual profile.

A4.2. More Advanced Approaches

The insurance and finance literature have developed risk measurement methods in parallel fashion, and these lines of research have only recently crossed. One method in particular holds great promise: the computation of the joint distribution using copulas. A copula is a function that links the marginals to the joint distribution. Beyond allowing for the aggregation of diverse marginal distributions which capture some of the essential features found in risk management, like fat tails, for example, copulas also allow for richer dependence structure than allowed for by simple models like the multivariate normal. For a review of the theory, see Nelsen (1998). Embrechts, McNeil and Straumann (1999, 2002) were among the first to introduce this toolkit to the finance literature. Li (2000) provides an application to credit risk and credit derivatives. Wang (1999, 2002) proposes an application to insurance with particular emphasis to enterprise-wide risk management (Wang, 2002). Ward and Lee (2002), for example, use a Gaussian copula to aggregate diverse set of risks to arrive at the joint

distribution for a diversified insurer. These methods are now being put to the test, and we eagerly anticipate their reported performance.

A2. Level III Calculations

For computing diversification benefits at Level III, combining a universal bank and insurance company, we used correlations from different sources: KSW, Dimakos and Aas (2002), Ward and Lee (2002) and Estrella (2001). The basic idea is to produce a set of diversification benefit scenarios using correlations from different studies to help us understand the possible range of outcomes. Correlations for the first three are reproduced in Table 7 below. The Estrella scenario simply used his correlations as reported in Estrella (2001, Table 9).

The correlation matrix has a block structure, with the major blocks being (universal) banking, comprising commercial banking and a securities firm, and insurance. In addition there may be an entity labeled "other" which may be thought of as a commercial subsidiary. This came into play in only one scenario (see Table 5 in Section 3.7). When the inter-sector (banking/insurance) correlations between risk types were not available, we simply reduced the within sector risk type correlations by 10%. One may view this "haircut" to be conservative, but not knowing otherwise we thought it reasonable to be prudent. Moreover as will become clear, the correlations from the different studies do have a wide range, from very low correlations found in Ward and Lee (2002) to the higher ones in KSW.

Table 7: Level III Correlations

1. KSW

		BANKING					INSURANCE							OTHER
		Credit	*Market*	*ALM*	*Business*	*Event*	*Credit*	*Market*	*ALM*	*Business*	*Event*	*P&C*	Life & H	Business
BANKING	*Credit*	100%	80%	80%	70%	10%	90%	80%	80%	70%	10%	20%	10%	10%
	Market	80%	100%	80%	70%	10%	80%	90%	80%	70%	10%	20%	10%	10%
	ALM	80%	80%	100%	70%	10%	80%	80%	90%	70%	10%	20%	10%	10%
	Business	70%	70%	70%	100%	10%	70%	70%	70%	80%	10%	20%	10%	10%
	Event	10%	10%	10%	10%	100%	10%	10%	10%	10%	40%	10%	10%	10%
INSURANCE	*Credit*	90%	80%	80%	70%	10%	100%	80%	80%	70%	10%	20%	10%	10%
	Market	80%	90%	70%	70%	10%	80%	100%	80%	70%	10%	20%	10%	10%
	ALM	80%	70%	70%	80%	10%	80%	80%	100%	70%	10%	20%	10%	10%
	Business	70%	70%	70%	80%	10%	70%	70%	70%	100%	10%	20%	10%	10%
	Event	10%	10%	10%	10%	40%	10%	10%	10%	10%	100%	10%	10%	10%
	P&C	20%	20%	20%	20%	10%	20%	20%	20%	20%	10%	100%	10%	10%
	Life& Health	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%	10%
OTHER	Business	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

2. Dimakos & Aas plus KSW

		BANKING					INSURANCE							OTHER
		Credit	*Market*	*ALM*	*Business*	*Event*	*Credit*	*Market*	*ALM*	*Business*	*Event*	*P&C*	Life & H	Business
BANKING	*Credit*	100%	30%	30%	44%	44%	90%	80%	80%	70%	10%	20%	10%	10%
	Market	30%	100%	80%	13%	13%	80%	90%	80%	70%	10%	20%	10%	10%
	ALM	30%	80%	100%	13%	13%	80%	80%	90%	70%	10%	20%	10%	10%
	Business	44%	13%	13%	100%	10%	70%	70%	70%	80%	10%	20%	10%	10%
	Event	44%	13%	13%	10%	100%	10%	10%	10%	10%	40%	10%	10%	10%
INSURANCE	*Credit*	90%	80%	80%	70%	10%	100%	80%	80%	70%	10%	20%	10%	10%
	Market	80%	90%	70%	70%	10%	80%	100%	80%	70%	10%	20%	10%	10%
	ALM	80%	70%	70%	80%	10%	80%	80%	100%	70%	10%	20%	10%	10%
	Business	70%	70%	70%	80%	10%	70%	70%	70%	100%	10%	20%	10%	10%
	Event	10%	10%	10%	10%	40%	10%	10%	10%	10%	100%	10%	10%	10%
	P&C	20%	20%	20%	20%	10%	20%	20%	20%	20%	10%	100%	10%	10%
	Life& Health	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%	10%
OTHER	Business	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

Cells colored salmon in the banking sub-matrix are from Dimakos & Aas; all other cells from KSW.

3. Dimakos & Aas plus Ward & Lee

		BANKING					INSURANCE							OTHER
		Credit	*Market*	*ALM*	*Business*	*Event*	*Credit*	*Market*	*ALM*	*Business*	*Event*	*P&C*	Life & Health	Business
BANKING	*Credit*	100%	30%	30%	44%	44%	90%	27%	27%	40%	40%	0%	0%	10%
	Market	30%	100%	80%	13%	13%	27%	90%	72%	12%	12%	0%	0%	10%
	ALM	30%	80%	100%	13%	13%	27%	72%	90%	12%	12%	18%	0%	10%
	Business	44%	13%	13%	100%	10%	40%	12%	12%	90%	9%	18%	9%	10%
	Event	44%	13%	13%	10%	100%	40%	12%	12%	9%	90%	9%	9%	10%
INSURANCE	*Credit*	90%	27%	27%	40%	40%	100%	20%	30%	20%	10%	0%	0%	10%
	Market	27%	90%	72%	12%	12%	20%	100%	20%	20%	10%	0%	0%	10%
	ALM	27%	72%	90%	12%	12%	30%	20%	100%	20%	10%	20%	0%	10%
	Business	40%	12%	12%	90%	9%	20%	20%	20%	100%	10%	20%	20%	10%
	Event	40%	12%	12%	9%	90%	10%	10%	10%	10%	100%	10%	10%	10%
	P&C	0%	0%	18%	18%	9%	0%	0%	20%	20%	10%	100%	0%	10%
	Life& Health	0%	0%	0%	9%	9%	0%	0%	0%	20%	10%	0%	100%	10%
OTHER	Business	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

Cells colored salmon in the banking sub-matrix are from Dimakos & Aas; cells in the insurance sub-matrix are from Ward & Lee. Correlations across business lines are given a 10% haircut from their within-line correlations. Thus banking market risk has a 30% correlation with banking credit risk but only a 27% correlation with insurance market risk.

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